



# 3.7.1.1: Total number of Collaborative activities per year for research/ faculty exchange/ student exchange/ internship/ on-the-job training/ project work

| S.<br>No                  | Name of the participant     | Duration   | Nature of the activity | Page No |
|---------------------------|-----------------------------|--|------------------------|---------|
| 750                       | Talla Rakesh                | 18-03-22 to 18-<br>05-22 (8 Weeks)                   | Internship             | 10      |
| 751                       | Mr.Naveen Viparthi          | 17-04-2022 TO<br>16-05-2022 (4<br>Weeks)             | Internship             | 11      |
| 752                       | Ms Munukuntla Hrithika Goud | 0103-2022 TO<br>15-04-2022(6<br>Weeks)               | Internship             | 12      |
| 753                       | Ms Puli Pavitra             | 01-03-2022 TO<br>15-04-2022(6<br>Weeks)              | Internship             | 13      |
| 754                       | Tanupally Snehitha          | 18-03-2022 To<br>18-05-2022 (8<br>Weeks)             | Internship             | 14      |
| 755                       | Medikonda Yamini            | 21-03-2021 To  |                        | 15      |
| 756                       | Medam Chinni Kalyan         | 04-03-2022 To<br>30-06-2022 (8<br>Weeks)             | Internship             | 16      |
| 757                       | Mr Gopi Sainath M           | 14-02-2022 To<br>14-05-2022 (12 Internship<br>Weeks) |                        | 17      |
| 758                       | Nigamananda Janjanam        | 21-03-2022 To<br>21-05-2022 (8<br>Weeks)             | Internship             | 18      |
| 759                       | Pinjarla Pranav             | 3 Weeks  | Internship             | 19      |
| 760                       | Mr Rohan Yallamanchili      | 8 Weeks  | Internship             | 20      |
| 761 Mr Rohith Reddy Katta |                             | 14-02-2022 To<br>14-05-2022 (12<br>Weeks)            | Internship             | 21      |
| 762                       | Mr Sai Ganesh Gunda         | 16-03-2022 To<br>16-05-2022 (8<br>Weeks)             | Internship             | 22      |
| 763                       | Shashreek reddy Mallem      | 14-02-2022 To<br>30-06-2022 (18<br>Weeks)            | Internship             | 23      |
| 764                       | Shaik Sayeed                | 22-01-2022 To<br>22-06-2022 (20<br>Weeks)            | Internship             | 24      |

#### 2021-22 INDEX

Principal Chaitanya Bharathi Institute of Technology (Autonomous) Gandipet, Hyderabad-500-075,

| S.<br>No | Name of the participant             | Duration  | Nature of the activity | Page No. |
|----------|-------------------------------------|---|------------------------|----------|
| 765      | Mr Summet Mekala                    | 16-03-2022 To<br>16-05-2022 (8                      | Internship             | 25       |
| 766      | Mr Boniti Umesh Chandra             | Weeks)  |                        |          |
| 700      | ivit Boniti Offesti Chandra         | 54 Weeks  | Internship             | 26       |
| 767      | Ms Mamidi Rani                      | 01-03-2022 To<br>15-04-2022 (6<br>Weeks)            | Internship             | 32       |
| 768      | Ms Gontu Samhitha Reddy             | 01-03-2022 To<br>15-04-2022 (6<br>Weeks)            | Internship             | 34       |
| 769      | Mr Peguda Sree nandini              | 04-03-2022 To<br>30-06-2022 (16<br>Weeks)           | Internship             | 35       |
| 770      | Aravindam Vigayender G              | 14-03-2022 To<br>13-04-2022 (4<br>Weeks)            | Internship             | 36       |
| 771      | Manas Jain                          | Aug 10 2022   | Internship             | 37       |
| 772      | Mr Syed Zuhair Ahmed                | 07-04-2021 To<br>30-05-2021 (8<br>Weeks)            | Internship             | 38       |
| 773      | Mr Venkata Koushik<br>BakkaMunthala | 01-04-2022 To<br>30-04-2022 (4<br>Weeks)            | Internship             | 39       |
| 774      | MR ANNAPUREDDY<br>YASHPALKUMARREDDY | 02-03-2022 To<br>01-04-2022 (4<br>Weeks)            | Internship             | 40       |
| 775      | T Shiva Goud                        | 25-01-2022 To 6-<br>8-2022 (18<br>Weeks)            | Internship             | 41       |
| 776      | Mr Kukadapu PrithviRaj Singh        | 21-02-2022 То                                       |                        | 42       |
| 777      | Ms Veeram Reddy Bhavana             | 23-07-2022 To<br>07-08-2022 (2<br>Weeks)            | Internship             | 43       |
| 778      | Chandra Eepsita Jasty               | 04-05-2022 To<br>18-05-2022 (6<br>Weeks)            | Internship             | 44       |
| 779      | P Deepa                             | 07-03-2022 To<br>07-04-2022 (4<br>Weeks)            | Internship             | 45       |
| 780      | PRODDUTURI DEEPA                    | 01-06-2022 To<br>08-07-2022 (5<br>Weeks)            | Internship             | 46       |
| 781      | PRODDUTURI DEEPA                    | 20-7-2022 To 6-8-<br>2022 (2 Weeks) Internship      |                        | 47       |
| 82       | G NAVYA                             | 07-03-2022 To<br>07-04-2022 (4<br>Weeks)            | Internship             | 48       |
| 83       | GAJULA NAVYA                        | 04-06-2022 To<br>02-07-2022 (4 Internship<br>Weeks) |                        | 49       |
| 84       | E.PRANITHA RAJ                      | 25-04-2022 To<br>09-04-2022 (2                      | Internship             | 50       |

-78 7.0 Principal Chaitanya Bharathi Institute of Technology

(Autonomous)

2

| S.<br>No | Nome of the states   | Duration                                  | Nature of the activity | Page No |
|----------|----------------------|---|------------------------|---------|
|          |                      | Weeks)                                    |                        |         |
| 785      | P.PRAVALLIKA         | 25-04-2022 To<br>09-04-2022 (2<br>Weeks)  | Internship             | 51      |
| 786      | P.PRAVALLIKA         | 16-07-2022 To<br>29-07-2022 (2<br>Weeks)  | Internship             | 52      |
| 787      | N.SATVIKA            | 25-04-2022 To<br>09-04-2022 (2<br>Weeks)  | Internship             | 53      |
| 788      | MENDE SHREYA         | 01-07-2022 To<br>16-07-2022 (2<br>Weeks)  | Internship             | 54      |
| 789      | BIKKINENI AJITH RAO  | 20-7-2022 To 6-8-<br>2022 (2 Weeks)       | Internship             | 55      |
| 790      | S.DEEPAK REDDY       | 29-06-2022 To<br>31-07-2022 (5<br>Weeks)  | Internship             | 56      |
| 791      | S.DEEPAK REDDY       | 6 Weeks                                   | Internship             | 57      |
| 792      | S.DEEPAK REDDY       | 6 Weeks                                   | Internship             | 58      |
| 793      | S.DEEPAK REDDY       | 22-05-2022 To<br>03-07-2022 (6<br>Weeks)  | Internship             | 59      |
| 794      | S.DEEPAK REDDY       | 01-07-2022 To<br>12-08-2022 (6<br>Weeks)  | Internship             | 60      |
| 795      | S.DEEPAK REDDY       | 8 Weeks                                   | Internship             | 61      |
| 796      | S.DEEPAK REDDY       | 8 Weeks                                   | Internship             | 62      |
| 97       | S.DEEPAK REDDY       | 16-07-2022 To<br>27-08-2022 (6<br>Weeks)  | Internship             | 63      |
| 98       | SHRI DIVIJ           | 13-03-2022 To<br>26-07-2022 (19<br>Weeks) | Internship             | 64      |
| 99       | C.HAVISH RAG         | 04-05-2022 To<br>18-05-2022 (2<br>Weeks)  | Internship             | 65      |
| 00       | C.HAVISH RAO         | 29-06-2022 To<br>31-07-2022 (4<br>Weeks)  | Internship             | 66      |
| 01       | C.HAVISH RAO         | 06-07-2022 To<br>26-07-2022 (3<br>Weeks)  | Internship             | 67      |
|          | HEMANTH YADAV POMKOM | 06-7-2022 To 05-<br>08-2022 (4<br>Weeks)  | Internship             | 68      |
| 03       | HEMANTH YADAV POMKOM | 12 Weeks                                  | Internship             | 69      |
| 04       | HEMANTH YADAV POMKOM | 15-07-2022 To<br>30-07-2022 (2<br>Weeks)  | Internship             | 70      |
| 05       | KETAN KADALI         |   | Internship             | 71      |

O.ArinE 3

Principal Chaitanya Bharathi Institute of Technology (Autonomous) Gandipet, Hyderabad-500 075

3

| S.<br>No | Name of the participant      | Duration                                       | Nature of the activity | Page No. |
|----------|------------------------------|--|------------------------|----------|
| 806      | B.KOUSHIK RAJA VAMSI<br>GOUD | 29-06-2022 To<br>31-7-2022 (4<br>Weeks)        | Internship             | 72       |
| 807      | B.KOUSHIK RAJA VAMSI<br>GOUD | 06-07-2022 To<br>26-07-2022 (3<br>Weeks)       | Internship             | 73       |
| 808      | SRI MAHESH KUMAR             | 13-03-2022 To<br>26-07-2022 (19<br>Weeks)      | Internship             | 74       |
| 809      | SRI MAHESH KUMAR             | 15-07-2022 To<br>30-07-2022 (2<br>Weeks)       | Internship             | 75       |
| 810      | NIKHIL GATTU                 | 23-10-2022 To<br>31-10-2022 (1<br>Week)        | Internship             | 76       |
| 811      | NIKHIL GATTU                 | 23-08-2021 To<br>21-09-2021 (4<br>Weeks)       | Internship             | 78       |
| 812      | NIKHIL KUMAR NALLA           | 12 Weeks                                       | Internship             | 79       |
| 813      | NIKHIL KUMAR NALLA           | 23-06-2022 To<br>07-07-2022 (2<br>Weeks0       | Internship             | 80       |
| 814      | PRAJEET GOUD                 | 15-07-2022 To<br>30-07-2022 (2<br>Weeks)       | Internship             | 81       |
| 815      | PRAJEET GOUD                 | 1 Week   | Internship             | 82       |
| 816      | RACHKONDA SAI KIRAN          | 28-6-2022 To 12-<br>7-2022 (2 Weeks)           | Internship             | 83       |
| 817      | RACHKONDA SAI KIRAN          | 19-7-2022 To 02-<br>8-2022 (2 Weeks            | Internship             | 84       |
| 818      | N.SAI.VAMSHI                 | 29-06-2022 To<br>31-7-2022 (4<br>Weeks)        | Internship             | 85       |
| 819      | N.SAI.VAMSHI                 | 05-6-2022 To 25-<br>6-2022 (3 Weeks)           | Internship             | 86       |
| 820      | Redabothu Saketh Reddy       | 30-6-2022 To 14-<br>07-2022 (2<br>Weeks)       | Internship             | 92       |
| 821      | Redabothu Saketh Reddy       | 16-7-2022 To 29-<br>7-2022 (2 Weeks)           | Internship             | 93       |
| 822      | Redabothu Saketh Reddy       | 01-6-2022 To 8-7-<br>2022 (5 Weeks)            | Internship             | 94       |
| 823      | Ayaluri Sasi Kiran           | 27-7-2022 To 16-<br>08-2022 (3 Weeks           | Internship             | 95       |
| 324      | Ayaluri Sasi Kiran           | 04-6-2022 To 02-<br>7-2022 (4 Weeks)           | Internship             | 96       |
| 325      | Ayaluri Sasi Kiran           | 06-7-2022 To 26-<br>7-2022 (3 Weeks Internship |                        | 97       |
| 326      | Gandham Shanmukha Swaroop    | 06-7-2022 To 26-<br>7-2022 (3 Weeks            | Internship             | 98       |

O.A.ms

Principal Chaitanya Bharathi Institute of Technology (Autonomous) Gandipet, Hyderabad-500 075-

4

| S.<br>No | Name of the participant  | Duration                                 | Nature of the activity | Page No. |
|----------|--|--|------------------------|----------|
| 827      | Sudhansh Tanneru   | 28-6-2022 To 12-<br>7-2022 (2 Weeks)     |                        | 99       |
| 828      | Sudhansh Tanneru   | 18-11-2021 To<br>10-12-2021 (3<br>Weeks) | Internship             | 100      |
| 829      | Tarun Vishnu Vardhan Chirumella  | 27-7-2022 To 16-<br>08-2022 (3 Weeks     | Internship             | 101      |
| 830      | Tarun Vishnu Vardhan Chirumella  | 6 Weeks                                  | Internship             | 102      |
| 831      | Tarun Vishnu Vardhan Chirumella  | 4 Weeks                                  | Internship             | 102      |
| 832      | Tarun Vishnu Vardhan Chirumella  | 4 Weeks                                  | Internship             | 103      |
| 833      | Tarun Vishnu Vardhan Chirumella  | 8 Weeks                                  | Internship             | 104      |
| 834      | Tarun Vishnu Vardhan Chirumella  | 6 Weeks                                  | Internship             | 105      |
| 835      | Tarun Vishnu Vardhan Chirumella  | 01-7-2022 To 31-<br>7-2022 (4 Weeks)     | Internship             | 107      |
| 836      | A. Thandava Sai Rohith   | 04-7-2022 To 17-<br>7-2022 (2 Weeks)     | Internship             | 108      |
| 837      | A Uday Kiran   | 29-06-2022 To<br>31-7-2022 (4<br>Weeks)  | Internship             | 109      |
| 838      | P Venkata Sri Harsha   | 13-3-2022 To 26-<br>7-2022 (19<br>Weeks) | Internship             | 110      |
| 839      | Maduri Yashovardhan  | 04-5-2022 To 18-<br>5-2022 (2 Weeks)     | Internship             | 111      |
| 840      | Maduri Yashovardhan  | 27-7-2022 To 16-<br>08-2022 (3 Weeks     | Internship             | 112      |
| 841      | Maduri Yashovardhan  | 29-06-2022 To<br>31-7-2022 (4<br>Weeks)  | Internship             | 113      |
| 842      | Maduri Yashovardhan  | 01-6-2022 To 30-<br>6-2022 (4 Weeks)     | Internship             | 114      |
| 343      | Maduri Yashovardhan  | 06-7-2022 To 26-<br>7-2022 (3 Weeks)     | Internship             | 115      |
| 344      | K Yashwanth  | 13-3-2022 To 26-<br>7-2022 (19<br>Weeks) | Internship             | 116      |
| 345      | Anjali Vanam   | 8-7-2022 To 22-7-<br>2022 (2 Weeks)      | Internship             | 117      |
|          | Nama Divya   | 9-7-2022 To 23-7-<br>2022 (2 Weeks)      | Internship             | 118      |
| 47 I     | Lakshmi Anusha Wudali  | 12 Weeks                                 | Internship             | 119      |
| 48       |  | 8-7-2022 To 22-7-<br>2022 (2 Weeks)      | Internship             | 120      |
| 49 S     | ratio on a contration of the second sec | 8-7-2022 To 22-7-<br>2022 (2 Weeks)      | Internship             | 121      |
| 50 C     | ZITERACY PETERINA PETERI   | 28-6-2022 To 12-<br>7-2022 (2 Weeks)     | Internship             | 122      |

Principal Chaitanya Bharathi Institute of Technology (Autonomous) Ganctipet, Hyderabad-500 075;

| S.<br>No | Name of the participant | Duration  | Nature of the activity | Page No. |
|----------|-------------------------|---|------------------------|----------|
| 851      | Chinmay Krishna Peri    | 18-11-2021 To<br>10-12-2021 (3 Internship<br>Weeks) |                        | 123      |
| 852      | Mr. K. Hemamshu         | 14-7-2022 To 13-<br>8-2022 (4 Weeks)                | Internship             | 124      |
| 853      | E. Prema Sai            | 08-7-2022 To 22-<br>7-2022 (2 Weeks0                | Internship             | 125      |
| 854      | Mr. V. Sai Anjan Kumar  | 4-10-2022 To 4-<br>11-2022 (4<br>Weeks)             | Internship             | 126      |
| 855      | Y Sai Krishna           | 3-7-2022 To 22-7-<br>2022 (2 Weeks)                 | Internship             | 127      |
| 856      | Mr. M. Yasasvi          | 4-10-2022 To 4-<br>11-2022 (4<br>Weeks)             | Internship             | 128      |
| 857      | Koppula Sumanth Reddy   | 10-6-2022 To 10-<br>8-2022 (8 Weeks)                | Internship             | 129      |
| 858      | KASAM NIKHIL            | 2-8-2022 To 16-8-<br>2022 (2 Weeks)                 | Internship             | 130      |
| 859      | K. Rahul                | 29-06-2022 To<br>31-7-2022 (4<br>Weeks)             | Internship             | 131      |
| 860      | Kannoju Sharath Babu    | 2-8-2022 To 16-8-<br>2022 (2 Weeks)                 | Internship             | 132      |
| 861      | Hemalatha Maheshwaram   | 30-6-2022 To 14-<br>7-2022 (2 Weeks) Internship     |                        | 133      |
| 862      | S. Pavan Kalyan         | 29-6-2022 To 31-<br>7-2022 (4 Weeks) Internship     |                        | 135      |
| 863      | K Praveen Kumar         | 29-6-2022 To 31-<br>7-2022 (4 Weeks)                | Internship             | 136      |
| 864      | Gajula Laxman           | 2-8-2022 To 16-8-<br>2022 (2 Weeks)                 | Internship             | 137      |
| 865      | Ganji Sairam            | 2-8-2022 To 16-8-<br>2022 (2 Weeks)                 | Internship             | 138      |
| 866      | Manisha Modela          | 30-6-2022 To 14-<br>7-2022 (2 Weeks)                | Internship             | 139      |
| 867      | Manisha Modela          | 6 Weeks   | Internship             | 140      |
| 868      | Ajmeera Rachana         | 9-7-2022 To 23-7-<br>2022 (2 Weeks) Internship      |                        | 141      |
| 869      | Nirmit Naha             | 28-6-2022 To 12-<br>7-2022 (2 Weeks) Internship     |                        | 142      |
| 870      | G. Choodamani Chandana  | 16-7-2022 To 29-<br>7-2022 (2 Weeks) Internship     |                        | 143      |
| 371      | D bhavani Rath Reddy    | 16-7-2022 To 29-<br>7-2022 (2 Weeks) Internship     |                        | 144      |
| 372      | Maloth Mahesh           | 16-7-2022 To 29-<br>7-2022 (2 Weeks)                | Internship             | 145      |

O.A .

Principal Chaitanya Bharathi Institute of Technology (Autonomous) Gandipet, Hyderabad-500 0.75

| S.<br>No | Name of the participant   | Duration                             | Nature of the activity | Page No |
|----------|---|--------------------------------------|------------------------|---------|
| 873      | S Deepak  | 29-6-2022 To 31-<br>7-2022 (4 Weeks) | Internship             | 146     |
| 874      | A Uday Kiran  | 29-6-2022 To 31-<br>7-2022 (4 Weeks) | Internship             | 147     |
| 875      | Manoj Kumar   | 12-7-2022 To 31-<br>7-2022 (2 Weeks) | Internship             | 148     |
| 876      | vamshi  | 12-7-2022 To 31-<br>7-2022 (2 Weeks) | Internship             | 149     |
| 877      | Bharadwaj   | 12-7-2022 To 31-<br>7-2022 (2 Weeks) | Internship             | 150     |
| 878      | Rajesh  | 12-7-2022 To 31-<br>7-2022 (2 Weeks) | Internship             | 151     |
| 879      | C. Nagendranatha Reddy, Sanath<br>Kondaveeti, Booki Min   | 6 Month                              | Research               | 152     |
| 880      | Rajitha Nampally , Shylaja<br>Somannagari, Chinna Rajanna<br>Kamatala, *, Yadagiri Bhongiri ,<br>Umesh Kumar Utkoor   | 7 Month                              | Research               | 154     |
| 881      | Rajasri Y, Hariprasad R, John<br>Reddy P, C. Nagendranatha<br>Reddy, Chandrasekhar K  | 4 Month                              | Research               | 156     |
| 882      | Bishwambhar Mishra, Awdhesh<br>Kumar Mishra, Sanjay Kumar,<br>Sanjeeb Kumar Mandal,<br>Lakshmayya NSV, Vijay Kumar,<br>Kwang-Hyun Baek, Yugal Kishore<br>Mohanta  | 2 Month                              | Research               | 172     |
| 383      | Reddy, C. Nagendranatha, Sanath<br>Kondaveeti, Gunda<br>Mohanakrishna, and Booki Min  | 6 Month                              | Research               | 231     |
| 384      | Nilanjana Das, Ashwini Prabhakar<br>Shende, Keerthana G, Sanjeeb<br>Kumar Mandal  | 4 Month                              | Research               | 220     |
|          | Bishwambhar Mishra, Yugal<br>Kishore Mohanta, Sunita Varjani,<br>Sanjeeb Kumar Mandal,<br>Lakshmayya NSV, Preeti<br>Chaturvedi, Mukesh Kumar<br>Awasthi. Zengqiang Zhang,<br>Raveendran Sindhu,<br>Parameswaran Binod, Reeta Rani<br>Singhania, Vinod Kumar | 6 Month                              | Research               | 238     |
| 886      | B Mishra, Sunita V, M Parida,<br>Gayathri Pl. M Awasthi, SK<br>Awasthi, Z Zhang   | 12 Month                             | Research               | 276     |
| 87       | Sunita V, B Mishra, R Yadavalli,<br>XT Bui, MJ Taberzadeh, DC<br>Agrawal, S You, JS Chang   | 13 Month                             | Research               | 308     |
| 88       | C. Nagendranatha Reddy, S<br>Mehariya, S. Kavitha, RY Kannah,<br>K Jayaprakash, R Yadavalli, JR<br>Banu, PK Obulisamy   | 12 Month                             | Research               | 310     |

·L Principal

Chaitanya Bharathi Institute of Technology (Autonomeus) Gandinet, Hyderabad-500 075.

| S.<br>No                               |  | Duration                            | Nature of the activity | Page No    |
|--|--|-------------------------------------|------------------------|------------|
| 889                                    | Arvind Bangaru, Kamasani Aarya<br>Sree, Chandana Kruthiventi,<br>Meenakshi Banala, Vadapalli<br>Shreya, Y. Vineetha, A. Shalini,<br>Bishwambhar Mishra, Rajasri<br>Yadavalli, K. Chandrasekhar & C.<br>Nagendranatha Reddy | 13 Month                            | Research               | 331        |
| 890                                    | C. Nagendranatha Reddy, B<br>Mishra, SK Mandal, DC Agarwal,<br>Chandana K.   | 18 Month                            | Research               | 359        |
| 891                                    | Chunduru Sai Hari Hara<br>Sudheshna  | 3 weeks (06-09 to<br>24-<br>09)     | Internship             | 373        |
| 892                                    | Spoorthi Sada  | 2 weeks (11-09-<br>21-25-<br>09-21) | Internship             | 374        |
| 893                                    | Balaji Doolam  | 3 weeks (06-09 to<br>24-<br>09)     | Internship             | 375        |
| 894                                    | Matta Chenna Keshava Charan  | 3 weeks (06-09 to<br>24-<br>09)     | Internship             | 376        |
| 895                                    | CHUNDURI KAUSHIK   | 6 Months                            | Project Work           | 377        |
| 896                                    | AVADHANULA JAHNAVI   | 6 Months                            | Project Work           | 378        |
| 897                                    | KIRANMAI DORNALA   | 6 Months                            | Project Work           | 379        |
| 898                                    | VENNAMANENI KRISHNA<br>PRIYA RAO k   | 6 Months                            | Project Work           |            |
| 899                                    | NIVEDITHA D  |                                     |                        | 380        |
|  | SUCHETA RAJARAMAN  | 6 Months<br>6 Months                | Project Work           | 381        |
|  | USHASWINI SUNKARA  | 6 Months                            | Project Work           | 382        |
|  | ARLIBANDI YAMINI   | 6 Months                            | Project Work           | 383        |
|  | DEEPAK MOHAN REDDY S   | 6 Months                            | Project Work           | 384        |
|  | JALIGAMA DHANISH   |                                     | Project Work           | 385        |
| 704                                    | DAAMAN RAU   | 6 Months                            | Project Work           | 386        |
|  | MOHITH REDDY ARIKATLA  | 6 Months                            | Project Work           | 387        |
|  | SOURAB MASHETTY  | 6 Months                            | Project Work           | 388        |
| 1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1.1. | DAMALLA DEEPIKA  | 6 Months                            | Project Work           | 389        |
| 100                                    | GANGA DIVYA  | 6 Months                            | Project Work           | 390        |
|  | G DIVYA TEJA   | 6 Months                            | Project Work           | 391        |
|  | Nishath  | 6 Months                            | Project Work           | 392        |
|  | 3hauana  | 6 Months                            | Project Work           | 393        |
|  | NADIMPALLI SPHOORTHY   | 6 Months                            | Project Work           | 394        |
| I3<br>R<br>R                           | LAHARI ANUMANDLA 2.<br>NAVYA PRIYA DARSHIINI 3.<br>SAMYUK THA YADAVELLY 4.<br>PRASHANTH DAPPU 5.<br>SRAVAN KUMAR<br>RENUKUNTLA 6. SUMANTH<br>FORULA 7. PRAVALLIKA<br>REDDY TARIMELA 8. VISHAL<br>JAYANA                    | 45 days                             | Internship             | 395 TO 417 |

Principal Chaitanya Bharathi Institute of Technology (Autonomous) Condiset. EyderaBad-500 075.

8

| S.<br>No |   | Duration                        | Nature of the<br>activity | Page No. |
|----------|---|---------------------------------|---------------------------|----------|
| 914      | 1. ANIL P 2. VINAY KRISHNA<br>Konjeti 3. Vinay prakash<br>Maddipati   | 38 days                         | Internship                |          |
| 915      | 1. HARSHITHA MUTHYALA 2.<br>Naraparaju chandu 3.<br>Tejaswini r   | 45 days                         | Internship                |          |
| 916      | 1. SWETHA EMMIDI N S 2.<br>HEMANTH SAI PRASAD RAJU<br>PORANKI<br>3. BRUNDAVANI HINDU S 4.<br>CHAITANYA CHIRRA<br>5. KEERTHANA MADGULA 6.<br>PRIYALEKHA LINGAPURAM<br>7. SRAVYA BOINDALA 8.<br>SWATHI BUCHANPALLI<br>9. CHAITANYA JWALA<br>MIDASALA 10. KALYAN<br>BAND!<br>11. MOHAN SWARGAM 12.<br>PAVAN KUMAR SUDDALA<br>13. POHITH T 14. SAI RAM<br>NALLOLLA<br>15. SRICHARAN VELETI 16.<br>VENKATAKRISHNA REDDY<br>ANNAPUREDDY | 60 days                         | Internship                |          |
| 917      | Dr Rajanikanth Aluvalu  | December<br>2021(30 Days)       | Research Publication      |          |
| 918      | Dr.Rajanikanth Aluvalu  | January-march 2022(90 days)     | Research Publication      |          |
| 919      | Dr.Rajanikanth Aluvalu  | January-April<br>2022(120 days) | Research Publication      |          |
| 920      | Dr. Ramana  | January-April<br>2022(120 days) | Research Publication      |          |
| 921      | R. Shoba Rani   |                                 | Research Publication      |          |
| 922      | Dr. Raianikanth Aluvalu.<br>Gangadhara Rao  |                                 | Research Publication      |          |
| 923      | Dr. K. Radhika  |                                 | Research Publication      |          |
| 924      | Dr.Rajanikanth Aluvalu  |                                 | Research Publication      |          |
| 925      | Dr.Raianikanth Aluvalu  |                                 | Research Publication      |          |
| 926      | Dr.Rajanikanth Alevalu  |                                 | Research Publication      |          |
| 927      | Dr.Rajanikanth Aluvalu  |                                 | Research Publication      |          |
|          | Dr. K. Radhika  |                                 | Research Publication      |          |
| 929      | Mr. D.Jayaram   |                                 | Research Publication      |          |
| 930      | Dr. M. Venu Gopalachari   |                                 | Research Publication      |          |
|          | Vis. T. Satya Kiranmai  |                                 | Research Publication      |          |
| 932      |   |                                 | - contraction             |          |

8.0 2

Principal Chaitanya Bharathi Institute of Technolor (Autonomous) Gandipet, Hyderabad-500 075.

ISO 9001-2015 CERTIFIED



Date: 06/04/2022

**REGD NO: 97588** 

#### **INTERNSHIP CERTIFICATE**

This is to certify that **Mr. THALLA RAKESH, S/O Mr. T SADANANDAM** from Chaitanya Bharathi institute of technology, has started training Under internship program at **3D CAD SOLUTIONS** from 18<sup>TH</sup> MARCH 2022. He is working as a "CATIA TRAINEE" and Will be reporting directly to CATIA team lead.

For this position, the major duties include Product design and development. The internship shall be approximately 20 hours per week and will conclude by 18<sup>TH</sup> MAY 2022.

We wish him the best for his tenure at 3D CAD SOLUTIONS.

Name: SUNIL VADIPILLA

Title: CEO

Signature



#218, 2<sup>nd</sup> Floor, Annapurna Block, Near Mythrivanam, Aditya Enclave, Ameerpet, Hyd-38.

Email: 3dcadsol@gmail.com.



شرڪة **يو او جي اي انترناشيونا**ل للتجارة العامة والمقاولات

18/05/2022

#### TO WHOOM SO EVER IT MAY CONCERN

This is to inform that Mr. Naveen Vipparthi S/o. Venkatesh Vipparthi bearing Passport No. V7394333 from M/s.CBIT college of Engineering completed his internship awareness Programme in Oil and Gas facilities.

During this Programme Mr. Naveen Vipparthi shown outstanding performance and enthusiasm with his learning objectives on scheduled Programme from 17/04/2022 to 16/05/2022.

In this regards, management would like to take this opportunity to wish him very great success in his future endeavors.

Good Luck,

Regards,

Lakshmi Narasaiah. U

**General Manager** UOGE International General Trading & Contracting Co.

Copy: File



702, 7th Floor Tower B, 247 Park LBS Road, Vikhroli (West) Mumbai - 400 083, Maharashtra, India Tel. : +91 22 61362000 Fax : +91 22 61362090 www.dhl.co.in CIN : U74120MH2013PTC242240 E-mail id : dhlsupplychain@dhl.com

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Munukuntla Hrithika Goud** was working in our organization from 1<sup>st</sup> March 2022 to 15<sup>th</sup> April 2022 under DHL Interns' Program. At the time of leaving the organization, her designation was **Operations Intern**.

We wish her success in all her future endeavours.

#### For DHL Supply Chain India Pvt. Ltd,

Beena arob

Beena Jacob Senior Director - Human Resources DSC

24<sup>th</sup> April 2022



702, 7th Floor Tower B, 247 Park LBS Road, Vikhroli (West) Mumbai - 400 083, Maharashtra, India Tel. : +91 22 61362000 Fax : +91 22 61362090 www.idht.co.in CIN : U74120MH2013PTC242240 E-mail id : dhlsupplychain@dhl.com

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Puli Pavitra** was working in our organization from 1<sup>st</sup> March 2022 to 15<sup>th</sup> April 2022 under DHL Interns' Program. At the time of leaving the organization, her designation was **Operations Intern**.

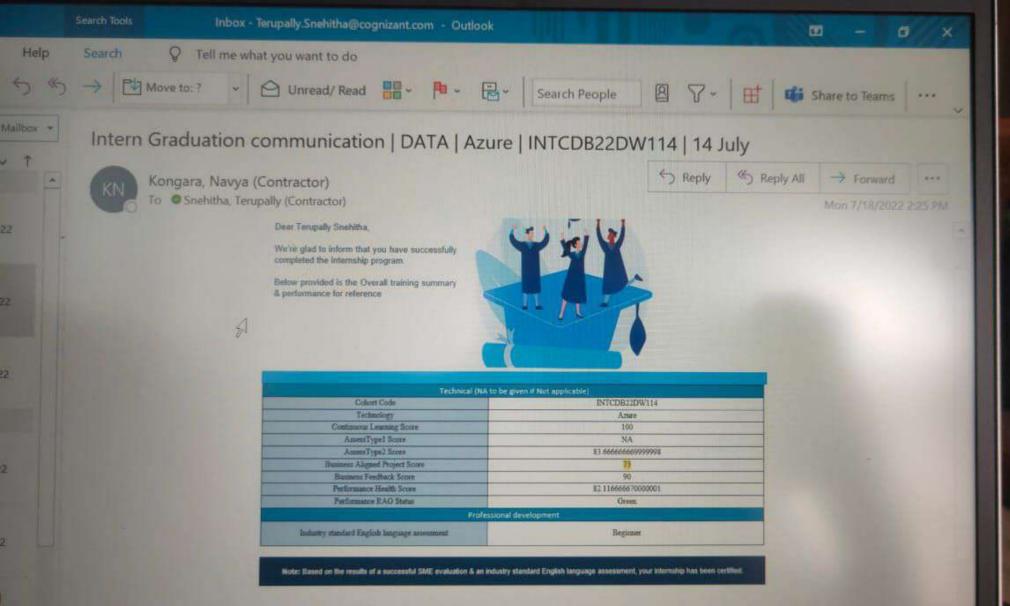
We wish her success in all her future endeavours.

#### For DHL Supply Chain India Pvt. Ltd,

Beenafacob

Beena Jacob Senior Director - Human Resources DSC

24<sup>th</sup> April 2022





Date: 21.03.2022

Ms. Medikonda Yamini, H.N: 16-7-167/2, Madhuranagar Colony Road No: 12, Khammam Urban Sai Baba Temple Road, Khanapuram Haveli Rural, Telangana – 507002

#### Dear Ms. Medikonda Yamini,

Adverting to the interview and discussions we had with you, we are pleased to inform you that you have been selected as an **Intern** in our Organization you will be on a probation period. After the completion of the engineering studies and on submission of relevant proofs of graduation certificates, you will be considered as a **Graduate Engineer Trainee (GET)**.

You will be rendering services at our Plant Office, located at Jadcherla, on the following mutually agreed terms & conditions;

- It is understood that you have joined us today i.e. 21.03.2022.
- The tenure of your training initially will be for Twelve Months from the date of your joining i.e. 21.03.2022. Unless otherwise extension if any, is granted by us in writing.
- During the period of Internship, you shall be paid an amount of Rs. 14,000/- per month [Rupees Fourteen Thousand per month] as a stipend. After your appointment, you shall be paid compensation as detailed in Annexure-1.
- You will report to the AGM EV Manufacturing Plant Operations or any person nominated by the management and will be taking up periodical assignments from him.
- Your services are governed by the Service Conditions, Rules and Regulations, as applicable to your cadre of the Company.
- The services rendered under this letter are terminable by 30 days' notice, at the sole discretion of the management.



At the sole discretion of the management, you shall also be rendering services on such other new assignments and designations at the appropriate time under such mutually agreed terms & conditions.

You are liable to be posted or transferred / attached to any of our associate companies or to any of the offices / subsidiaries / units associate offices of the company to any town or city in India or abroad, at the sole discretion of the management.

**Electric Mobility** 

KETO Motors Private Limited.

**Registered** Office

9-1-83 & 84, Amarchand Sharma Complex, S.D. Road Secunderabad Telangana, India. 500003.

info@ketomotors.com

Corporate Office

5<sup>th</sup> Floor, Block - II, My Home Hub, Hitec City, Madhapur, Hyderabad, Telangana, India. 500081.

www.ketomotors.com

<u>Plant</u> Plot No. L19 to L28, TSIIC Green Industrial Park, Jadcherla, Mahabubnagar (Dist), Telangana, India. 509302.

CIN: U74999TG2018PTC128723



### TO WHOMSOEVER IT MAY CONCERN

#### **INTERNSHIP LETTER**

This is to certify that Mr. Medam ChinniKalyan has interned with our Company, BizAcuity Solutions Pvt. Ltd. from 4<sup>th</sup> March 2022 to 30<sup>th</sup> June 2022 as a Software Developer Intern.

During the internship he has undergone the training on SQL, Tableau, Linux, AWS, ETL, Java, Scala and Excel.

During his tenure with us, he was able to handle major responsibilities and was found to be a hardworking and dedicated individual who exhibited a quest for learning and a flair for problem solving.

We at **BizAcuity**, are satisfied with his work and wish him all the very best for all his future endeavors.

Sincerely, utio Hyderaba Prachi Kulkar **HR** Manager

### **BizAcuity Solutions Pvt. Ltd.**

H.No. 1-98/G/7, (P) & 8 (P), No. 101, Hi Tech Pearl, Shilpi Valley, Madhapur, Hyderabad - 500 081, India. Ph:+91 40 43111808 E-mail: Info@bizacuity.com, www.bizacuity.com, CIN: U72200TG2011PTC074277



Date: 18th May 2022.

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. Gopisainath M**, from Chaitanya Bharathi Institute of Technology, has successfully completed three months internship from 14<sup>st</sup> February 2022 to 14<sup>st</sup> May 2022, at H-BOTS ROBOTICS Pvt. Ltd. As part of his internship, he has done a study on "Design and Automation of Autonomous Mobile Robots".

During his tenure with us, we found him extremely inquisitive, hardworking, sincere, and result-oriented. He was very much interested to learn the functions of our core division and also willing to put his best efforts and get into the depth of the subject to understand it better.

We wish him all the best in his future endeavors.

Sincerely,

Kisshhan PSV CEO H-BOTS ROBOTICS PVT LTD



Date: 23rd May 2022.

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. Nigamananda Janjanam**, from Chaitanya Bharathi Institute of Technology, has successfully completed two months internship from 21<sup>st</sup> March 2022 to 21<sup>st</sup> May 2022, at H-BOTS ROBOTICS Pvt. Ltd. As part of his internship, he has done a study on "Design and Manufacturing of Autonomous Mobile Robots".

During his tenure with us, we found him extremely inquisitive, hardworking, sincere, and result-oriented. He was very much interested to learn the functions of our core division and also willing to put his best efforts and get into the depth of the subject to understand it better.

We wish him all the best in his future endeavors.

Sincerely,

Kisshhan PSV CEO H-BOTS ROBOTICS PVT LTD



Dear Candidate,

160118736026

Greetings from Cognizant !

Mech F1

We observe that you are an Intern with us and have completed your Internship training and are yet to receive further updates regarding your Date of Joining as an FTE in Cognizant.

This email is to update you with a few key pointers with regard to your internship completion and the next steps with Cognizant.

- 1. Your Internship would be certified as successful only after you complete the Technical Evaluation with an identified subject matter expert.
- You will be intimated about the schedule of the same through your coach. Kindly prepare thoroughly for this session on all topics that you have gone through as part of your Internship.
- 3. If you perform below the expectations in the evaluation,
  - a. you will be put through remedial and additional training to help you better your skills. The remedial training would be for 2-3 weeks followed by a re-evaluation.
  - b. During the remedial / additional training period for 2-3 weeks there would not be any stipend payment. You must use this period completely to improve your skills and perform better in the reevaluation.
  - c. If your performance is still below the benchmarks in the re-evaluation, your Internship will be terminated and your FTE offer rollout and onboarding would be stopped. If you already have the offer from Cognizant then it would be cancelled. While your Internship would get over at this stage you will only receive the Internship Participation Letter.
  - d. If you pass the re-evaluation , your Internship would be certified as completed and you will be lined up for your FTE onboarding as per Cognizant onboarding process

Regards, Human Resources – Cognizant ORANGE AUTO PVT LTD Passenger Car Dealer



Ref. No. 50612

### Internship Certificate

This is to clarify that **Mr. Rohan Yalamanchili** from Chaitanya Bharathi Institute of Technology, Gandipet, successfully completed his internship of 2 months with Orange Auto Pvt. Ltd.

Internship: Digital Marketing Creative Designer

During his tenure, we found him very active and competent in executing all assigned works and services were found to be satisfactory.

We wish him great success in all of his future endeavours.

Date: May 16, 2022

man. E

Battula Naveen Kumar

HR, Orange Auto Pvt. Ltd

SHOWROOM : #8-3-164/2, Beside Gokul Theatre , Erragadda, Hyderabad - 500018
SHOWROOM : SY No. 54, Vikrampuri Main road, Kharkhana, Secunderabad - 500015
SHOWROOM : Pillar No. 92, Municipal Nos. 13-6-432/33 & 13-6 432/33/A, Gudimalkapur, Attapur, Hyderabad - 500028
SHOWROOM : Plot No. 1 & 10, Shree Enclave, Sy.No. 311, 312 & 313/B, Athwelly Village, Medchal Mandal, R.R. Dist.
WORKSHOP : Plot No.16, ABC, Mini Industrial Estates, Hafeezpet, Hyderabad - 500049. 20 / 426



Date: 18th May 2022.

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. Rohith Reddy Katta**, from Chaitanya Bharathi Institute of Technology, has successfully completed three months internship from 14<sup>st</sup> February 2022 to 14<sup>st</sup> May 2022, at H-BOTS ROBOTICS Pvt. Ltd. As part of his internship, he has done a study on "Design and Manufacturing of Autonomous Mobile Robots".

During his tenure with us, we found him extremely inquisitive, hardworking, sincere, and result-oriented. He was very much interested to learn the functions of our core division and also willing to put his best efforts and get into the depth of the subject to understand it better.

We wish him all the best in his future endeavors.

Sincerely,

Kisshhan PSV CEO H-BOTS ROBOTICS PVT LTD

ORANGE AUTO PVT LTD Passenger Car Dealer



Ref. No. 50614

### Internship Certificate

This is to clarify that **Mr. Sai Ganesh Gunda** from Chaitanya Bharathi Institute of Technology, Gandipet, successfully completed his internship of 2 months with Orange Auto Pvt. Ltd.

Internship: Digital Marketing Creative Designer

During his tenure, we found him very active and competent in executing all assigned works and services were found to be satisfactory.

We wish him great success in all of his future endeavours.

Date: May 16, 2022

Battula Naveen Kumar

HR, Orange Auto Pvt. Ltd

| SHOWROOM              | : #8-3-164/2, Beside Gokul Theatre , Erragadda, Hyderabad - 500018  |
|-----------------------|---|
| SHOWROOM              | : SY No. 54, Vikrampuri Main road, Kharkhana, Secunderabad - 500015                                       |
| SHOWROOM              | : Pillar No. 92, Municipal Nos. 13-6-432/33 & 13-6 432/33/A,<br>Gudimalkapur, Attapur, Hyderabad - 500028 |
| SHOWROOM/<br>WORKSHOP | Village, Medchal Mandal, R.R. Dist.   |
| WORKSHOP              | : Plot No.16, ABC, Mini Industrial Estates, Hafeezpet, Hyderabad - 500049.                                |

22 / 426

**Building on belief** 



Building greater futures through innovation and collective knowledge

**TCS** Commitment



Bring everything.





Master the journey.

# Internship Certificate

# Sashreek Reddy Mallem

Course: B.E. in Mechanical Engineering Institute: Chaitanya Bharati Institute of Technology (CBIT), Hyderabad

From **14-Feb-2022** to **30-Jun-2022** Mentor Name: **Avishake Chatterjee** Project: **Usage of SAP ERP In Digital Supply Chain Operations** 

Chandra Koduru Head – Academic Interface Programme

# **Cognizant Internship Participation**



•

Letter Inbox

G

# GenCInternsCSDSupp@co... Jul 7









Dear Candidate,

Greetings from Cognizant !

We would like to thank you for your participation in the Cognizant Internship Program 2022.

This is to acknowledge your Internship training completion with us between 1/22/2022 and 6/22/2022.

Hope the training has been effective in upskilling your capabilities.

Wishing you Good luck for your future endeavors.

Regards,

Human Resources - Cognizant

ORANGE AUTO PVT LTD Passenger Car Dealer



Ref. No. 50613

### Internship Certificate

This is to clarify that **Mr. Sumeet Mekala** from Chaitanya Bharathi Institute of Technology, Gandipet, successfully completed his internship of 2 months with Orange Auto Pvt. Ltd.

Internship: Digital Marketing Creative Designer

During his tenure, we found him very active and competent in executing all assigned works and services were found to be satisfactory.

We wish him great success in all of his future endeavours.

Date: May 16, 2022

Battula Naveen Kumar

HR, Orange Auto Pvt. Ltd

| SHOWROOM              | : #8-3-164/2, Beside Gokul Theatre , Erragadda, Hyderabad - 500018   |
|-----------------------|--|
| SHOWROOM              | : SY No. 54, Vikrampuri Main road, Kharkhana, Secunderabad - 500015  |
| SHOWROOM              | : Pillar No. 92, Municipal Nos. 13-6-432/33 & 13-6 432/33/A,<br>Gudimalkapur, Attapur, Hyderabad - 500028  |
| SHOWROOM/<br>WORKSHOP | : Plot No. 1 & 10, Shree Enclave, Sy.No. 311, 312 & 313/B, Athwelly<br>Village, Medchal Mandal, R.R. Dist. |
| WORKSHOP              | : Plot No.16, ABC, Mini Industrial Estates, Hafeezpet, Hyderabad - 500049.                                 |

KETØ

Date: 21.03.2022

Mr. Bonithi Umesh Chandra, H.N: 2-2-24/3, Morangapally Mominpet, Morangapally, K.V. Rangareddy, Telangana – 501202.

#### Dear Mr. Bonithi Umesh Chandra,

Adverting to the interview and discussions we had with you, we are pleased to inform you that you have been selected as an **Intern** in our Organization you will be on a probation period. After the completion of the engineering studies and on submission of relevant proofs of graduation certificates, you will be considered as a **Graduate Engineer Trainee (GET)**.

You will be rendering services at our Plant Office, located at **Jadcherla**, on the following mutually agreed terms & conditions;

- It is understood that you have joined us today i.e. 21.03.2022.
- The tenure of your training initially will be for Twelve Months from the date of your joining i.e. 21.03.2022. Unless otherwise extension if any, is granted by us in writing.
- During the period of Internship, you shall be paid an amount of Rs. 14,000/- per month [Rupees Fourteen Thousand per month] as a stipend. After your appointment, you shall be paid compensation as detailed in **Annexure-1**.
- You will report to the AGM EV Manufacturing Plant Operations or any person nominated by the management and will be taking up periodical assignments from him.
- Your services are governed by the Service Conditions, Rules and Regulations, as applicable to your cadre of the Company.
- The services rendered under this letter are terminable by 30 days' notice, at the sole discretion of the management.

At the sole discretion of the management, you shall also be rendering services on such other new assignments and designations at the appropriate time under such mutually agreed terms & conditions.



You are liable to be posted or transferred / attached to any of our associate companies or to any of the offices / subsidiaries / units associate offices of the company to any town or city in India or abroad, at the sole discretion of the management.

#### KETO Motors Private Limited.

#### **Registered Office**

9-1-83 & 84, Amarchand Sharma Complex, S.D. Road Secunderabad Telangana, India. 500003.

info@ketomotors.com

Corporate Office

5<sup>th</sup> Floor, Block - II, My Home Hub, Hitec City, Madhapur, Hyderabad, Telangana, India. 500081.

#### www.ketomotors.com

#### <u>Plant</u>

Plot No. L19 to L28, TSIIC Green Industrial Park, Jadcherla, Mahabubnagar (Dist), Telangana, India. 509302.

**Electric Mobility** 

- SECRECY: You shall not give, divulge or disclose anyone, by word of mouth, or in writing facsimile or through any device any particulars or details, which you gain access during the course of your employment of our working systems, technical knowhow, designs and drawings security arrangements, administrative and / or organizational matters etc., of our establishment and our clients, whether confidential or otherwise, either during your employment with company or thereafter. Any breach of this term, will attract legal remedy and recovery of damages, as assessed by the company.
- Please note that, the terms & conditions of your training as stipulated here-fore-to or to be intimated hereafter, are to be treated as strictly confidential and you should not divulge its contents to any employee of the company / person connected with the company.
- Please furnish us with copies of all credentials in support of your candidature including
  proof of your date of birth, qualification, 02 passport size photographs, a copy of your
  residential proof & photo identity card and a fitness certificate granted by any Medical
  Practitioner, qualified not lower than MBBS, together with 02 references with whom we
  may contact, for our records.
- All disputes arising out of your appointment with us, if not settled between ourselves are subject to the Courts of Hyderabad / Secunderabad only.

This letter is being issue to you in duplicate, a copy of which may please be signed and sent back to us in token of your unconditional acceptance.



Bumest

Cc to: Accounts Department

|    | ANNEXURE - I TO APPOINTMEN  | NT OFFER DATED: 21.03.2     | 022                      |  |  |  |
|----|---|-----------------------------|--------------------------|--|--|--|
|    | KETO MOTORS PR  | RIVATE LIMITED              |                          |  |  |  |
|    | Salary Structure of Mr. E   | Sonithi Umesh Chandra.      |                          |  |  |  |
| I  | Fixed Gross   | Monthly(Rs.)                | Yearly(Rs.)              |  |  |  |
| 1  | Basic   | 10,260                      | 1,23,120                 |  |  |  |
| 2  | HRA   | 4,104                       | 49,248                   |  |  |  |
| 3  | LTA   | 855                         | 10,260                   |  |  |  |
| 4  | Special Allowances  | 1,881                       | 22,572                   |  |  |  |
|    | Gross Salary  | 17,100                      | 2,05,200                 |  |  |  |
| 11 | Annual / Retiral benefits:  | -                           |                          |  |  |  |
| 1  | Employer's share of Provident Fund  | 1,560                       | 18,714                   |  |  |  |
|    | Employer's share of ESI   | 556                         | 6,672                    |  |  |  |
| 2  | Gratuity  |                             | 5,919                    |  |  |  |
| 3  | Mediclaim & Personal Accident Insurance   |                             | 3,500                    |  |  |  |
|    | Total CTC   |                             | 2,40,005                 |  |  |  |
| No | tes:  |                             |                          |  |  |  |
| 1  | Retention Bonus of Rs. 48,000/- is paid after of organization.  | completion of 2yrs service  | bond in the              |  |  |  |
| 2  | Income Tax, Professional Tax, Employee's Share of Provident Fund and any other applicable taxes will be deducted from the salary as per the applicable rates. |                             |                          |  |  |  |
| 3  | You can claim your LTA tax exemption. LTA ex<br>years. The Current block is 2021-25"  | xemption is available for 2 | journeys in a block of 4 |  |  |  |
| 4  | Above break up is tentative and may change CTC same   | as per company policy fro   | m time to time keeping   |  |  |  |

\* OMO 0 d S

B. Umes 4

28 / 426

# 

BOOMER ACTINIT TELANGANA SI. No: <u>-68/4</u> Date: 01/02/2022 Sold to Santosti: <u>G. Alosenhann</u> S/o. D/o. W/o: <u>Yesuperdann</u> R/o. M.M. Dist For Whom: <u>KETO Mators PV</u>. Do

E

T-Darbar Kedy AN 629212 T. DARBAR REDDY

REDR

LICENCED STAMP VENDOR Licence No: 15-11-006/2021 H.No: 6-2-1/6, Vivek Nagar, Kukatpally Medchal-Malkajgiri Dist-500 072. Cell: 9989179907

Contd..

29 / 426

#### SERVICE AGREEMENT

This Service Agreement has been entered into by and between M/s. KETO Motors Private Limited, a Private Limited company registered under Indian Companies Act, 1956, having its Registered Office at Plot No 19-28, TSIIC Green Industrial Park, Rajapur Village, Jadcherla – 509302. Mahabubnagar Dist, Telengana, INDIA represented by its Managing Director hereinafter called the "Employer" which term shall mean and include its successors-in-office authorized representatives attorneys on the one part.

#### AND

B. Umest

Mr. Bonithi Umesh Chandra, H.N: 2-2-24/3, Morangapally Mominpet, Morangapally, K.V. Rangareddy, Telangana – 501202. India hereinafter referred to as "EMPLOYEE" which term shall mean and include his authorized representatives on the other part.

Whereas the Employer through its letter of appointment dated 21.03.2022 offered employment to the Employee stipulating various terms and condition for which the employee has unconditionally accepted and gained such employment with effect from 21.03.2022.

And Whereas one of the conditions for the said appointment letter is that the employee shall enter into a service agreement with the Employer subject to the following terms and conditions:

- 1. That the employee has accepted to continue in service for a minimum period of 2 years with the Employer from the date of his joining.
- 2. That the said period of 2 years shall not include the period of working days lost due to strike, lock out or other force majeure reasons with the Employer.
- 3. That the Employer has got the right to terminate the services of the employee during the said period of agreement without any notice, for any acts of inefficiency unsatisfactory work, laxity, willful disorderly behavior, adopting slow down tactics, indulging in any act of misconduct or turpitude instigating co-employees and intimidating in acts of misconduct, causing material/financial loss or damages and bringing disrepute to the employer by any such other acts of the employee or through him/her, for which no compensation is payable by the employer to the employee.
- 4. That in the event of the employee failing to serve the employer for the said minimum period of 2 years, the employee has to compensate the employer with a sum of **Rs.1,00,000/- (Rupees One Lakh only)** as estimated damages that would be caused to the employer by the employee by leaving employment prematurely.

The employee herein has agreed to provide a signed letter from surety who shall undertake to discharge any liability arising out of the non-compliance of the terms of this Service Agreement on the part of the employee.

5. That the employer has the option to pursue any remedy that is legally available, against the employee, and surety either jointly or severally for recovery of such damages or costs as estimated by the employer.

Contd...

B. Umest

- 6. The conditions of employment of the employee with the employer contained in the letter of appointment issued to the employee, subject to any lateral modifications if any, shall remain binding on the employee.
- 7. All disputes arising out of understanding and implementing the terms of this agreement are subject to the jurisdiction of Hyderabad / Secunderabad Courts only.

In witness whereof, both the parties have this 21st day of March, 2022 signed this document at Hyderabad.

For KETO Motors Private Limited



B. Umes Signature

Witness:

1.

2.



702, 7th Floor Tower B, 247 Park LBS Road, Vikhroli (West) Mumbai - 400 083, Maharashtra, India Tel. : +91 22 61362000 Fax : +91 22 61362090 www.dhl.co.in CIN : U74120MH2013PTC242240 E-mail id : dhlsupplychain@dhl.com

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Mamidi Rani** was working in our organization from 1<sup>st</sup> March 2022 to 15<sup>th</sup> April 2022 under DHL Interns' Program. At the time of leaving the organization, her designation was **Operations Intern**.

We wish her success in all her future endeavours.

#### For DHL Supply Chain India Pvt. Ltd,

Seena arob

Beena Jacob Senior Director - Human Resources DSC

24th April 2022



702, 7th Floor Tower B, 247 Park LBS Road, Vikhroli (West) Mumbai - 400 083, Maharashtra, India Tel. : +91 22 61362000 Fax : +91 22 61362090 www.dhl.co.in CIN : U74120MH2013PTC242240 E-mail id : dhlsupplychain@dhl.com

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Mamidi Rani** was working in our organization from 1<sup>st</sup> March 2022 to 15<sup>th</sup> April 2022 under DHL Interns' Program. At the time of leaving the organization, her designation was **Operations Intern**.

We wish her success in all her future endeavours.

#### For DHL Supply Chain India Pvt. Ltd,

Seena arob

Beena Jacob Senior Director - Human Resources DSC

24th April 2022



702, 7th Floor Tower B, 247 Park LBS Road, Vikhroli (West) Mumbai - 400 083, Maharashtra, India Tel. : +91 22 61362000 Fax : +91 22 61362090 www.dhl.co.h CIN : U74120MH2013PTC242240 E-mail id : dhisuppiychain@dhl.com

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Gontu Samhitha Reddy** was working in our organization from 1<sup>st</sup> March 2022 to 15<sup>th</sup> April 2022 under DHL Interns' Program. At the time of leaving the organization, her designation was **Operations Intern**.

We wish her success in all her future endeavours.

#### For DHL Supply Chain India Pvt. Ltd,

aub

Beena Jacob Senior Director - Human Resources DSC

24th April 2022



#### TO WHOMSOEVER IT MAY CONCERN

#### **INTERNSHIP LETTER**

This is to certify that Mr. Peguda Sree Nandini has interned with our Company, BizAcuity Solutions Pvt. Ltd. from 4<sup>th</sup> March 2022 to 30<sup>th</sup> June 2022 as a Software Developer Intern.

During the internship She has undergone the training on SQL, Tableau, Linux, AWS, ETL and Excel.

During her tenure with us, She was able to handle major responsibilities and was found to be a hardworking and dedicated individual who exhibited a quest for learning and a flair for problem solving.

We at **BizAcuity**, are satisfied with her work and wish her all the very best for all her future endeavors.

Sincerely,

Prachi Kulkarni

tio

## **BizAcuity Solutions Pvt. Ltd.**

H.No. 1-98/G/7, (P) & 8 (P), No. 101, Hi Tech Pearl, Shilpi Valley, 426 adhapur, Hyderabad - 500 081, India. Ph:+91 40 43111808 E-mail: Info@bizacuity.com, www.bizacuity.com, CIN: U72200TG2011PTC074277

|     | भारत डायनामिक्स लिमिटेड   |
|-----|---|
|     | BHARAT DYNAMICS LIMITED   |
|     | (भारत सरकार का उद्यम A Govt. of India Enterprise)<br>रक्षा मंत्रालय Ministry of Defence   |
|     | कंचनबाग Kanchanbagh :: हैदराबाद Hyderabad – 500058.   |
|     | प्रणाली प्रौद्योगिकी तथा प्रबंधन संस्थान  |
|     | INSTITUTE OF SYSTEMS, TECHNOLOGY AND MANAGEMENT   |
|     |   |
| l   | पंजीकरण संख्या Regd. No. 14-7   |
|     | वर्ष Year 2022 क्र.स. S.No. P-2021-109  |
|     | परियोजना प्रमाण-पत्र PROJECT CERTIFICATE  |
|     | सुश्री/श्री   |
|     | Ms./Mr. Arauindam Vijayender G  |
|     | पुत्री/पुत्र श्रीमती एवं श्री   |
|     | gai/ga aital lea ait<br>Daughter/Son of Smt. <u>Gr. Guella Rami</u> Shri Gr. Vijayender Rody<br>कॉलेज/संस्थान<br>College/Institute Chaitanya Bharathi Institute of Technology   |
|     | कॉलेज/संस्थान   |
|     |   |
|     | ative |
|     | परियोजना कार्य/प्रशिक्षण कार्य  |
|     | has completed Project Work / Training on Manu loctubing of on China   |
|     | Mose come on a CNC Turnmel  |
|     | Duration month Period from 12/2022 to 12/04/2022  |
|     | Duration  |
|     |   |
|     | इस कार्य के दौरान इन्होंने अध्ययन में पर्याप्त रुचि दिखाई है.<br>Ho / She had a have t  |
|     | He / She has shown keen interest in learning during the period of Project.  |
|     | Walling Ward Nroway 22/4/2022   |
|     |   |
| 2   | * Seal  |
| Dy. | General Manager (Head-HR) KR  |
|     | अवधक (मा.सं.) शिव्यु प्रशीक्षण एव विश्वि<br>36/426 Manager (HR) APP TRG & LEGAL   |



# ONLINE

Aug 10, 2021

## Manas Jain

has successfully completed

### **Customer Analytics**

an online non-credit course authorized by University of Pennsylvania and offered through Coursera

Enc T. Bradlow Atter Fach Rom Berman

Eric Bradlow, Peter Fader, Raghu Iyengar, and Ron Berman The Wharton School

### COURSE CERTIFICATE



#### Verify at coursera.org/verify/RM5GN543MLF2

Coursera has confirmed the identity of this individual and their participation in the course.

The online course named in this certificate may draw on material from courses taught on-campus, but it is not equivalent to an on-campus course. Participation in this online course does not constitute enrollment at the University of Pennsylvania. This certificate does not confer a University grade, course credit or degree, and it does not verify the identity of the learner.



April 5, 2022

### **Internship Letter**

This is to certify that **Mr. Syed Suhair Ahmed** has done internship with us as **"Business Development Executive"** 

Details are given below:-

| Mr. Syed Suhair Ahmed | suhair.ahd@gmail.com |
|-----------------------|----------------------|
| Date of joining       | April 7, 2021        |
| Relieving date        | May 30, 2021         |
| Mobile                | 7093711950           |

We wish all the best in her future endeavors.

lanj

Dr.SSN Raju Head-HR Mobile/WhatsApp: 9391101403 Email: ssnraju@confluenceedu.com

> Confluence Educational Services Private Limited No:302, 3rd Floor, Sri Sai Goverdhan Kunj, SRNagar, Hyderabad, Telangana, India-500038



### **CERTIFICATE OF INTERNSHIP**

This is to certify that **Mr. Venkata Koushik Bakkamunthala, bearing roll no, 1601-18-736-107** and student of **B.Tech**, **Chaitanya Bharati Institute of Technology**, Hyderabad, has successfully completed his Internship Program in our company during the period from **01**<sup>st</sup> of April 2022 to 30<sup>th</sup> of April 2022.

During the period of Internship Program, he is found to be committed to the assignments & a task assigned and has shown a desire to learn and complete the tasks systematically.

We wish him all success in future endeavors. (For Pro Logging-In Limited)

Yours truly,

HR Manager Sandeep Srivastav

Pro Logging-In IT Pvt Ltd, 2nd Floor, Balaji Empire, Jayabheri Enclave, Gachibowli, Hyderabad-500032, Telangana

भारत सरकार अंतरिक्ष विमाग सतीश धवन अंतरिक्ष केंद्र शार श्रीहरिकोटा रेंज डा.घ. 524 124 श्री पोट्टि श्रीरामुलु नेल्लूर जिला, आं.प्र., भारत दूरभाष : +91-8623 245060 (6 जं) फैक्स : +91-8623 222099



Goverment of India Department of Space Satish Dhawan Space Centre SHAR Shriharikota Range P.O. 524 124 SPSR Nellore Dist., AP., India Telephone : +91-8623 245060 (6 Lines) Fax : +91-8623 222099

प्रबंधन प्रणाली क्षेत्र MANAGEMENT SYSTEMS AREA मानव संसाधन विकास प्रभाग HUMAN RESOURCE DEVELOPMENT DIVISION (Phone No. 08623 - 225047, Fax No - 225577)

No. HRDD/STU/I/PRJ2022011

Date: 01/04/2022

#### TO WHOMSOEVER IT MAY CONCERN

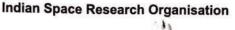
This is to certify that Mr. ANNAPUREDDY YASHPAL KUMAR REDDY (Roll. No. 1601-18-736-111) pursuing B.E IV Year (Mechanical Engineering) from Chaitanya Bharathi Institute of Technology, Hyderabad has undergone Internship training at Solid Motor Performance & Environmental Test Facilities (SMP & ETF) in SDSC SHAR, Sriharikota from 02/03/2022 to 01/04/2022.

During the above period, his character and conduct were found to be **Very Good**.



(P. Gopi Krishna) Group Director, MSG पी. गोपी कृष्णा P. Gopi Krishna रामूह निदंशक Group Director एमएसजी MSG एसडीएसरी) शार SDSC SHAR

भारतीय अंतरिक्ष अनुसंधान संगठन







Dear T Shiva Goud,

Greetings from Cognizant !

We would like to thank you for your participation in the Cognizant Internship Program 2022.

This is to acknowledge your Internship training completion with us between 1/25/2022 and 6/8/2022.

Hope the training has been effective in upskilling your capabilities.

Wishing you Good luck for your future endeavors.

Regards,

Human Resources - Cognizant



20th Jun 2022

#### **PROJECT COMPLETION CERTIFICATE**

This is to certify that Mr Kukkadapu Prudhvi Raj Singh Trainee ID 40107009 student of "Chaitanya Bharathi Institute of Technology, Hyderabad" has completed the project entitled "JAVA/ J2EE" under the guidance of "Sureka Rajeshwari" from 21st Feb 2022 to 20th Jun 2022 at Hyderabad for the academic requirements of his graduation.

We have observed that your work was excellent and we appreciate your sincere learning. You have performed the project with energy and enthusiasm. This letter is issued based on your request.

We wish you all the very best in your career ahead!

Yours sincerely, For Wipro Limited,

Aparna Shailen General Manager - Human Resources

Registered Office:

Wipro Limited T : +91 (80) 2844 0011 India

Doddakannelli F : +91 (80) 2844 0054 Sarjapur Road E : info@wipro.com Sarjapur Road E :info@wipro.com Bengaluru 560 035 W : wipro.com C :L32102KA1945PLC020800





ITC Limited PAPERBOARDS & SPECIALTY PAPERS DIVISION Unit : Bhadrachalam Factory : SARAPAKA - 507 128, Bhadradri Kothagudem District. (TELANGANA), India. Fax No.: +91- 8746 - 242460 Telephone : +91-8746 - 242331 - 40 www.itcpspd.com

9<sup>th</sup> Sep 2021

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Ms. Veeram Reddy Bhavana** has undertaken Internship at our organization in Paper Machine VI Mechanical Department. During her Internship, she completed a project titled "**Bearings Consumption and Its Reduction**" from **23<sup>rd</sup> July 2021** to **7<sup>th</sup> August 2021**.

We wish her all the success in future endeavors.

For ITC Limited Paperboards & Specialty Papers Division

M Srinivasa Rao Human Resources



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG4322

Date: 27th MAY 2022

### TO WHOMSOEVER IT MAY CONCERN

| This is to certify that Mr./Ms./Mrs. CHANDRA EEPSIT | TA JASTI          |
|---|-------------------|
| with college id no: 1601                            | 19736003          |
| Studying in CHATTANYA BHARATHI INSTITU              | TE OF TECHNOLOW   |
| pursuing B.E/B. Tech/MBA in MECHANICAL ENGIN        | EERING            |
| discipline had undergone project training from      | 7 2022            |
| to 18th MAY 2022 . The title of the project as pe   | er our records is |
| FUNDAMENTALS OF STEAM TURBINES                      |                   |

Solaton Project training in-charge SAIKIRAN REDOY MANDADI



Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph. 040-24583796 Fax No.040-24584587

No. DRDL/DHRTM/HRD/INTERNSHIP/2022

Date: 27th April 2022

### **CERTIFICATE**

This is to certify that the project work titled "A Study on Experimental Thermo-Structural Testing of Radomes" submitted by P. DEEPA, Roll. No. 160119736004 studying at CBIT, Hyderabad, in partial fulfillment of the requirement for the award of Bachelor of Engineering in Mechanical Engineering, is a record of the bonafide work carried out by her at STF, GD-T&S, Defence Research and Development Laboratory (DRDL) of DRDO, Hyderabad, during the period from 7<sup>th</sup> March 2022 to 7<sup>th</sup> April 2022. Her attendance, conduct and performance during this period were excellent.

Project Guide

Novent (S. NARENDAR) Scientist 'E' TSTF/STF, GD-T&S

seppind - hav

(S JEEVAN BABU) Scientist 'F' Head, HRD/DHRTM

S.JEEVAN BABU Sc-F,HEAD HRD/DHR&TM Defence Res.& Dev.Laboratory Kanchanbagh PO, Hyderabad-58 For DIRECTOR



### SOUTH CENTRAL RAILWAY



Office of the Sr. Divisional Mechanical Engineer/Diesel, Diesel Loco Shed, Kazipet – 506 003. Ph. & Fax No.0870-2576154

## CERTIFICATE

It is to certify that Ms. PRODDUTURI DEEPA D/o Dr. Prodduturi Ashok Kumar studying B.Tech. (Mech.) at Chaitanya Bharathi Institute of Technology, Hyderabad bearing with Roll.No.160119736004 has done Internship and Mini Project Work on a topic titled "Power Pack" at Diesel Loco Shed, Kazipet. She has performed live study as part of the completion of Internship. She has completed the Internship during from 20.07.2021 to 06.08.2021.

During this **Internship**, her performance found satisfactory and she has innovative ideas, deserves encouragement.

DWEERAJ KUMAR Consection incharge New thirds, onth Sr. Section Enginee A.SWARAJ KUMAR Divisional Mechanical Engineer Diesel Loco Shed/Kazipet

E THE STOL OF A U.S. ANTING



Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph. 040-24583796 Fax No.040-24584587

No. DRDL/DHRTM/HRD/INTERNSHIP/2022

Date: 27th April 2022

#### **CERTIFICATE**

This is to certify that the project work titled "A Study on Experimental Thermo-Structural Testing of Radomes" submitted by G. NAVYA, Roll. No. 160119736006 studying at CBIT, Hyderabad, in partial fulfillment of the requirement for the award of Bachelor of Engineering in Mechanical Engineering, is a record of the bonafide work carried out by her at STF, GD-T&S, Defence Research and Development Laboratory (DRDL) of DRDO, Hyderabad, during the period from 7<sup>th</sup> March 2022 to 7<sup>th</sup> April 2022. Her attendance, conduct and performance during this period were excellent.

Project Guide

(S. NARENDAR) Scientist 'E' TSTF/STF, GD-T&S

selling - for

(S. JEEVAN BABU) Scientist 'F' Head, HRD/DHRTM

S.JEEVAN BABU Sc-F,HEAD HRD/DHR&TM Defence Res.& Dev.Laboratory Kanchanbagh PO, Hyderabad-58 For DIRECTOR



# HYDERABAD INSTITUTE OF ELECTRICALENGINEERS

### An ISO 9001:2015 CERTIFIED Organization

# 8-3-191/101, UMASHANKar building, Opp : Vengalrao Nagar Post office, Vengal Rao Nagar, Sunder Nagar, Hyderabad, Telangana - 500038.

### **REGD. NO. 00YY33887503**

## **INTERNSHIP PROGRAM - 2020**



This is to certify that Mr./Ms. \_\_\_\_ GAJULA NAVYA

Son / Daughter of \_\_\_\_\_ GAJULA SRINIVAS

Has successfully completed the "**PYTHON**" Training program.

From 04/06/2020 to 02/07/2020

During the period he/she attended the course regularly and keenly participated in the course activities



**Authorised Signatory** 

Date of Issue :02/07/2020



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG4281

Date: 09-05-2022

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. E. PRANITHA RAJ

with college id no: 160119736007

studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL

discipline had undergone project training from \_\_\_\_\_\_\_\_\_\_

to 09-05-2022. The title of the project as per our records is

PRINCIPLES AND OPERATIONS OF CENTRIFUGAL

50/426

COMPRESSORS

X. lowel

Project training in-charge



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG4299

Date: 09-05-2022

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. P. PRAVALLIKA

with college id no: 160119736008

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in \_\_\_\_\_MECHANICAL

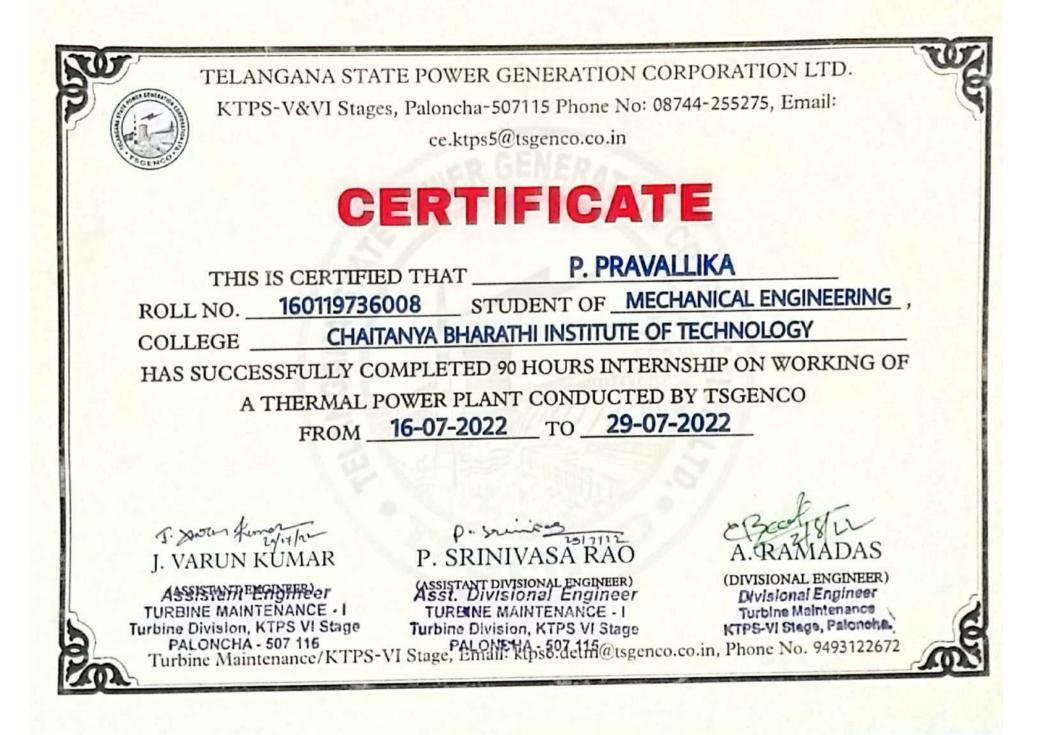
discipline had undergone project training from \_\_\_\_\_25-04 - 2022

to 09-05 - 2022 . The title of the project as per our records is

PRINCIPLES AND OPERATIONS OF CENTRIFUGAL

COMPRESSORS

Project training inwcharge K NARASIMHA SANDEEP GRI HRIGH / HL H - 2 C R RR Dr. Marger / HR - TUX Intine with Kore 2 HE - HPP. HD 2



Scamped with CanSe



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG 4300

Date: 09-05-2022

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. N. SATVIKA

with college id no: <u>160119736009</u>

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in \_\_\_\_\_MECHANICAL

discipline had undergone project training from \_\_\_\_\_\_\_

to 09-05-2022. The title of the project as per our records is

PRINCIPLES AND OPERATIONS OF CENTRIFUGAL

COMPRESSORS

Project training in-charge KNARASHAHA SANDEEP उप प्रताह / मा. सं - टो दो एस Dr. Manger / RF. TX धर्मा स्तरीर स्वर 2 88-1991032



Simha Motors Private Limited D.No. 48-10-12/1, Ramachandra Nagar, Opp. Dr. NTR Health University, Vijayawada - 520 008. CIN : U50400AP2018PTC109047 GSTIN : 37ABACS7221H1ZE

16.07.2022

**Ms. Mende Shreya** Student, CBIT Hyderabad.

#### Certificate of Internship

This is to certify that **Ms. Mende Shreya**, a student of Chaitanya Bharathi Institute of Technology (CBIT) Hyderabad was undergoing an internship i.e. (01-July-2022 to 16-July-2022) and she has successfully completed the project " **Service Operations**" under the guidance of **Mr. Abdul Samadh**.

Ms. Mende Shreya has been sincere and hardworking during the project, we wish her the very best for all the future endeavors.

PRIV IR Der HJAYAN Manager HR

## SOUTH CENTRAL RAILWAY



Office of the Sr. Divisional Mechanical Engineer/Diesel, Diesel Loco Shed, Kazipet – 506 003. Ph. & Fax No.0870-2576154



It is to certify that Mr. BIKKINENI AJITH RAO S/o Bikkineni Sampath Rao studying B.Tech. (Mech.) at Chaitanya Bharathi Institute of Technology, Hyderabad bearing with Roll.No.160119736013 has done Internship and Mini Project Work on a topic titled "Power Pack" at Diesel Loco Shed, Kazipet. He has performed live study as part of the completion of Internship. He has completed the I ernship during from 20.07.2021 to 06.08.2021.

During this **Internship**, his performance found satisfactory and he has innovative ideas, deserves encouragement.

DHEERAJ KUMAR Secontion Incharge for the de, with tr. Section Enginee



Scanned with CamScanner





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

#### No. DRDL/DOE/PED/2022

Dated: 1st Aug, 2022

#### CERTIFICATE

This is to certify that Mr. S Deepak Reddy, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736016) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

1. Verbo (CH.VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST- ¢ Defence Research & Development Laboratory Ministry of Defence, Govt. of India Kanchanbagh, Hyderabad.



## SOMALA DEEPAK REDDY

from CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, has successfully completed a six weeks online training on **Advanced SOLIDWORKS**. The training consisted of Features Bundle #1, Features Bundle #2, Design Tables and Configurations, Assemblies Advanced Mates, Assemblies Deep-Dive and Final Project modules.

We wish SOMALA all the best for the future endeavours.

arous

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2021-07-11

Certificate no.: 17DA2385-3CC8-48FF-A7FF-67EA5339125C



## SOMALA DEEPAK REDDY

from CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, has successfully completed a eight weeks online training on **Ansys**. The training consisted of Introduction to Finite Element Analysis (FEA), Understanding Concepts at Work & Installing Ansys, Introduction to Ansys Software, Static Structural Analysis, Modal, Thermal, & Buckling Analysis, Case Studies and Final Project modules.

We wish SOMALA all the best for the future endeavours.

ares

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2021-09-04

Certificate no.: 29DEDF9C-A068-D9BB-4C40-6824823C9F61



## SOMALA DEEPAK REDDY,

student of CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, has successfully completed a six weeks online training on **AutoCAD** from 22nd May, 2020 to 3rd July, 2020. The training consisted of Interface, Drawing Aids & Basic Objects, Complex Objects & Object editing, Blocks & Annotations and Plotting & Introduction to 3D modules. We wish SOMALA all the best for the future.

Sarvesh Agrawal

Sarvesh Agrawal Founder & CEO, Internshala

Date of certification: 2020-05-30

Certificate no.: CA72F5F6-A95D-A05B-625B-6915BE0138C4



### SOMALA DEEPAK REDDY

from **CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY** has successfully completed a six weeks online training on **Data Science** from 1st July, 2020 to 12th August, 2020. The training consisted of Introduction to Data Science, Python for Data Science, Understanding the Statistics for Data Science and Predictive Modeling and Basics of Machine Learning modules. In the final assessment, SOMALA scored 60% marks. We wish SOMALA all the best for the future.

Sarvesh Agrawal

Sarvesh Agrawal Founder & CEO, Internshala

Date of certification: 2020-07-07

Certificate no.: 51992E31-D4F9-CAB5-75BF-60A38602CB6F



## SOMALA DEEPAK REDDY,

student of CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, has successfully completed a eight weeks online training on **Data Structures & Algorithms**. The training consisted of Introduction to Data Structures, Introduction to Algorithms, Single & Double Dimensional Arrays, Searching & Sorting, Stacks & Queues, Revision of relevant topics in C, Implementation programs of Stacks & Queues, Linear linked list, Circular linked list, Doubly linked list, Trees and Graphs modules. We wish SOMALA all the best for the future.

arous

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2021-06-02

Certificate no.: FE66A67B-3E72-F302-78B0-3BB8D0CFF108



## SOMALA DEEPAK REDDY

from CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY has successfully completed an 8-week online training on **Programming with C and C++**. The training consisted of Getting Started With Programming in C, Diving Into C Programming, Fundamentals of Object Oriented Programming Using CPP, Diving into CPP Programming, and Building Cricket Game Application modules.

We wish SOMALA all the best for future endeavours.

ares

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2022-02-04

Certificate no. : 052AA6A4-6E46-6305-8083-809BFE58CB7C



## SOMALA DEEPAK REDDY

from **CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY, HYDERABAD** has successfully completed a six weeks online training on **SOLIDWORKS** from 16th July, 2020 to 27th August, 2020. The training consisted of SolidWorks- Introduction, Interface and Sketching, Applying Features and Material, SolidWorks Assembly, SolidWorks Drawing and Portfolio Building and Final Project- Air Piston-Cylinder Assembly modules. We wish SOMALA all the best for the future.

Sarvesh Agrawal Founder & CEO, Internshala

Date of certification: 2020-07-22

Certificate no.: C16E16D0-E93F-6A0B-B39E-E9144A3DC63A





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph. 040-2458 3495 Fax No.040-2434 7016

Letter No. DRDL/DHRTM/HRD/PROJECT/2022

Date: 26th July 2022

### CERTIFICATE

This is to certify that Shri DIVIJ (Roll No. 1601-19-736-018) B.E student of Mechanical Engineering, of Chaitanya Bharathi Institute of Technology, Hyderabad, successfully carried out Project on "Machining of EDM Die-Sinking" during the period from 13<sup>th</sup> March 2022 to 26<sup>th</sup> July 2022 at Defence Research and Development Laboratory, Hyderabad under guidance of Shri Niladri Mandal, Sc'F', DOE.

During this industrial training period from 13-03-2022 to 26-07-2022, he was found to be sincere & hard working.

Project Work carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

(Shri S JEEVAN BABU) Scientist 'F' Head, HRD DHRTM, DRDL

S.JEEVAN BABU Sc-F,HEAD HRD/DHR&TM Defence Res.& Dev.Laboratory Kanchanbegh PO, Hyderabed-58

RIMANDAL)

Scientist 'F' Head PDD DOE, DRDL

मिलाडी पंडल/NILADRI MANDAL देशनिक 'एक' /Scientist 'F' प्रमुख, उत्पाद विकास विभाग Head, Product Development Division डी ओ ई/DOE डी आर डी एल/DRDL हेदराबाद/Hyderabad-500 058.



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: LLENGG4324

Date : 27th MAY 2022

### TO WHOMSOEVER IT MAY CONCERN

| This is to certify that Mr./Ms./Mrs. CHENNAMANENT HAVISH FAO     |
|--|
| with college id no: 160119736020                                 |
| Studying in CHATTANYA BHARATHI INSTITUTE OF TECHNOLOWY           |
| pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING                |
| discipline had undergone project training from 4th MAY 2022      |
| to 18th MAY 2022. The title of the project as per our records is |
| FUNDAMENTALS OF STEAM TURBINES                                   |
|  |

 Project training in-charge কিন্তা কৈই ইই কেন্দ্রী নিজনি বিজনি স্ক্রাম্ট্রেমন্স REDDY MANDADI তথ্য স্কৃষ্যক / গানব নাম্রমণ বিজনা কর Dy. Mangour / HRDC

tain the trent BHE-FESD HIDS



Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

#### No. DRDL/DOE/PED/2022

Dated:1st Aug, 2022

#### CERTIFICATE

This is to certify that Mr. Ch. Havish Rao, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736020) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

al. Ventral

(CH VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST♥ Defence Research & Development Laboratory Ministry of Defence, Govt. of India Kanchanbagh, Hyderabad.



SCL/P&A/2020-21 Date:27.07.2021

### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.CHENNAMANENI HAVISH RAO S/o SANJAY RAO a student of 2<sup>nd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Hall ticket / Regd No.160119736020 has been completed his Internship / Project work at our Organization / Cement Factory situated at Mattampally Village & Mandal, Suryapet Dist, Telangana State 06.07.2021 to 26.07.2021 During the Internship Training / Project work he found to be punctual sincere and actively participated in assigned work. We wish him good luck and successful future.

For SAGAR CEMENTS LIMITED,

D.1.2.0.m

D.S.N.V.Prasad Sr.Vice President – Works

1.000



Registered Office : Plot No. 111, Road No.10, Jubilee Hills, Hyderabad - 500033, Telangana, India. Phone : +91-40-23351571, 23356572 Fax : +91-40-23356573 E-mail : info@sagarcements.in Website : www.sagarcements.in Factories : Mattampally. Via Huzurnagar, Suryapet-District, Telangana - 508204. Phone : 08683 - 247039 Bayyavaram Village, Kasimkota Mandal, Visakhapatnam District, Andhra Pradesh - 531031. Phone : 08924-244550 Fax : 08924-244570 CIN : L26942TG 1981PLC002887 GSTIN : 36AACCS8680H1ZZ 67 / 426



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG 5046

Date :06-08-2022

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. <u>HEMANTH YADAV POMKOM</u> with college id no: <u>160119736022</u> studying in <u>CHATTANYA BHARATHI TAISTITUTE OF TECHNOLOGY</u> pursuing B.E/B.Tech/MBA in <u>MECHANICAL ENCINEERING</u> discipline had undergone project training from <u>06-07-2022</u> to <u>05-08-2022</u>. The title of the project as per our records is <u>STUDY OF MANUFACTURING OF STEAM</u> TURBINES.

Project training in-charge ייש אוקעיים זיים איז איזע איז די בהקוראר אוקטר ביעורא קאיניה אוקטר ביאורא איז איז

# edtex



## **CERTIFICATE OF APPRECIATION**

This certificate is presented to

Hemanth Yadav

On completion of 3 months of the 'UNITE' internship programme and successfully executing the digital placements operations at ISB for PGP Co2022

white gawal

ANKIT AGARWAL Sr. Associate Director Career Advancement Services

KIRAN NETI Sr. Associate Director Career Advancement Services

Chandom Chowdhurry

Dr. CHANDAN CHOWDHURY Sr. Associate Dean & Practice Professor Indian School of Business

Anil Kumar

ANIL VISHWANADHULA Founder and CEO EdTex

18<sup>th</sup> March 2022



## S V TURBO ENGINEERING WORKS (P) LTD.

An ISO 9001-2015 Certified Company

### CIN No: U40200TG2005PTC046406 NSIC No: NISIC/TSC/HYD/GP/2011-12/321

GSTIN No : 36AAJCS2665M1ZS PAN No : AAJCS2665M MSN

1ZS TAN No : HYDS19736D ESIC / EPFO No: APPTC0048351000 IEC N MSME (Udyam) Reg No: UDYAM-TS-25-0000405

ESIC No: 52000274360000699 IEC No: 090 700 2366

Date: 01/08/2021

### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr. <u>Hemanth Yadav</u>, student Roll Number of <u>160119736022</u>, has successfully completed a summer internship in the field of <u>Steam Turbines spares Manufacturing and Reconditioning</u> from 15-07-2021 to 30-07-2021 under guidance of <u>R.Rajesh (GM)</u>.

During the period of his internship program with us, he had been exposed to different processes and was found diligent hardworking and inquisitive.

We wish him every success in his life and career.

For SV Turbo Engineering Works (P) Ltd,



www.svturbogroup.com

# D1 & E2, IE, Patancheru - 502 319, Hyderabad, Telangana, INDIA. Phone: +91 8455 221799 & 285254, E-mail: svtew@svturbogroup.com

# edtex



## **CERTIFICATE OF APPRECIATION**

This certificate is presented to

Ketan Kadali

On completion of 3 months of the 'UNITE' internship programme and successfully executing the digital placements operations at ISB for PGP Co2022

White Dawal

ANKIT AGARWAL Sr. Associate Director Career Advancement Services



KIRAN NETI Sr. Associate Director Career Advancement Services

Chandom Chowdhurry

Dr. CHANDAN CHOWDHURY Sr. Associate Dean & Practice Professor Indian School of Business

Anil Kumar

ANIL VISHWANADHULA Founder and CEO EdTex

18<sup>th</sup> March 2022





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

#### No. DRDL/DOE/PED/2022

#### Dated:1st Aug, 2022

#### CERTIFICATE

This is to certify that Mr. B. Koushik Raja Vamshi Goud, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736025) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

(CH VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST F Defence Research & Development Laboratory Ministry of Defence, Govt. of India Kanchanbagh, Hyderabad.

Scanned with CamScanner



SCL/P&A/2020-21 Date:27.07.2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.BARIGELA KOUSHIK RAJA VAMSHI GOUD S/o RAJU GOUD a student of 2<sup>rd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Hall ticket / Regd No.160119736025 has been completed his Internship/Project work at our Organization / Cement Factory situated at Mattampally Village & Mandal, Survapet Dist, Telangana State 06.07.2021 to 26.07.2021 During the Internship Training / Project work he found to be punctual sincere and actively participated in assigned work.

We wish him good luck and successful future.

For SAGAR CEMENTS LIMITED.

D.S.N.V.Prasad Sr.Vice President – Works

6dt



Registered Office ( Plot No. 111, Road No. 10 Justice Hills, Hydersland - 500033, Telungora, India Plane +91-40-2335(37), 23356372, Fac. +91-40-73356373, E-mail: edu@iospirtamenta.in: Website: www.sagarcamenta.in Pactories (Hattempelly, Vie Hatemitige: Surgaper-Ostrict: Telengora: 500204, Phone: 05681, 147(0)9 Renewaraw Village, Kasenkora Musell, Viesklapsenam Dourset, Anders Pradeet: 531(31), Phone: 05624, 344550, 7ax, 58924, 344570 CIN: L389427G199 (PLC002087, GSTIN: 34AACC586400412Z





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph. 040-2458 3495 Fax No.040-2434 7016

Letter No. DRDL/DHRTM/HRD/PROJECT/2022

Date: 26th July 2022

#### CERTIFICATE

This is to certify that Shri MAHESH KUMAR (Roll No. 1601-19-736-027) B.E student of Mechanical Engineering, of Chaitanya Bharathi Institute of Technology, Hyderabad, successfully carried out Project on "Machining of EDM Die-Sinking" during the period from 13<sup>th</sup> March 2022 to 26<sup>th</sup> July 2022 at Defence Research and Development Laboratory, Hyderabad under guidance of Shri Niladri Mandal, Sc'F', DOE.

During this industrial training period from 13-03-2022 to 26-07-2022, he was found to be sincere & hard working.

Project Work carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

(Shin S JEEVAN BABU) Scientist 'F' Head, HRD DHRTM, DRDL

S.JEEVAN BABU

NILADRIMANDAL)

Scientist 'F' Head PDD DOE, DRDL

रिलाडी मंडल/NILADRI MANDAL वैद्यानिक एफ /Scientist 'F' प्रमुख, उत्पाद विकास विभाग Head, Product Development Division दी आर ई/DOE दी आर डी एल/DRDL हेराम्साट/Hyderabad-500 058



SCL/P&A/2020-21 Date:27.07.2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.BARIGELA KOUSHIK RAJA VAMSHI GOUD S/o RAJU GOUD a student of 2<sup>rd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Hall ticket / Regd No.160119736025 has been completed his Internship/Project work at our Organization / Cement Factory situated at Mattampally Village & Mandal, Survapet Dist, Telangana State 06.07.2021 to 26.07.2021 During the Internship Training / Project work he found to be punctual sincere and actively participated in assigned work.

We wish him good luck and successful future.

For SAGAR CEMENTS LIMITED.

D.S.N.V.Prasad Sr.Vice President – Works

6dt



Registered Office ( Plot No. 111, Road No. 10 Justice Hills, Hydersland - 500033, Telungora, India Plane +91-40-2335(37), 23356372, Fac. +91-40-73356373, E-mail: edu@iospirtamenta.in: Website: www.sagarcamenta.in Pactories (Hattempelly, Vie Hatemitige: Surgaper-Ostrict: Telengora: 500204, Phone: 05681, 147039 Renewaraw Vilage, Kasenkora Mandal, Viesklapsteam Dourset, Anders Pradeet: 531031, Phone: 056924, 344550, 7ax, 58924, 344570 CIN: L389427G199 (PLC002087, GSTIN: 34AACC586400412Z



# **CERTIFICATE** OF PARTICIPATION

PROUDLY PRESENTED TO

#### **MR NIKHIL GATTU**

OF PRAHETI RACING FROM CHAITANYA BHARATI INSTITUTE OF TECHNOLOGY FOR HIS PARTICIPATION IN THE FORMULA GREEN CONCEPT 2021 ORGANISED BY ISNEE MOTORSPORTS PVT LTD FROM 23 OCT 2021 TO 31 OCT 2021.

WE WISH HIM SUCCESS IN ALL THE ENDEAVORS.

HEAD - RECORD CELL Mr. BRIJ KISHOR

EVENT MANAGER Mr. AKSHAT SINGH

#### 15 NOV 2021

DATE

76 / 426



#### PS-APSSDC-INTERN.EV2.0-01253 **Certificate No**

## Skill AP APSSDC

# CERTIFICATE OF INTERNSHIP

#### Mr NIKHIL GATTU NAME CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY COLLEGE

has Successfully Completed MASTER CLASS ON EV Design using MATLAB( 30 Days)

at Pantech e Learning Pvt Ltd, Chennai

78/426

From AUG 23,2021 To SEP 21,2021



Dr. Ravi Gujala Chief General Manager (Technical) APSSDC



Prof. Rama Koti Reddy Executive Director APSSDC

shan

N Bangara Raju Managing Director APSSDC



Pantech e Learning

DIGITAL LEARNING SIMPLIFIED

PARTECH SOLUTIONS

Technology Beyond The Dreams

M.Malaiappan Director

Pantech e Learning

# edtex



## **CERTIFICATE OF APPRECIATION**

This certificate is presented to



On completion of 3 months of the 'UNITE' internship programme and successfully executing the digital placements operations at ISB for PGP Co2022

White Dawal

ANKIT AGARWAL Sr. Associate Director Career Advancement Services

KIRAN NETI Sr. Associate Director Career Advancement Services

Chandom Chowelhurry

Dr. CHANDAN CHOWDHURY Sr. Associate Dean & Practice Professor Indian School of Business

Anil Kumar

ANIL VISHWANADHULA Founder and CEO EdTex

18<sup>th</sup> March 2022



RAMAGUNDAM

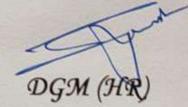
#### HUMAN RESOURCES DEPARTMENT EMPLOYEE DEVELOPMENT CENTRE

#### Ref.No.09/HR-EDC/RSTPS/2022

Date: 14.07.2022

## CERTIFICATE

This is to certify that *Mr.Nalla Nikhil Kumar*, (160119736032) student of B.E (*Mechanical*) of "*Chaitanya Bharathi Institute of Technology* (*A*)" Gandipet, Hyderabad, has done Mini Project Work on "*Steam Turbine And its Associated Systems*" in Mechanical Department at NTPC Ltd., Ramagundam from 23.06.2022 To 07.07.2022.



Employee Development Centre

कर्मचारी विकास केन्द्र प्रभारी Incharge Employee Development Centre NTPC-Ramagundam, PO: Jyothinagar-505 215, Dist: Pediappint, TS, Tele Fax, 08728-27265 REGD.OFFICE:NTPC Bhawan, SCOPE Complex, 7 Institutional New Della - 116 003 Tel.011-24360100 Fax, 011-24361018. Website: www.ntpc.co.in



## S V TURBO ENGINEERING WORKS (P) LTD.

An ISO 9001-2015 Certified Company

CIN No: U40200TG2005PTC046406 NSIC No: NISIC/TSC/HYD/GP/2011-12/321

GSTIN No. MGADICS2865M325 TAN No. HYDRS197360 ESIC I PAN No. AAUCS2665M EFFD No. APPTC0048351000 IEC N MSME (Udwarr) Reg No. UDWAM-15-25-0000405

ESIC No. 52000274360000669 IEC No. : 090 700 2366

Date: 01/08/2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr. <u>Praject Goud</u>, student Roll Number of <u>160119736034</u>, has successfully completed a summer internship in the field of <u>Steam Turbines spares Manufacturing and Reconditioning</u> from 15-07-2021 to 30-07-2021 under guidance of <u>R.Rajesh (GM)</u>.

During the period of his internship program with us, he had been increased to different processes and was found diligent hardworking and inquisitive.

We wish him every success in his life and career.

For SV Turbo Engineering Works (P) Ltd,

1. Joje (4 - 1) / 2) Authorized Signature.

www.svturbogroup.com

# **Certificate of Completion**

# This is to certify that **Prajeet Goud** successfully completed 18.5 total hours of **The complete AutoCAD 2018-21 course** online course on July 7, 2021

Jaiprakash Pandey

Jaiprakash Pandey, Instructor

Udemy

Certificate no: UC-e4b52c98-28f6-4b87-b4da-adbcd59c2f95 Certificate url: ude.my/UC-e4b52c98-28f6-4b87-b4da-adbcd59c2f95 Version 3

82 / 426

Scanned with CamScanne



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22EN005 5006

Date: 12-07-2022

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. RACHAKONDA SAI KIRAN

with college id no: <u>1601-19-736-042</u>

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in <u>MECHANICAL</u>

discipline had undergone project training from \_\_\_\_\_\_\_\_\_\_

to <u>12-07-2022</u>. The title of the project as per our records is

STUDY OF MANUFACTURING OF STEAM TURBINE

Soittle

ार्थ पुरु 2000 साईकिरन रेड्डी मजाडी SAIKIRAN REDDY MANDADI उप प्रयथक / मानव संसाधन दिकास केंद्र Dy Manager / HRDC

Project training in-charge



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22EN005 5006

Date: 12-07-2022

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. RACHAKONDA SAI KIRAN

with college id no: <u>1601-19-736-042</u>

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in <u>MECHANICAL</u>

discipline had undergone project training from \_\_\_\_\_\_\_\_\_

to <u>12-07-2022</u>. The title of the project as per our records is

STUDY OF MANUFACTURING OF STEAM TURBINE

Soittle

अध्य abod-साईफिरन रेड्डी मजाडी SAIKIRAN REDDY MANDADI उप प्रवधक / मानव संसाधन दिकास केंद्र Dy Manager / HRDC

Project training in-charge

MECH/B.E(4)/08/2022/16



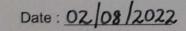


# Certificate

This is to certify that <u>Rachakonda Sai Kiran (160119736042)</u> Student of <u>Chaitanya Bharathi Institute of Technology</u> Studying B.E. Third Year in Department of Mechanical Engineering, has done Internship Project on <u>Maintenance Practices of Disc Brake System</u> <u>on LHB Coaches</u> at South Central Railway, Carriage Workshop, Lallaguda, Secunderabad from <u>19.07.2022</u> to <u>02.08.2022</u>.

This is a record of bonafide work under taken by his towards the partial fulfillment of the requirement for the award of Degree of **"Bachelor of Engineering"**.

He has completed the assigned task Satisfactorily





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

#### No. DRDL/DOE/PED/2022

Dated:1<sup>st</sup> Aug, 2022

#### CERTIFICATE

This is to certify that Mr. N. Sai Vamsi, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736044) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

Cl. Verlat

(CH VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST **T'** Defence Research & Development Laboratory Ministry of Defence, Govt. of India Kanchanbogh, Hyderabad.



DATE: 26-Jun-2020

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr. Nagamalla Sai Vamsi** S/O N Devaiah, a student of Mechanical Engineering 1<sup>st</sup> year from **CBIT College**, bearing Hall Ticket number 160119736044 has successfully completed his Internship at Saboo Marketing & Services, from **5-Jun-2020 to 25-Jun-2020**.

During the period of his Internship programme with us he was found punctual, hardworking and Inquisitive.

We wish him all the best in his future endeavors.

For Saboo Marketing & Services Pvt Ltd

gecta

**HR MANAGER** 



SCL/P&A/2020-21 Date:27.07.2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.NAGAMALLA SAI VAMSI S/o DEVAIAH a student of 2<sup>nd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Hall ticket / Regd No.160119736044 has been completed his Internship/ Project work at our Organization / Cement Factory situated at Mattampally Village & Mandal, Suryapet Dist, Telangana State 06.07.2021 to 26.07.2021

During the Internship Training / Project work he found to be punctual sincere and actively participated in assigned work.

We wish him good luck and successful future.

For SAGAR CEMENTS LIMITED,

NU. 4.1.03

D.S.N.V.Prasad Sr.Vice President – Works

loda



Registered Office : Plot No. 111, Road No.10. Jubilee Hills, Hyderabad - 500033, Telangana, India. Phone : +91-40-23351571, 23356572 Fax : +91-40-23356573 E-mail : info@sagarcements.in Website : www.sagarcements.in Factories : Mattampally, Via Huzurnagar, Suryapet-District, Telangana - 508204. Phone : 08683 - 247039 Bayyavaram Village, Kasimkota Mandal, Visakhapatnam District, Andhra Pradesh - 531031. Phone : 08924-244550 Fax : 08924-244570 CIN : L26942TG1981PLC002887 GSTIN : 36AACCS8680H1ZZ 88 / 426

## CHOGEN POWERS PRIVATE LIMITED

CPPL/HR/2020-21

Date: 17.08.2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.NAGAMALLA SAI VAMSI S/o N.DEVAIAH, a student of 2<sup>nd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Regd.No.160119736044 has completed his Internship/ Project work at our Organization / Gasifier Factory situated at S.M.Pet Village, Munagala Mandal, Suryapet District, Telangana State for a period of 21 days from 27.07.2021 to 16.08.2021. During his Internship Training / Project work he was found to be punctual, sincere, hard working and actively participated in the assigned work.

We wish him Good Luck and a successful future.

For CHOGEN POWERS PRIVATE LIMITED

farmforma MANAGING DIRECT



Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

#### No. DRDL/DOE/PED/2022

Dated:1st Aug, 2022

#### CERTIFICATE

This is to certify that Mr. N. Sai Vamsi, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736044) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

Cl. Venkat

(CH VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST **T'** Defence Research & Development Laboratory Ministry of Defence, Govt. of India Kanchanbrigh, Hyderabad.



on 214 & 22<sup>rd</sup> September 2019



This certificate is awarded to

# NAGAMALLA SAI VAMSI

**AUTOMOBILE & IC ENGINE WORKSHOP** in recognition for participation in

conducted by

Kyrion Technologies Pvt. Ltd.

at Indian Institute of Technology, Hyderabad on 21st & 22nd September 2019

Dinhable.

**Rishabh Mehta** Chairman & Editor -In-chief What After College

Sujata Mehta

Kynion Technologies Pvt. Ltd. Sujata Mehta **Chief Executive Officer** 

**Registration Number** 

WAC-IIT-H-256

CERTIFICATE OF

PARTICIPATION

91 / 426



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



# **BHARAT HEAVY ELECTRICALS LIMITED**

RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG 5021

Date: 14-07-2022

# **TO WHOMSOEVER IT MAY CONCERN**

This is to certify that Mr./Ms./Mrs. REDABOTHU SAKETH REPDY

with college id no: 1601-19-736-045

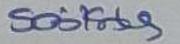
studying in <u>CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)</u> pursuing B.E/B.Tech/MBA in <u>MECHANICAL</u>

discipline had undergone project training from 30-06-2022

to 14 - 07 - 2022. The title of the project as per our records is

STUDY OF MANUFACTURING OF STEAM TURBINES AND

COMPRESSORS



SAIKIRAN REDDY MANDADI उप प्रबंधक / मानव संसाधन विकास केंद्र Dy. Manager / HRDC Project training Einescharge



Scanned by TapScanner





DATE: 18/07/2020



(CERTIFICATION NO.: 19ZQZG02548Q)

Enovate Skill

(NITTTR CHANDIGARH START-UP)



UKAC UKAC UKAC UKAC UK ACKREDITERING CERTIFICATION LIMITED

REF. No.: ESKILL/3D/60

THIS IS CERTIFIED THAT <u>REDABOTHU SAKETH REDDY</u>, ROLL NO./ENROLMENT NO. <u>1601-19-736-045</u> STUDENT OF <u>MECHANICAL ENGINEERING</u>, <u>CHAITANYA</u> <u>BHARATHI INSTITUTE OF TECHNOLOGY (A), GANDIPET, TELANGANA</u> HAS SUCCESSFULLY COMPLETED 60 HOURS (6 WEEKS) INDUSTRIAL TRAINING/INTERNSHIP ON "<u>3D DESIGN</u>" CONDUCTED BY ENOVATE SKILL VIA ICT MODE. HIS/HER PERFORMANCE IN THE TRAINING IS RATED HIGH.

FROM <u>01-06-2020</u> TO <u>08-07-2020</u>.



ENOVATE SKILL

thurders

Director

## CHOGEN POWERS PRIVATE LIMITED

CPPL/HR/2020-21 Date: 17.08.2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.AYALURI SASI KIRAN S/o PHANEENDRA KUMAR, a student of 2<sup>nd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Regd.No.160119736047 has completed his Internship/ Project work at our Organization / Gasifier Factory situated at S.M.Pet Village, Munagala Mandal, Suryapet District, Telangana State for a period of 21 days from 27.07.2021 to 16.08.2021. During his Internship Training / Project work he was found to be punctual, sincere, hard working and actively participated in the assigned work.

We wish him Good Luck and a successful future.



Head Office : Plot No. 25, Phase 1, Paigah Colony, S.P. Road, Secunderbad - 500 003. Tel : 040-27908910, Email : info@chogenpowers.com, www.chogenpowers.com Regd. Office : No. 10, Rajagopal, Street, Rajaji Road, West Tambaram, Chennai - 600045 Ph : 044-43000503 CIN No. : U40300TN2012PTC087289

## HYDERABAD INSTITUTE OF ELECTRICAL ENGINEERS

An ISO 9001:2015 Certified Organisation

REGD. NO. 00YY33887503

 This is to Certify that Mr/Ms
 Sasi Kiran Ayaluri

 Son/Daughter of
 Phaneendra Kumar A

 has successfully completed the "PYTHON" Internship Program from

 04th June '20
 to

During this period he/she has attended the course regularly and keenly participated in the course activities.







SCL/P&A/2020-21 Date:27.07.2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.AYALURI SASI KIRAN S/o PHANEENDRA KUMAR a student of 2nd year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Hall ticket / Regd No.160119736047 has been completed his Internship / Project work at our Organization / Cement Factory situated at Mattampally Village & Mandal, Survapet Dist, Telangana State 06.07.2021 to 26.07.2021 During the Internship Training / Project work he found to be punctual sincere and actively participated in assigned work.

We wish him good luck and successful future.

For SAGAR CEMENTS LIMITED.

D.J. N. V. MIN D.S.N.V.Prasad

Sr. Vice President - Works



Registered Office : Plot No. 111, Road No. 10, Jubilee Hills, Hyderabad - 500033, Telangana, India. Phone : +91-40-23351571, 23356572 Fax : +91-40-23356573 E-mail : info@sagarcements.in Website : www.sagarcements.in Factories : Mattampally, Via Huzurnagar, Suryapet-District, Telangana - 508204. Phone : 08683 - 247039 Bayyavaram Village, Kasimkota Mandal, Visakhapatnam District, Andhra Pradesh - 531031. Phone : 08924-244550 Fax : 08924-244570 CIN : L26942TG1981PLC002887 GSTIN : 36AACCS8680H1ZZ 97 / 426



SCL/P&A/2020-21 Date:27.07.2021

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.GANDHAM SHANMUKHA SWAROOP S/o NARAYANA RAO a student of 2<sup>nd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Hall ticket / Regd No.160119736049 has been completed his Internship / Project work at our Organization / Cement Factory situated at Mattampally Village & Mandal, Suryapet Dist, Telangana State 06.07.2021 to 26.07.2021 During the Internship Training / Project work he found to be punctual sincere and actively participated in assigned work.

We wish him good luck and successful future.

For SAGAR CEMENTS LIMITED,

Dis-v-u-mil D.S.N.V.Prasad Sr.Vice President - Works

6.000



Registered Office : Plot No. 111, Road No.10, Jubilee Hills, Hyderabad - 500033, Telangana, India. Phone : +91-40-23351571, 23356572 Fax : +91-40-23356573 E-mail : info@sagarcements.in Website : www.sagarcements.in Factories : Mattampally, Via Huzurnagar, Suryapet-District, Telangana - 508204. Phone : 08683 - 247039 Factories : Mattampally, Via Huzurnagar, Suryapet-District, Andhra Pradesh - 531031. Phone : 08924-244550 Fax : 08924-244570 Bayyavaram Village, Kasimkota Mandal, Visakhapatnam District, Andhra Pradesh - 531031. Phone : 08924-244550 Fax : 08924-244570 CIN : L26942TG1981PLC002887 GSTIN : 36AACCS8680H1ZZ 98/426



भारत हेवी इलेक्ट्रिकल्स लिमिटेड रामचंद्रापुरम, हैदराबाद मानव संसाधन विकास केंद्र



BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG 5005

Date: 12-07-2022

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. SUDHANSH TANNERU

\_\_\_\_ with college id no: \_\_\_\_\_\_1601-19-736-051

STUDYING IN CHAITAN YA BHARATHI INSTITUTE OF TECHNOLOGY

discipline had undergone project training from \_\_\_\_\_\_\_

to 12-07-2022. The title of the project as per our records is

STUDY OF MANUFACTURING OF STEAM TURBINE

Sostarsa

- ८२४ जु २००४ सर्वनिगम रेड्से मजाही SAIKIRAN REDDY MANDADI तप प्रवयक / मानव संस्थान विकास केव Dy Manager / HRDC Project training in-charge



BRHM/IN/3DP19/2021 17/12/2021,December,Chennai, India.06

#### **CERTIFICATE**

We are glad to inform that Sudhansh Tanneru from Chaitanya Bharathi Institute of Technology has successfully completed the internship program at Brahmastra Aerospace Systems from 18/11/2021 - 10/12/2021.

During the internship, the candidate was exposed to various activities and discussion in the internship division, the candidate also closely worked as a part of the Project trainee programme and the candidate successfully completed the role of project trainee entitled as Specific Heat of Dry Air and Water Level of a Draining Tank at Brahmastra Aerospace Systems.

We found the candidate to be extremely inquisitive and hard working. The candidate was much interested in learning the functions of our core division and also willing to put best efforts to understand the subject and willing to work towards creative thinking. The candidate worked in various software and met the objectives of the project.

The candidate's association with us was very fruitful and we wish him all the best in his future endeavours.





## Tarun Vishnu Vardhan Chirumella

from Chaitanya Bharathi Institute of Technology(A), Hyderabad has successfully completed a 6-week online training on **3D Printing**. The training consisted of Introduction to 3D Printing, Principles, Technologies, and Materials, The Printing Journey, Applications of 3D Printing, Merits, Advancements, and Scope, and Final Project modules.

Tarun Vishnu Vardhan scored 94% marks in the final assessment and is a top performer in the training. We wish Tarun Vishnu Vardhan all the best for future endeavours.

arong

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2022-03-02

Certificate no.: 3DFA1A54-87B1-13AC-5636-1EF1E3D81B09



## Tarun Vishnu Vardhan Chirumella

from CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A), HYDERABAD has successfully completed a 6week online training on **Advanced SOLIDWORKS**. The training consisted of Features Bundle #1, Features Bundle #2, Design Tables and Configurations, Assemblies Advanced Mates, Assemblies Deep-Dive, and Final Project modules.

Tarun Vishnu Vardhan scored 100% marks in the final assessment and is a top performer in the training. We wish Tarun Vishnu Vardhan all the best for future endeavours.

and

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2021-07-31

Certificate no. : E4C27690-B615-760F-4246-06CB5A12F328



## **Tarun Vishnu Vardhan Chirumella**

has successfully completed a 4-week online training on **Business Communication Skills**. The training consisted of Introduction to Business Communication, Essential Communication Skills, The Application Process, and Workplace Communication Skills modules. In the final assessment, Tarun Vishnu Vardhan scored 78% marks. We wish Tarun Vishnu Vardhan all the best for future endeavours.

arous

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2022-04-30

Certificate no. : 7D89606D-DB7E-2C57-9414-8C0375CC081D



## Tarun Vishnu Vardhan Chirumella

from Chaitanya Bharathi Institute of Technology has successfully completed a 4-week online training on Internship & Job Preparation. The training consisted of Getting Started with the Job Hunt, Building up your Gears, Going at the Front, and The Final Project modules. In the final assessment, Tarun Vishnu Vardhan scored 88% marks. We wish Tarun Vishnu Vardhan all the best for future endeavours.

arours

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2021-10-14

Certificate no. : C789AB99-E944-19C0-1DAA-1AF6C7BAD75D



## Tarun Vishnu Vardhan Chirumella

has successfully completed an 8-week online training on **Programming with C and C++**. The training consisted of Getting Started With Programming in C, Diving Into C Programming, Fundamentals of Object Oriented Programming Using CPP, Diving into CPP Programming, and Building Cricket Game Application modules. Tarun Vishnu Vardhan scored 100% marks in the final assessment and is a top performer in the training. We wish Tarun Vishnu Vardhan all the best for future endeavours.

arens

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2022-06-23

Certificate no.: 64FB479A-3B60-3BC2-A68A-BE6FE95B243D



## Tarun Vishnu Vardhan Chirumella

from CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY(A), HYDERABAD has successfully completed a 6week online training on **SOLIDWORKS**. The training consisted of SolidWorks- Introduction, Interface and Sketching, Applying Features and Material, SolidWorks Assembly, SolidWorks Drawing and Portfolio Building, and Final Project- Air Piston-Cylinder Assembly modules. In the final assessment, Tarun Vishnu Vardhan scored 85% marks. We wish Tarun Vishnu Vardhan all the best for future endeavours.

ares

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2021-07-16

Certificate no.: 9701A4F0-30EE-70B3-A83E-5B9D9D23BDCD

### **Keerthika Technologies**

2-39/1/B, Besides DENA Bank, Chandanagar Hyderabad – 500050, Telangana, India

Ph:+91-8297118877

http://garuda3d.com/

email : selvakumaran@garuda3d.com

Date: 31-July-22

#### To whomsoever it may concern

This letter is to certify that **Mr. Tarun Vishnu Vardhan Chirumella** has successfully completed his internship program. His internship tenure was from **01-Jul-2022 to 31-July-22**. He was working with our '3D Printers Production' section and was actively involved in the projects and tasks assigned to him.

During this internship, he was exposed to the various activities in the FFF (Fused Filament Fabrication) 3D printing section. (Assembly, Troubleshooting, 3D Designing, Slicing, 3D Printing etc.).

We found him competent and active with sincerity and determination.

We wish him all the best in his future endeavors.

For Keerthika Technologies

For Keerthika Technologies

Proprietor

Selvakumaran



(भारत सरकार का उपक्रम – महारत्न कम्पनी)

## GAIL (India) Limited

(A Government of India Undertaking - A Maharatna Company)

REF: NO. GAIL/VIZAG/HR/SUM-TRNG/2022/07

एक्जिम् पार्क, विकास कॉलेज के पीछे, शीला नगर, बी एच पी वी (पोस्ट), विशाखपट्नम – 530012 (आं.प्र.)

EXIM PARK, BEHIND VIKAS COLLEGE, SHEELA NAGAR, BHPV (POST), VISAKHAPATNAM - 530 012 (A.P.)

फोन नं / PHONE : 2749771/2749772 : 2748423 / 2513682 जीएसटी नं / GSTNo. : 37AAACG1209J1ZV

July 28, 2022

## CERTIFICATE

This is to certify that Mr. A. Thandava Sai Rohith, a student of B. Tech, Mechanical Engineering, from Chaitanya Bharathi Institute of Technology, Hyderabad had undergone Internship / Industrial Training for a duration of two weeks w.e.f. 04-07-2022 to 17-07-2022 at GAIL, G. Konduru.

During the above period we found him sincere, keen to learn, courteous and adaptable to work environment. His conduct during the above period of training was good.

We wish him a great success in all his feature endeavours.

UNSS (W.N.S.S. PRASAD) Manager (HR) India /

पंजीकृत कार्यालय : 16 भीकाएजी कामा प्लेस आर के पुरम नई दिल्ली–110066



Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

#### No. DRDL/DOE/PED/2022

Dated:1<sup>st</sup> Aug, 2022

#### CERTIFICATE

This is to certify that Mr. A Uday Kiran, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736054) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

Il, Und

(CH.VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST<sup>-</sup>F<sup>-</sup>-Defence Deserve Informent Laboratory of India







Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph. 040-2458 3495 Fax No.040-2434 7016

Letter No. DRDL/DHRTM/HRD/PROJECT/2022

Date: 26th July 2022

### CERTIFICATE

This is to certify that Shri P VENKATA SRI HARSHA (Roll No. 1601-19-736-055) B.E student of Mechanical Engineering, of Chaitanya Bharathi Institute of Technology, Hyderabad, successfully carried out Project on *"Machining of EDM Die-Sinking"* during the period from 13<sup>th</sup> March 2022 to 26<sup>th</sup> July 2022 at Defence Research and Development Laboratory, Hyderabad under guidance of Shri Niladri Mandal, Sc'F', DOE.

During this industrial training period from **13-03-2022** to **26-07-2022**, he was found to be sincere & hard working.

Project Work carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

Shri S JEEVAN BABU) Scientist 'F' Head, HRD DHRTM, DRDL

S.JEEVAN BABU Sc-F,HEAD HRD/DHR&TM Defence Res.& Dev.Laboration Kanchanbagh PO

NILAORI MANDAL) Scientist 'F' Head PDD DOE, DRDL

निलाद्री मंडल/NILADRI MANDAL वैज्ञानिक 'एफ' /Scientist 'F' प्रमुख, उत्पाद विकास विभाग Head, Product Development Division डी ओ ई/DOE डी आर डी एल/DRDL हैदराबाद/Hyderabad-500 058.





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22 ENGG 4323

Date: 27th MAY 2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. MADURI YASHOVARDHAN

\_with college id no: 160119736059

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_+th; MAY ; 2022

to 18th MAY 2022. The title of the project as per our records is

FUNDAMENTALS OF STEAM TURBENES

Project training in-charge المحمد साइंकिरण रेवडी मंडाडी SAIKIRAN REDDY MANDADI उप प्रबंधक / मानव संसाधन विकास केंद्र

TTT STRA - USTERS, ACTOR 32 BHEL-PESD HYD-37

Saikas

CPPL/HR/2020-21

Date: 17.08.2021

### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.MADURI YASHOVARDHAN S/o M.VIJAY, a student of 2<sup>nd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Regd.No.160119736059 has completed his Internship/ Project work at our Organization / Gasifier Factory situated at S.M.Pet Village, Munagala Mandal, Suryapet District, Telangana State for a period of 21 days from 27.07.2021 to 16.08.2021. During his Internship Training / Project work he was found to be punctual, sincere, hard working and actively participated in the assigned work.

We wish him Good Luck and a successful future.

For CHOGEN POWERS PRIVATE LIMITED

formyon HYDERABAD MANAGING DIRECTOR

Head Office : Plot No. 25, Phase 1, Paigah Colony, S.P. Road, Secunderbad - 500 003. Tel : 040-27908910, Email : info@chogenpowers.com, www.chogenpowers.com Regd. Office : No. 10, Rajagopal, Street, Rajaji Road, West Tambaram, Chennai - 600045 Ph : 044-43000503 CIN No. : U40300TN2012PTC087289



and the second second



Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

209944444

#### No. DRDL/DOE/PED/2022

Dated:1st Aug, 2022

#### CERTIFICATE

This is to certify that **Mr. M. Yashovardhan**, student of **Bachelor of Engineering** 4<sup>th</sup> Year, (Roll No. 160119736059) of **Chaitanya Bharathi Institute of Technology**, has undergone the Internship during the period from 29<sup>th</sup> **June 2022 to 31<sup>st</sup> July 2022** at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

Cl. Verley

(CH.VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST 'F' Defence Research & Development Laboratory Ministry of Defence, Govt. of India Kanchanbagh, Hyderabad.



## MTAR TECHNOLOGIES PRIVATE LIMITED

(100% Export Oriented Unit) Survey No. 149/P, IDA, Jagadgirigutta Road, Gandhinagar, Hyderabad - 500 037 Ph +91-40-44555999, Fax +91-40-44555903 E-mail: info@mtar.in CIN No. U722001G1999PTC032836, GSTIN: 36AACCM2021N17L

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr. Maduri Yashovardhan, S/O Mr. Maduri Vijay Kumar, a student of 1<sup>st</sup> year Mechanical Engineering from CBIT with Hall ticket No. 160119736059 had undergone Internship in our organisation from 1<sup>st</sup> June 2020 to 30<sup>th</sup> June 2020 successfully.

During this Internship period we found him to be very hard working and intelligent . We wish him all success and a bright future .

Yours sincerely

BH. Lakshmana Babu

Head – Aerospace Division



SCL/P&A/2020-21 Date:27.07.2021.

#### TO WHOM SO EVER IT MAY CONCERN

This is to certify that Mr.MADURI YASHOVARDHAN S/o VIJAY a student of 2<sup>nd</sup> year Mechanical Engineering from Chaitanya Bharathi Institute of Technology, Hyderabad with Hall ticket / Regd No.160119736059 has been completed his Internship/ Project work at our Organization / Cement Factory situated at Mattampally Village & Mandal, Suryapet Dist, Telangana State 06.07.2021 to 26.07.2021

During the Internship Training / Project work he found to be punctual sincere and actively participated in assigned work.

We wish him good luck and successful future.

For SAGAR CEMENTS LIMITED,

D. ( . w. le mi

D.S.N.V.Prasad Sr.Vice President – Works



Registered Office : Plot No. 111, Road No.10, Jubilee Hills, Hyderabad - 500033, Telangana, India. Phone : +91-40-23351571, 23356572 Fax : +91-40-23356573 E-mail : info@sagarcements.in Website : www.sagarcements.in Factories : Mattampally, Via Huzurnagar, Suryapet-District, Telangana - 508204. Phone : 08683 - 247039 Bayyavaram Village, Kasimkota Mandal, Visakhapatnam District, Andhra Pradesh - 531031. Phone : 08924-244550 Fax : 08924-244570 CIN : L26942TG1981PLC002887 C55TIN : 36AACCS8680H1ZZ





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph. 040-2458 3495 Fax No.040-2434 7016

Letter No. DRDL/DHRTM/HRD/PROJECT/2022

Date: 26th July 2022

### **CERTIFICATE**

This is to certify that Shri K YASHWANTH (Roll No. 1601-19-736-060) B.E student of Mechanical Engineering, of Chaitanya Bharathi Institute of Technology, Hyderabad, successfully carried out Project on *"Machining of EDM Die-Sinking"* during the period from 13<sup>th</sup> March 2022 to 26<sup>th</sup> July 2022 at Defence Research and Development Laboratory, Hyderabad under guidance of Shri Niladri Mandal, Sc'F', DOE.

During this industrial training period from **13-03-2022** to **26-07-2022**, he was found to be sincere & hard working.

Project Work carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

(Shri S JEEVAN BABU) Scientist 'F' Head, HRD DHRTM, DRDL

S.JEEVAN BABU Sc-F,HEAD HRD/DHR&TM Defence Res.& Dev.Laboratory Kanchanbach PO Hyderabad-58

(NILADRIMANDAL)

Scientist 'F' Head PDD DOE, DRDL

निलाद्री मंडल/NILADRI MANDAL वैज्ञानिक 'एफ' /Scientist 'F' प्रमुख, उत्पाद विकास विभाग Head, Product Development Division डी ओ ई/DOE डी आर डी एल/DRDL हैदराबाद/Hyderabad-500 058.





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

22ENG65049

Date : 25-07-2022

## TO WHOMSOEVER IT MAY CONCERN

| This is to certify that Mr./Ms./Mrs | ANJALI VANAM |  |
|-------------------------------------|--------------|--|
|-------------------------------------|--------------|--|

with college id no: 1601-19-736-062

Studying in CHASTANYA BHARATHE JOIGH MUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_\_\_\_\_\_

to 22-07-2022 . The title of the project as per our records is

PLATOR भार गई कार**ार्ट** आहंकिएम रेड्या महार SAIKIRAN REDDY MANDADI वप प्रबंधक / गानव संसम्भन विकास केद Project training in-charge





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG 5059

Date: 23/07/2022

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. NAMA. DIVYA

with college id no: 1601-19-736-064

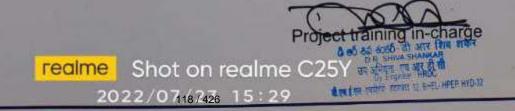
Studying in CHAITHNINYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_ 09 03 2022

to 23/07/2022 . The title of the project as per our records is

STUDY OF MANUFACTURING OF STEAM TURBINES



# edtex



## **CERTIFICATE OF APPRECIATION**

This certificate is presented to

Lakshmi Anusha Mudali

On completion of 3 months of the 'UNITE' internship programme and successfully executing the digital placements operations at ISB for PGP Co2022

White gawal

ANKIT AGARWAL Sr. Associate Director Career Advancement Services

KIRAN NETI Sr. Associate Director Career Advancement Services

Chandom Chowdhurry

Dr. CHANDAN CHOWDHURY Sr. Associate Dean & Practice Professor Indian School of Business

Anil Kumar

ANIL VISHWANADHULA Founder and CEO EdTex

18<sup>th</sup> March 2022





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENG6047

Date: 23-07-2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. NAGASREE- Y

\_\_\_\_ with college id no: 1601-19-136-069

Studying in CHAITBANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_08-01-2022

to 22-01-2022. The title of the project as per our records is

BALANCING OF TURBINE ROTOR



Scanned with CamScanner





## BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22 ENGG 5054

Date: 23/07/2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. <u>SARIKONDA</u>. <u>ABHINAV</u> with college id no: <u>1601-19-136-092</u> studying in <u>CHAITANYA</u> <u>BHARATHI INSTITUTE OF TECHNOLOGY</u>. pursuing B.E/B.Tech/MBA in <u>MECHANICAL</u> <u>ENGINEERING</u> discipline had undergone project training from <u>09/09/2022</u> to <u>23/09/2022</u>. The title of the project as per our records is <u>STUDY OF MANUFACTURING OF STEAM JURBINES</u>

Project training in charge उप अभियता एव आर ही सी ליד ליה ידמווזים בלחמר אב BHEL- HPEP HYD-12





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGL 500%

Date: 12-07-2022

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. CHINMAY KRISHNA PERI

\_ with college id no: <u>1601-19-736-075</u>

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

discipline had undergone project training from \_\_\_\_\_\_\_\_

to <u> $12-03-202\nu$ </u>. The title of the project as per our records is

STUDY OF MANUFACTURING OF STEAM TURBINE

Sostate



BRHM/IN/3DP19/2021 17/12/2021,December,Chennai, India.06

#### **CERTIFICATE**

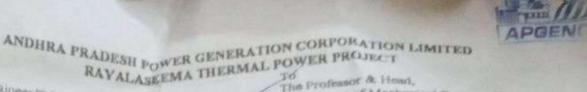
We are glad to inform that Chinmay Krishna Peri from Chaitanya Bharathi Institute of Technology has successfully completed the internship program at Brahmastra Aerospace Systems from 18/11/2021 - 10/12/2021.

During the internship, the candidate was exposed to various activities and discussion in the internship division, the candidate also closely worked as a part of the Project trainee programme and the candidate successfully completed the role of project trainee entitled as Specific Heat of Dry Air and Water Level in Tank at Brahmastra Aerospace Systems.

We found the candidate to be extremely inquisitive and hard working. The candidate was much interested in learning the functions of our core division and also willing to put best efforts to understand the subject and willing to work towards creative thinking. The candidate worked in various software and met the objectives of the project.

The candidate's association with us was very fruitful and we wish him all the best in his future endeavours.





From The Chief Engineer/O&M. V. V. Reddy Nagar - 516 312 Kadapa Dist , A.P.

The Professor & Hend, Department of Mechanical Regimeering Chaitanya Bharathi Institute of Technology Gandipeta, Hyderabad - 500 075. Telangana

LE.No. CE/O& M/RTPP/SE/A& MM/EE/Adm/PO(B)/JAO/F /D.No. 958/22. Dt. 15.97.2922.

- Sub.- APGENCO RTPP Internation Representation of the Professor & Head Department of Mechanical Engineering Chaitanya Bharathi Institute of Technology Gandipeta, Hyderabad -
- Ref.- I) Representation dated Nil, from the Professor & Head Department of Mechanical
  - Engineering, Chaitanya Bharathi Institute of Technology Gandipeta, Hyderabed
  - 2) Payment made for Internaliup vide Pay Order No. 229347 Rs.3,000-00 dt .13.07.2022

In consideration of representation vide reference 1st cited, the internship permission is hereby accorded to Mr. K Hemamshu B. Tech (Roll. No. 1601-19-736-078) Student of Mechanical Engineering for the period from 14.07.2022 to 13.08.2022 subject to non-existence of exigencies as decided by Sri A. Suresh Babu (Id.No.1016341) Deputy Executive Engineer/TM SD-I/Stage-I/RTPP after receipt of Pay Order vide reference 2<sup>nd</sup> cited.

The following are the terms and conditions while in Internship.

- 1) The student may be attached to Sri A. Suresh Babu (Id.No.1016341) Deputy Executive Engineer/TM SD-I L/RTPP under the control of the SE/O&M Stage-I/RTPP for necessary guidance.
- 2) The facility to undergo internship is accorded as a part of his curriculum and at the request of Head of the concarned.
- 3) The student should follow all the safety precautions such as wearing Helmet, Identity Card, Shoes, Tuck etc. during the Internship and APGENCO shall not be liable for any type of injury/accident occurred to you
- 4) The concerned college shall depute one of his faculty member to monitor during the Internship.
- 5) The student shall have to make his own anangements for lodging/ boarding and transport.
- 6) The concerned college shall be held responsible for any loss/damage caused, to the APGENCO equips student.
- 7) The student is directed to produce 2 Nos. passport size photos to the Assistant Security Officer/F&I/RTP gate pass.
- 8) No Electronic goods are allowed in side the plant premises including TABS, CELL PHONES, CAMERAS
- 9) The student is Strictly instructed not to travel in departmental Bus. If travelled his permission will t without any information.
- 10) The Student is strictly instructed not to wander in the Project/Colony premises & he should accompany w only.
- 11 The guide must accompany with the student. If any violation of the student found (like taking photos & going to edges of highest places) the guide will be punished.
- The above permission will be cancelled at any time due to any misbehavior of the student in the colony/ 12) premises or with the officials.
- 13) The Internship Sanctioned vide Register. No. 29/22-23 dt . -06.2022.

For CHIF

Copy to: 1) Sri A. Suresh Babu (Id.No.1016341) Deputy Executive Engineer/TM SD-I/ Stage-I/RTPP through SE/O&M Stage-I/RTPP as per consent given for necessary guidance during Internship & also obtain a copy of project report from the student in order to keep in E&P Library for reference. He will be solely responsible for the safety and Security of the student during the period of Internship.

2) The Assistant Security Officer/F&I/RTPP.

 The Assistant Security Commandant/SPF/RTPP. It is directed to ensure Helmet, Identity card and shoes etc. as stipulate Point No.3, 9 and 10 of this letter.





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENG 65048

Date: 23-07-2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. E. PREMA SAT

\_\_\_\_ with college id no: 1601-19-136-089

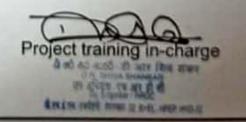
Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_\_\_\_\_02-ot-2022

to 22-01-2022 . The title of the project as per our records is

"BALANCING OF TURBINE ROTOR"



Scanned with CamScanner



## Centre for Product Design, Development And Additive Manufacturing (CPDDAM)

(A Centre of Excellence of OU under RUSA 2.0, MHRD, GoI) Ground Floor, TDC Building, University College of Engineering (Autonomous), OSMANIA UNIVERSITY, Hyderabad - India – 500007. E-mail: director.cpddam@osmania.ac.in Ph. No.: +919154269155, +91 9440408333, +91 9849867046



Date: 28-01-2022

#### **CERTIFICATE**

This is to certify that **Mr. V. Sai Anjan Kumar (1601-19-736-093)** student of Chaitanya Bharathi Institute of Technology, Hyderabad, has gone through internship programme for a period of One month (04<sup>th</sup> October 2021 to 04<sup>th</sup> November 2021) at 'Centre for Product Design, Development and Additive Manufacturing, O.U'.

During his internship, he was regular to the centre and performance was satisfactory.

Run

(Prof. Sriram Venkatesh) DIRECTOR







BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDEMABAD-882052 Human Resolutes Development Centre

Ref No: 22ENGG 5050

Date : 25/07/2022

## TO WHOMSOEVER IT MAY CONCERN

|              |               |             |            |       | AL MA M AN | PEDDY MANDA<br>PEDDY MANDA<br>TITO RELIT DATE<br>anaper, HRDC<br>raining, In-c | 54     |
|--------------|---------------|-------------|------------|-------|------------|--|--------|
|              |               |             |            |       |            |  |        |
|              | 22<br>LANCING |             |            |       |            | r our reco   | rds is |
| iscipline ha | id undergone  | project t   | raining fr | om    | 03-07-     | 2022   | _      |
| ursuing B.E  | /B.Tech/MBA   | in <u>r</u> | ECHAN      | ICAL  | ENGIN      | EERING   |        |
| tudying in_  | CHAITANYA     | BAR         | ATHI IN    | STITU | TE OF      | TECHNON  | DGY    |



## Centre for Product Design, Development And Additive Manufacturing (CPDDAM)



(A Centre of Excellence of OU under RUSA 2.0, MHRD, GoI) Ground Floor, TDC Building. University College of Engineering (Autonomous), OSMANIA UNIVERSITY, Hyderabad - India – 500007. E-mail: director.cpddam@osmania.ac.in Ph. No.: +919154269155, +91 9440408333, +91 9849867046

Date: 28-01-2022

#### **CERTIFICATE**

This is to certify that **Mr. M. Yasasvi (1601-19-736-097)** student of Chaitanya Bharathi Institute of Technology, Hyderabad, has gone through internship programme for a period of One month (04<sup>th</sup> October 2021 to 04<sup>th</sup> November 2021) at 'Centre for Product Design, Development and Additive Manufacturing, O.U'.

During his internship, he was regular to the centre and performance was satisfactory.

rung

(Prof. Sriram Venkatesh) DIRECTOR











THIS CERTIFICATE IS PROUDLY PRESENTED TO

## Koppula Sumanth Reddy

participated in "Robotics" from 10th Jun, 2021 to 10th Aug, 2021 and successfully completed the program.

29-Aug-2021

DATE

PAUL MATHEW. I OVERALL COORDINATOR

129 / 426





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG 5092

Date: 16-08-2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. <u>KASAM NIKHIL</u>

with college id no: 160119736301

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL EMGINEERING

discipline had undergone project training from 02-08-2022

to 16-08-2022. The title of the project as per our records is

FUNDAMENTALS OF STEAM TURBINES AND

COMPRESSORS.

Scanned with CamScanner

मेका हेर्ड देवे केवलके साइकिल्म रेस्ट्री मंडाही SAIKIRAN REDDY MANDADI उप प्रबंधक / मानव सत्तावन दिकास केट Projecty traininguo-charge बारव रात-पहिल्द, सरवर 22 हमटा-PESD MD-22 PHONE: 040-24583150 040-24583151 : 040-24583154 FAX



Government Of India **Ministry Of Defence** Defence Research & Development Orgn., **DEFENCE RESEARCH &** DEVELOPMENT LABORATORY P.O Kanchanbagh Hyderabad - 500058

No. DRDL/DHRTM/HRD/INTERNSHIP/2022

To

Dr.P.V.R. Ravindra Reddy, B.E (Mech), M.Tech (Mfg.Engg, Ph.D. Date: 29th June. 2022

#### MIE, MSAE, MSME, Professor, Dept. of Mechanical Engineering, Chaitanya Bharathi Institute of Technology . Kokapet(V), Gandipet(M), Hyderabad-500 075

#### Sub: PERMISSION FOR INTERNSHIP B.E (Mech Engg) (OFFLINE MODE)

1 The following students of your college has been accepted for doing Internship (OFFLINE MODE) in this organization, for a duration of One Month, i.e., 29/06/2022 to 31/07/2022, under the guidance of SHRI. VENKATESWARLU CHEPURU, SC F, PED/DOE.

| S.No | NAMES OF STUDENTS | ROLL NO.        |
|------|-------------------|-----------------|
| 1    | S Deepak          | 1601-19-736-016 |
| 2    | S Pavan Kalyan    | 1601-19-736-305 |
| 3    | K Praveen Kumar   | 1601-19-736-306 |
| 4    | K. Rahul          | 1601-19-736-302 |
| 5    | A.Uday Kiran      | 1601-19-736-054 |

- 2. Kindly advise your students to report to the undersigned along with 02 passport size photographs, police verification and Xerox copy of permission letter for making security pass.
- 3. On Completion of internship, one copy of Project report should be submitted to HRD, along with the Certificate signed by Project guide and the Xerox copy of Permission Letter.

selgustation

(S. JEEVAN BABU) Sc 'F' Head, HRD/DHRTM

S.JEEVAN BABU Sc-F, HEAD HRD/DHR&TM Defence Res.& Dev.Laboratory Kanchanbagh PO, Hyderabad-58 For DIRECTOR





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG5094

Date : 16-08-2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. KANNOJU SHARATH BABU

with college id no: 160119736303

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_\_\_\_\_\_

to  $\underline{16-08-2022}$ . The title of the project as per our records is

FUNDAMENTALS OF STEAM TURBINES AND

COMPRESSORS

 अध्य ६८६ २३ २००० माइकिरण रेड्डी मंडाडी SAIKIRAN REDDY MANDADI उप प्रबंधक / मानव संसाधन विकास केंद्र Project training in-charge





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG5019

Date : 14-07-2022

#### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. HEMALATHA MAHESHWARAM

with college id no: 1601-19-736-304

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)

pursuing B.E/B.Tech/MBA in MECHANICAL

discipline had undergone project training from \_ 30-06-2022

to 14-07-2022. . The title of the project as per our records is

STUDY OF MANUFACTURING OF STEAM TURBINES AND

COMPRESSORS

SOSKAS

Ark RAN REDOY MANDADI II III III III III III III III III Dy Manager / HRDC Project training in charge

# edtex



## **CERTIFICATE OF APPRECIATION**

This certificate is presented to

Karthik Modugula

On completion of 3 months of the 'UNITE' internship programme and successfully executing the digital placements operations at ISB for PGP Co2022

White Dawal

ANKIT AGARWAL Sr. Associate Director Career Advancement Services

KIRAN NETI Sr. Associate Director Career Advancement Services

Chandom Chowelhurry

Dr. CHANDAN CHOWDHURY Sr. Associate Dean & Practice Professor Indian School of Business

Anil Kumar

ANIL VISHWANADHULA Founder and CEO EdTex

18<sup>th</sup> March 2022





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

#### No. DRDL/DOE/PED/2022

#### Dated: 1st Aug, 2022

#### CERTIFICATE

This is to certify that Mr. S Pavan Kalyan, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736305) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

(CH.VENKATESWARLU) Scientist 'F'

CH. VENKAT AVARLU SCIEM P Defence Research & Deconst Laboratory Ministry of Defence of India Karchanbagh, sad.





Govt. of India Ministry of Defence DEFENCE RESEARCH & DEV. ORGN. DEFENCE RESEARCH & DEV. LABORATORY PO: KANCHANBAGH HYDERABAD – 500 058 Ph.040-24583479

No. DRDL/DOE/PED/2022

#### Dated:1st Aug, 2022

#### CERTIFICATE

This is to certify that Mr. K Praveen kumar, student of Bachelor of Engineering 4<sup>th</sup> Year, (Roll No. 160119736306) of Chaitanya Bharathi Institute of Technology, has undergone the Internship during the period from 29<sup>th</sup> June 2022 to 31<sup>st</sup> July 2022 at Defence Research & Development Laboratory (DRDL), Kanchanbagh, Hyderabad. He has successfully completed the Internship under my guidance and Internship on "Advanced Manufacturing".

During internship period he was found to be sincere & hard working and has taken keen interest in learning new techniques and technologies associated.

This Internship carried out in DRDL, Hyderabad is a part of academic curriculum and cannot be claimed as experience.

Ch. Unbal (CH.VENKATESWARLU) Scientist 'F'

CH. VENKATESWARLU SCIENTIST F' Defence Research & Development Laboratory Ministry of Defence, Govt. of Indie Kanchanbagh, Hyderabad.





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG5093

Date: 16-08-2022

## TO WHOMSOEVER IT MAY CONCERN

| This is to certify that Mr./Ms./Mrs. GAJULA LAXMAN  |
|---|
| with college id no: 160119736307  |
| studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY  |
| pursuing B.E/B.Tech/MBA in MECHANTICAL ENGINEERING  |
| discipline had undergone project training from  |
| to <u>16-08-2022</u> . The title of the project as per our records is   |
| FUNDAMENITALS OF STEAM TURBINES AND   |
| COMPRESSORS   |
|   |
| Sosilers  |
| रुष्ण ३०७ ८५ व्यु व्यव्यवे-साइंकिरण रेड्डी मंडाडी<br>SAIKIRAN REDDY MANDADI<br>उप प्रबंधक / मानव संसाधन विकास केंद्र<br>Dy. Manager / HRDC<br>Project training insecharge |
|   |





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG5091

Date : 16-08-2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. GANJI SAIRAM

with college id no: 160119736308

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_\_\_\_\_02-08-2022

to <u>16-08-2022</u>. The title of the project as per our records is

FUNDAMENTALS OF STEAM TURBINES AND

COMPRESSORS

 अध्य हैंठई देई २०००ई- साइंकिरण रेड्डी मंडाडी SAIKIRAN REDDY MANDADI उप प्रविधक / मानव संसाधन विकास केंद्र Dy. Manager / HRDC Project training in-charge





### BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGIG15020

Date: 14-07-2022

### TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. MANISHA MODELA

\_\_\_\_\_ with college id no: 1601-19-736-309

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGG

discipline had undergone project training from 30-06-2022

\_\_\_\_\_. The title of the project as per our records is to 14-07-2022 TURBINES AND COMPRESSORS .

Sorta

िक रेले 25 माजने- साइजिस्ट रेडडी मंडाये SAIKIRAN REDDY MANDADI उप प्रवधक / मानव संसाधन विकास केंद्र Dy Manager / HRDC Aref tone 11 BE. 312 MOT Project training in-charge



## **Certificate of Training**

## **MANISHA MODELA**

from CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (CBIT) has successfully completed a 6-week online training on **CATIA**. The training consisted of Introduction to CATIA and Sketcher Workbench, Part Design Workbench, Wireframe and Surface Design, Assembly Workbench, Drafting Workbench, and Final Training Project modules.

MANISHA scored 90% marks in the final assessment and is a top performer in the training. We wish MANISHA all the best for future endeavours.

and

Sarvesh Agarwal FOUNDER & CEO, INTERNSHALA

Date of certification: 2022-02-02

Certificate no. : F01428D2-FA32-B671-47FD-1ABC2DA492E1

For certificate authentication, please visit https://trainings.internshala.com/verify\_certificate





BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22ENGG 5053

Date: 23/07/2022

#### TO WHOMSOEVER IT MAY CONCERN

| This is to certify that Mr./Ms./Mrs | AJMEERA RACHANA |  |
|-------------------------------------|-----------------|--|
|                                     |                 |  |

with college id no: 1601-19-736-311

Studying in CHAITHANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in MECHANICAL ENGINEERING

discipline had undergone project training from \_ 09/03/2022

to 23/09/2022 . The title of the project as per our records is

141 / 426

STUDY OF MANUFACTURING OF STEAM TURBINES







BHARAT HEAVY ELECTRICALS LIMITED RAMACHANDRAPURAM, HYDERABAD-502032 Human Resource Development Centre

Ref No: 22 ENGG 5009

Date: 12-07-2022

## TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr./Ms./Mrs. NIRMIT NAHA

\_ with college id no: 1601-19-736-313

Studying in CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

pursuing B.E/B.Tech/MBA in \_\_\_\_\_MECHANICAL

discipline had undergone project training from \_\_\_\_\_\_

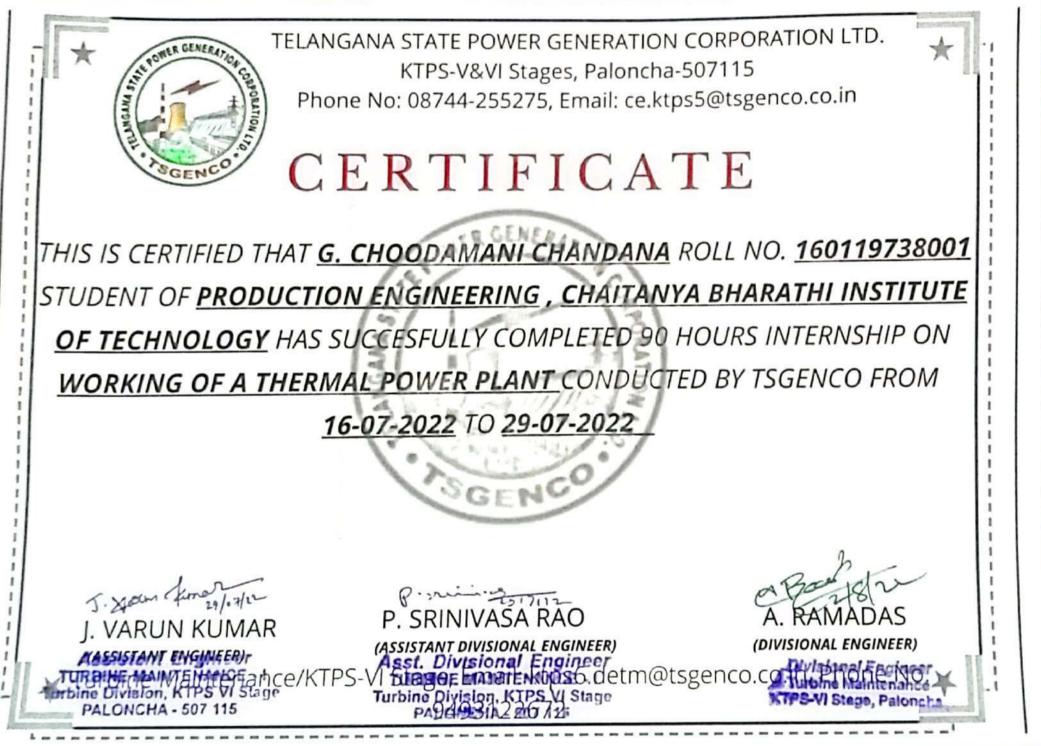
to 12-03-2022. The title of the project as per our records is

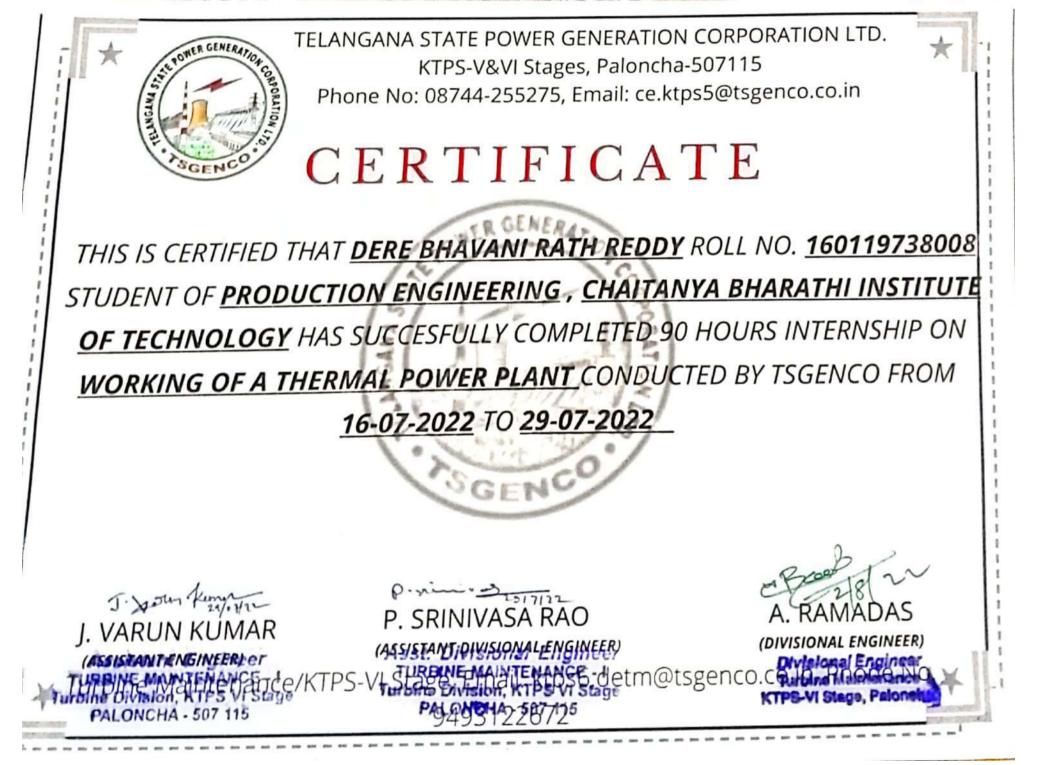
STUDY OF MANUFACTURING OF STEAM TURBINE

Southe

SAIKIRAN REDDY MANDADI JU YAUA / मानव संसाधन विकास केंद्र Dy. Manager / HRDC जर्ड ल-बीहल्बी सेरावर 22 BHEL-PESD HTD 22 Project training in-charge







144 / 426

Scanned with CanScan

TELANGANA STATE POWER GENERATION CORPORATION LTD. KTPS-V&VI Stages, Paloncha-507115 Phone No: 08744-255275, Email: ce.ktps5@tsgenco.co.in CERTIFICATE THIS IS CERTIFIED THAT MALOTH MAHESH ROLL NO. 160119738010 STUDENT OF PRODUCTION ENGINEERING, CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY HAS SUCCESFULLY COMPLETED 90 HOURS INTERNSHIP ON WORKING OF A THERMAL POWER PLANT CONDUCTED BY TSGENCO FROM 16-07-2022 TO 29-07-2022 J Seous fime rafet P. SRINIVASA RÃO AASSISTANT DIVISIONAL ENGINEER) s6.detm@tsgenco.co.m KTPS-VIS

145 / 426

PHONE: 040-24583150 040-24583151 : 040-24583154 FAX



Government Of India Ministry Of Defence Defence Research & Development Orgn., **DEFENCE RESEARCH &** DEVELOPMENT LABORATORY P.O Kanchanbagh Hyderabad - 500058

No. DRDL/DHRTM/HRD/INTERNSHIP/2022

To

Dr.P.V.R. Ravindra Reddy, B.E (Mech), M.Tech (Mfg.Engg, Ph.D. Date: 29th June. 2022

## MIE, MSAE, MSME, Professor, Dept. of Mechanical Engineering, Chaitanya Bharathi Institute of Technology . Kokapet(V), Gandipet(M), Hyderabad-500 075

## Sub: PERMISSION FOR INTERNSHIP B.E (Mech Engg) (OFFLINE MODE)

1 The following students of your college has been accepted for doing Internship (OFFLINE MODE) in this organization, for a duration of One Month, i.e., 29/06/2022 to 31/07/2022, under the guidance of SHRI. VENKATESWARLU CHEPURU, SC F, PED/DOE.

| S.No | NAMES OF STUDENTS | ROLL NO.        |
|------|-------------------|-----------------|
| 1    | S Deepak          | 1601-19-736-016 |
| 2    | S Pavan Kalyan    | 1601-19-736-305 |
| 3    | K Praveen Kumar   | 1601-19-736-306 |
| 4    | K. Rahul          | 1601-19-736-302 |
| 5    | A.Uday Kiran      | 1601-19-736-054 |

- 2. Kindly advise your students to report to the undersigned along with 02 passport size photographs, police verification and Xerox copy of permission letter for making security pass.
- 3. On Completion of internship, one copy of Project report should be submitted to HRD, along with the Certificate signed by Project guide and the Xerox copy of Permission Letter.

selgustation

(S. JEEVAN BABU) Sc 'F' Head, HRD/DHRTM

S.JEEVAN BABU Sc-F, HEAD HRD/DHR&TM Defence Res.& Dev.Laboratory Kanchanbagh PO, Hyderabad-58 For DIRECTOR

PHONE: 040-24583150 040-24583151 : 040-24583154 FAX



Government Of India Ministry Of Defence Defence Research & Development Orgn., **DEFENCE RESEARCH &** DEVELOPMENT LABORATORY P.O Kanchanbagh Hyderabad - 500058

No. DRDL/DHRTM/HRD/INTERNSHIP/2022

To

Dr.P.V.R. Ravindra Reddy, B.E (Mech), M.Tech (Mfg.Engg, Ph.D. Date: 29th June. 2022

## MIE, MSAE, MSME, Professor, Dept. of Mechanical Engineering, Chaitanya Bharathi Institute of Technology . Kokapet(V), Gandipet(M), Hyderabad-500 075

## Sub: PERMISSION FOR INTERNSHIP B.E (Mech Engg) (OFFLINE MODE)

1 The following students of your college has been accepted for doing Internship (OFFLINE MODE) in this organization, for a duration of One Month, i.e., 29/06/2022 to 31/07/2022, under the guidance of SHRI. VENKATESWARLU CHEPURU, SC F, PED/DOE.

| S.No | NAMES OF STUDENTS | ROLL NO.        |
|------|-------------------|-----------------|
| 1    | S Deepak          | 1601-19-736-016 |
| 2    | S Pavan Kalyan    | 1601-19-736-305 |
| 3    | K Praveen Kumar   | 1601-19-736-306 |
| 4    | K. Rahul          | 1601-19-736-302 |
| 5    | A.Uday Kiran      | 1601-19-736-054 |

- 2. Kindly advise your students to report to the undersigned along with 02 passport size photographs, police verification and Xerox copy of permission letter for making security pass.
- 3. On Completion of internship, one copy of Project report should be submitted to HRD, along with the Certificate signed by Project guide and the Xerox copy of Permission Letter.

selgusta

(S. JEEVAN BABU) Sc 'F' Head, HRD/DHRTM

S.JEEVAN BABU Sc-F, HEAD HRD/DHR&TM Defence Res.& Dev.Laboratory Kanchanbagh PO, Hyderabad-58 For DIRECTOR



Office of the Superintending Engineer/O&M, RTS-D, Ramagundam

Proceedings, No. SE/O&M/RTS-B/DF(AT&F)/DM(HR)/Jr.Asst/F.MINI Project/D.No.679/2022, Dt:11.07.2022

Sub:- TSGENCO - RTS-B Stn -- MINI Project work, at RTS-B to the B.E students of Chaitanya Bharati Institute of Technologly, Hyderabad-Permission Accorded - Reg.

Ref-1)/G.O.D.No.579/CGM(Adm)/2012, Dt:05.02.2013.

 Request letter from the Professor & Head, Dept. of Mechanical Engineering, Chaitanya Bharati Institute of Technologly, Hyderabad.

#### \*\*\*\*

ORDER: As per the request made in the reference 2<sup>nd</sup> cited, the student of III rd Year, B.E. Mechanical Engineering (VI-Sem) of Chaitanya Bharati Institute of Technologly are allotted to <u>DE/MM</u> to do Mini Project work at RTS-B for a period of 2 Weeks commencing from 12.07.2022 (09:00 AM to 12:00 PM).

| SLNo | Name of the Student | Reg.Number      |
|------|---------------------|-----------------|
| 1    | B.Manoj Kumar       | 1601-19-736-082 |
| 2    | G.Vamshi            | 1601-19-736-114 |
| 3    | J.Bharadwaj         | 1601-19-736-074 |
| 4    | P.Rajesh            | 1601-19-736-091 |

2 The concerned College/Institute shall depute one of their faculty member along with the students to monitor their activities during the period of Mini Project.

 The fee for doing Mini Project Work per student is Rs.590/-, furnished by the candidates are received as per the Demand Drafts details mentioned below.

| SLNo | Demand Draft No. | Date       | Amount   |
|------|------------------|------------|----------|
| 1    | 484496           | 07.07.2022 | Rs 5904  |
| 2    | 484498           | 07.07.2022 | Rs.590/- |
| 3    | 484499           | 07.07.2022 | Rs.590/- |
| 4    | 484497           | 07.07.2022 | Rs.590/- |

4. The permission now accorded to do Mini Project work is subject to the terms and conditions enclosed in the ANNEXURE and the undersigned reserves right to withdraw permission at any time without assigning any reasons thereof.

5. The students are directed to report to <u>DE/MM</u> for doing Mini Project work. They are further informed that they shall contact Assistant Commandant/TSSPF/RTS-B with two recent passport size photographs(colour) for issue of temporary gatepass. They will produce the gatepass as and when required for verification, and entry to the plant will be permitted only on production of the same.

#### Eacl:-1)Annexure

2) Indemnity Bond ( Proforma)

#### Sd/-Superintending Engineer/O&M RTS.B/Ramagundam

#### Tor

- Copy to the <u>DE/MM</u> along with a copy of ANNEXURE. It is requested to obtain "Indemnity Bond" at the time of joining of the students and certificate issued after completion of the Mini Project work in the prescribed format. On completion of Mini Project work, the students are directed to submit one copy of the report to this office for records.
- Copy to the Accounts Officer/RTS-B-The fee collected from the above students will be remitted to the AO/RTS-B, Ramagundam separately
- 4. Copy to the Assistant Commandant/TSPF/RTS-B for necessary action Temporary gatepass (with colour photos) may be issued to the above candidates for a period of 2 Weeks from 12.07.2022, entry to the plant may be restricted duly insisting the candidates to produce the gatepass for inspection.



Office of the Superintending Engineer/O&M, RTS-D, Ramagundam

Proceedings, No. SE/O&M/RTS-B/DF(AT&F)/DM(HR)/Jr.Asst/F.MINI Project/D.No.679/2022, Dt:11.07.2022

Sub:- TSGENCO - RTS-B Stn -- MINI Project work, at RTS-B to the B.E students of Chaitanya Bharati Institute of Technologly, Hyderabad-Permission Accorded - Reg.

Ref-1)/G.O.D.No.579/CGM(Adm)/2012, Dt:05.02.2013.

 Request letter from the Professor & Head, Dept. of Mechanical Engineering, Chaitanya Bharati Institute of Technologly, Hyderabad.

#### ....

ORDER: As per the request made in the reference 2<sup>nd</sup> cited, the student of III rd Year, B.E. Mechanical Engineering (VI-Sem) of Chaitanya Bharati Institute of Technologly are allotted to <u>DE/MM</u> to do Mini Project work at RTS-B for a period of 2 Weeks commencing from 12.07.2022 (09:00 AM to 12:00 PM).

| SLNo | Name of the Student | Reg.Number      |  |
|------|---------------------|-----------------|--|
| 1    | B.Manoj Kumar       | 1601-19-736-082 |  |
| 2    | G.Vamshi            | 1601-19-736-114 |  |
| 3    | J.Bharadwaj         | 1601-19-736-074 |  |
| 4    | P.Rajesh            | 1601-19-736-091 |  |

2 The concerned College/Institute shall depute one of their faculty member along with the students to monitor their activities during the period of Mini Project.

 The fee for doing Mini Project Work per student is Rs.590/-, furnished by the candidates are received as per the Demand Drafts details mentioned below.

| SLNo | Demand Draft No. | Date       | Amount   |
|------|------------------|------------|----------|
| 1    | 484496           | 07.07.2022 | Rs 5904  |
| 2    | 484498           | 07.07.2022 | Rs.590/- |
| 3    | 484499           | 07.07.2022 | Rs.590/- |
| 4    | 484497           | 07.07.2022 | Rs.590/- |

4. The permission now accorded to do Mini Project work is subject to the terms and conditions enclosed in the ANNEXURE and the undersigned reserves right to withdraw permission at any time without assigning any reasons thereof.

5. The students are directed to report to <u>DE/MM</u> for doing. Mini Project work. They are further informed that they shall contact Assistant Commandant/TSSPF/RTS-B with two recent passport size photographs(colour) for issue of temporary gatepass. They will produce the gatepass as and when required for verification, and entry to the plant will be permitted only on production of the same.

#### Eacl:-1)Annexure

2) Indemnity Bond ( Proforma)

#### Sd/-Superintending Engineer/O&M RTS.B/Ramagundam

#### Tor

- Copy to the <u>DE/MM</u> along with a copy of ANNEXURE. It is requested to obtain "Indemnity Bond" at the time of joining of the students and certificate issued after completion of the Mini Project work in the prescribed format. On completion of Mini Project work, the students are directed to submit one copy of the report to this office for records.
- Copy to the Accounts Officer/RTS-B-The fee collected from the above students will be remitted to the AO/RTS-B, Ramagundam separately
- 4. Copy to the Assistant Commandant/TSPF/RTS-B for necessary action Temporary gatepass (with colour photos) may be issued to the above candidates for a period of 2 Weeks from 12.07.2022, entry to the plant may be restricted duly insisting the candidates to produce the gatepass for inspection.



Office of the Superintending Engineer/O&M, RTS-D, Ramagundam

Proceedings, No. SE/O&M/RTS-B/DF(AT&F)/DM(HR)/Jr.Asst/F.MINI Project/D.No.679/2022, Dt:11.07.2022

Sub:- TSGENCO - RTS-B Stn -- MINI Project work, at RTS-B to the B.E students of Chaitanya Bharati Institute of Technologly, Hyderabad-Permission Accorded - Reg.

Ref-1) G.O.D.No.579/CGM(Adm)/2012, Dt:05.02.2013.

 Request letter from the Professor & Head, Dept. of Mechanical Engineering, Chaitanya Bharati Institute of Technologly, Hyderabad.

#### ....

ORDER: As per the request made in the reference 2<sup>nd</sup> cited, the student of III rd Year, B.E. Mechanical Engineering (VI-Sem) of Chaitanya Bharati Institute of Technologly are allotted to <u>DE/MM</u> to do Mini Project work at RTS-B for a period of 2 Weeks commencing from 12.07.2022 (09:00 AM to 12:00 PM).

| SLNo | Name of the Student | Reg.Number      |  |
|------|---------------------|-----------------|--|
| 1    | B.Manoj Kumar       | 1601-19-736-082 |  |
| 2    | G.Vamshi            | 1601-19-736-114 |  |
| 3    | J.Bharadwaj         | 1601-19-736-074 |  |
| 4    | P.Rajesh            | 1601-19-736-091 |  |

2 The concerned College/Institute shall depute one of their faculty member along with the students to monitor their activities during the period of Mini Project.

 The fee for doing Mini Project Work per student is Rs.590/-, furnished by the candidates are received as per the Demand Drafts details mentioned below.

| SLNo | Demand Draft No. | Date       | Amount   |
|------|------------------|------------|----------|
| 1    | 484496           | 07.07.2022 | Rs 5904  |
| 2    | 484498           | 07.07.2022 | Rs.590/- |
| 3    | 484499           | 07.07.2022 | Rs.590/- |
| 4    | 484497           | 07.07.2022 | Rs.590/- |

4. The permission now accorded to do Mini Project work is subject to the terms and conditions enclosed in the ANNEXURE and the undersigned reserves right to withdraw permission at any time without assigning any reasons thereof.

5. The students are directed to report to <u>DE/MM</u> for doing Mini Project work. They are further informed that they shall contact Assistant Commandant/TSSPF/RTS-B with two recent passport size photographs(colour) for issue of temporary gatepass. They will produce the gatepass as and when required for verification, and entry to the plant will be permitted only on production of the same.

#### Eacl:-1)Annexure

2) Indemnity Bond ( Proforma)

#### Sd/-Superintending Engineer/O&M RTS.B/Ramagundam

#### Tor

- Copy to the <u>DE/MM</u> along with a copy of ANNEXURE. It is requested to obtain "Indemnity Bond" at the time of joining of the students and certificate issued after completion of the Mini Project work in the prescribed format. On completion of Mini Project work, the students are directed to submit one copy of the report to this office for records.
- Copy to the Accounts Officer/RTS-B-The fee collected from the above students will be remitted to the AO/RTS-B, Ramagundam separately
- 4. Copy to the Assistant Commandant/TSPF/RTS-B for necessary action Temporary gatepass (with colour photos) may be issued to the above candidates for a period of 2 Weeks from 12.07.2022, entry to the plant may be restricted duly insisting the candidates to produce the gatepass for inspection.



Office of the Superintending Engineer/O&M, RTS-D, Ramagundam

Proceedings, No. SE/O&M/RTS-B/DF(AT&F)/DM(HR)/Jr.Asst/F.MINI Project/D.No.679/2022, Dt:11.07.2022

Sub:- TSGENCO - RTS-B Stn -- MINI Project work, at RTS-B to the B.E students of Chaitanya Bharati Institute of Technologly, Hyderabad-Permission Accorded - Reg.

Ref-1)/G.O.D.No.579/CGM(Adm)/2012, Dt:05.02.2013.

 Request letter from the Professor & Head, Dept. of Mechanical Engineering, Chaitanya Bharati Institute of Technologly, Hyderabad.

#### ....

ORDER: As per the request made in the reference 2<sup>nd</sup> cited, the student of III rd Year, B.E. Mechanical Engineering (VI-Sem) of Chaitanya Bharati Institute of Technologly are allotted to <u>DE/MM</u> to do Mini Project work at RTS-B for a period of 2 Weeks commencing from 12.07.2022 (09:00 AM to 12:00 PM).

| SLNo | Name of the Student | Reg.Number      |  |
|------|---------------------|-----------------|--|
| 1    | B.Manoj Kumar       | 1601-19-736-082 |  |
| 2    | G.Vamshi            | 1601-19-736-114 |  |
| 3    | J.Bharadwaj         | 1601-19-736-074 |  |
| 4    | P.Rajesh            | 1601-19-736-091 |  |

2 The concerned College/Institute shall depute one of their faculty member along with the students to monitor their activities during the period of Mini Project.

 The fee for doing Mini Project Work per student is Rs.590/-, furnished by the candidates are received as per the Demand Drafts details mentioned below.

| SLNo | Demand Draft No. | Date       | Amount   |
|------|------------------|------------|----------|
| 1    | 484496           | 07.07.2022 | Rs 5904  |
| 2    | 484498           | 07.07.2022 | Rs.590/- |
| 3    | 484499           | 07.07.2022 | Rs.590/- |
| 4    | 484497           | 07.07.2022 | Rs.590/- |

4. The permission now accorded to do Mini Project work is subject to the terms and conditions enclosed in the ANNEXURE and the undersigned reserves right to withdraw permission at any time without assigning any reasons thereof.

5. The students are directed to report to <u>DE/MM</u> for doing. Mini Project work. They are further informed that they shall contact Assistant Commandant/TSSPF/RTS-B with two recent passport size photographs(colour) for issue of temporary gatepass. They will produce the gatepass as and when required for verification, and entry to the plant will be permitted only on production of the same.

#### Eacl:-1)Annexure

2) Indemnity Bond ( Proforma)

#### Sd/-Superintending Engineer/O&M RTS.B/Ramagundam

#### Tor

- Copy to the <u>DE/MM</u> along with a copy of ANNEXURE. It is requested to obtain "Indemnity Bond" at the time of joining of the students and certificate issued after completion of the Mini Project work in the prescribed format. On completion of Mini Project work, the students are directed to submit one copy of the report to this office for records.
- Copy to the Accounts Officer/RTS-B-The fee collected from the above students will be remitted to the AO/RTS-B, Ramagundam separately
- 4. Copy to the Assistant Commandant/TSPF/RTS-B for necessary action Temporary gatepass (with colour photos) may be issued to the above candidates for a period of 2 Weeks from 12.07.2022, entry to the plant may be restricted duly insisting the candidates to produce the gatepass for inspection.



#### Process Biochemistry Volume 102, March 2021, Pages 213-219

# Influence of Trace Metals concentration on Methane generation using Microbial Electrochemical Systems

C. Nagendranatha Reddy <sup>a, b</sup>, Sanath Kondaveeti <sup>c</sup>, Booki Min <sup>a</sup>  $\stackrel{\circ}{\sim}$  🖾

#### Show more $\sim$

\Xi Outline 🛛 🖧 Share 🗦 Cite

https://doi.org/10.1016/j.procbio.2020.12.021

Get rights and content

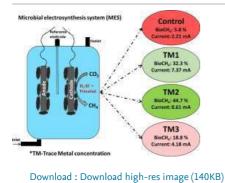
#### Highlights

- Optimum concentrations of trace metals enhanced biocatalyst's metabolic activity.
- Higher concentrations of trace metals inhibited the overall performance of MES.
- CH<sub>4</sub> production in TM2 was almost 3.9 folds higher than the control without metal addition.
- Cyclic voltammograms showed higher reduction profiles over <u>oxidation</u> in TM operations.

#### Abstract

The biomethane generation in microbial electrosynthesis systems (MESs) was affected by the addition of trace metals (TMs) during biocatalyst's metabolic activity. The functional role of various TMs ( $Mg^{2+}$ ,  $Fe^{2+}$ ,  $Ni^{2+}$ ,  $Zn^{2+}$ ,  $Co^{2+}$ ,  $Mn^{2+}$ , and  $Mo^{2+}$ ) in regulating the CH<sub>4</sub> production potential of a <u>biocatalyst</u> was evaluated under three different ranges of TM concentrations, and their performances were compared with the control operation (no trace metals). The TM level in a relatively medium concentration range exhibited the best efficiency and could enhance the CH<sub>4</sub> production and currents generation by 3.9 and 7.7 folds higher than the values from the control. Cyclic voltammogram profiles depicted increment in redox catalytic currents during MES operation with TMs and also supported the involvement of mediators towards CH<sub>4</sub> generation. The optimum TM concentrations could enhance MES performance as a constituent of ferredoxin and hydrogenase linked to energy metabolism.

#### Graphical abstract



Download : Download full-size image



Next >

#### Keywords

Microbial electrochemical system; Divalent cations; Trace elements; Inorganic carbon (CO<sub>2</sub>); Biomethane

Special issue articles Recommended articles

Cited by (2)

Regulation and augmentation of anaerobic digestion processes via the use of bioelectrochemical systems 2022, Bioresource Technology

Show abstract  $\checkmark$ 

#### Strategies in the direction of scaling-up aspects of microbial electrolysis cells

2022, Scaling Up of Microbial Electrochemical Systems: From Reality to Scalability

Show abstract  $\checkmark$ 

View full text

© 2021 Elsevier Ltd. All rights reserved.



Copyright © 2022 Elsevier B.V. or its licensors or contributors. ScienceDirect<sup>®</sup> is a registered trademark of Elsevier B.V.

**RELX**<sup>™</sup>



Chemical Data Collections Volume 31, February 2021, 100645

#### Data Article

Micellar effects on the kinetics and mechanism of ceric ammonium nitrate oxidation of bicyclic monoterpenes under acid free conditions

Rajitha Nampally <sup>a</sup>, Shylaja Somannagari <sup>a, c</sup>, Chinna Rajanna Kamatala <sup>a, b</sup>  $\stackrel{>}{\sim}$   $\stackrel{\boxtimes}{\sim}$ , Yadagiri Bhongiri <sup>a</sup>, Umesh Kumar Utkoor <sup>a</sup>

#### Show more $\sim$

📃 Outline 🛛 🖧 Share 🗦 Cite

https://doi.org/10.1016/j.cdc.2020.100645

Get rights and content

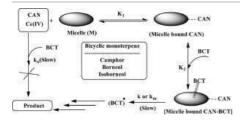
#### Highlights

- Ceric ammonium nitrate (CAN) is explored for effective oxidation of bicyclic monoterpenes.
- Oxidation underwent smoothly in aqueous acetonitrile medium under acid-free conditions.
- Sodium dodecyl sulfate (SDS), and Triton X-100 (Tx-100) were found as efficient catalysts.
- Reactions revealed first order in [Substrate], [CAN] under acid-free conditions.
- Participation of micelle-bound CAN and BCT in the slow step, to explain the mechanism.

#### Abstract

Ceric ammonium nitrate (CAN) oxidation of bicyclic monoterpenes (BMT) such as borneol (BORN), isoborneol (IBORN) and camphor (CAMP) in aqueous acetonitrile medium did not proceed even under reflux conditions and mineral acid-free conditions. But addition of micelle forming surfactants (M) like sodium dodecylsulfate (SDS), cetyltrimethylammonium bromide (CTAB), and Triton X-100 accelerated the rate of oxidation. Kinetics of oxidation of the reactions revealed first order dependence on both [CAN] and [BMT]. Mechanism of oxidation has been explained through the participation of micelle-bound oxidant (M-CAN) and bicyclic monoterpene in the slow step.

#### Graphical abstract



Download : Download high-res image (98KB)

Download : Download full-size image



#### Keywords

Ceric ammonium nitrate (CAN); Oxidation of Bicyclic monoterpenes (BCT) in micellar media; Sodium dodecylsulfate (SDS); Triton X-100 (TX-100); Cetyl triethylammonium bromide (CTAB)

Recommended articles

Cited by (0)

View full text

© 2021 Elsevier B.V. All rights reserved.



Copyright © 2022 Elsevier B.V. or its licensors or contributors. ScienceDirect® is a registered trademark of Elsevier B.V.

*R***ELX**<sup>™</sup>



Original Article | <u>Published: 12 January 2021</u> Simultaneous production of astaxanthin and lipids from *Chlorella sorokiniana* in the presence of reactive oxygen species: a biorefinery approach

Rajasri Yadavalli, Hariprasad Ratnapuram, John Reddy Peasari, C. Nagendranatha Reddy, Veeramuthu Ashokkumar & Chandrasekhar Kuppam <sup>CC</sup>

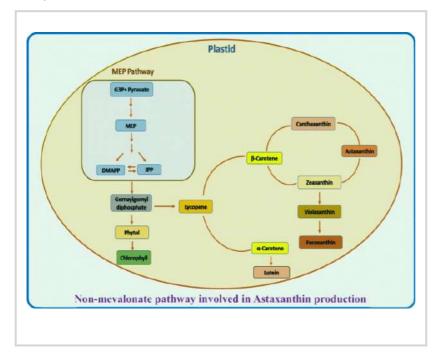
*<u>Biomass Conversion and Biorefinery</u>* **12**, 881–889 (2022) **676** Accesses | **12** Citations | <u>Metrics</u>

## Abstract

The current study aimed to investigate the concurrent production of astaxanthin and lipids using *Chlorella sorokiniana* under mixotrophic conditions in an external loop airlift photobioreactor (ELAPB). Supplementation of Fe<sup>2+</sup> into the media in the red phase (stress phase) induced the astaxanthin production. The maximum yield of 154.36 mg  $L^{-1}$  was obtained by the end of the red phase, which is equivalent to 3.4% of the dry biomass weight. The role of reactive oxygen species in the formation of astaxanthin, which protects the microalgal cells from different oxidative stress, has been elucidated. Apart from astaxanthin, unsaturated fatty acids (81.34%) were also produced with excellent biodiesel properties. Unsaturated fatty acids viz., palmitoleic acid (16:1),

have resulted in high yields (22.85%), followed by linoleic acid (18:2), 28.27%; oleic acid (C18:1), 14.38%; and eicosapentaenoic acid (20:5), 4.49%. Hence, the simultaneous production of high valueadded products, viz., astaxanthin, and lipids makes the whole process economically viable and environmentally sustainable and elevates the commercial potential during scale-up. The astaxanthin radical scavenging activity was also assessed by H<sub>2</sub>O<sub>2</sub> assay, and the maximum scavenging activity was determined as 91%. The study confers the potential advantages of algal cultivation for high-value commercial product synthesis towards additional revenue generation and development of an efficient microalgae-based biorefinery process.

Graphical abstract



This is a preview of subscription content, <u>access via</u> <u>your institution</u>.

| Access options                               |
|--|
|  |
| Buy article PDF                              |
| 39,95 €                                      |
| Price includes VAT (India)                   |
| Instant access to the full article PDF.      |
|  |
| Rent this article via DeepDyve.              |
|  |
| Learn more about Institutional subscriptions |

# References

Ratnapuram HP, Vutukuru SS, Yadavalli R

 (2018) Mixotrophic transition induced lipid
 productivity in Chlorella pyrenoidosa under
 stress conditions for biodiesel production.
 Heliyon. 4:e00496.

https://doi.org/10.1016/j.heliyon.2017.e00496

Enamala MK, Dixit R, Tangellapally A, Singh M, Dinakarrao SMP, Chavali M, Pamanji SR, Ashokkumar V, Kadier A, Chandrasekhar K
(2020) Photosynthetic microorganisms (algae) mediated bioelectricity generation in microbial fuel cell: concise review. Environ Technol Innov 19:100959. https://doi.org/10.1016/j.eti.2020.100959

- Aghajanpour M, Nazer MR, Obeidavi Z et al (2017) Functional foods and their role in cancer prevention and health promotion: a comprehensive review. Am J Cancer Res
- 4. Hwang SW, Choi HIL, Sim SJ (2019) Acidic cultivation of Haematococcus pluvialis for improved astaxanthin production in the presence of a lethal fungus. Bioresour Technol 278:138–144.
  https://doi.org/10.1016/j.biortech.2019.01.080
- 5. Lin WC, Chien JT, Chen BH (2005)
  Determination of carotenoids in spear shrimp shells (Parapenaeopsis hardwickii) by liquid chromatography. J Agric Food Chem 53:5144– 5149. <u>https://doi.org/10.1021/jf050664y</u>
- 6. Takaichi S, Matsui K, Nakamura M, Muramatsu M, Hanada S (2003) Fatty acids of astaxanthin esters in krill determined by mild mass spectrometry. Comp Biochem Physiol B Biochem Mol Biol 136:317–322. https://doi.org/10.1016/S1096-4959(03)00209-4
- 7. Sun Z, Li T, Zhou ZG, Jiang Y (2016) Microalgae as a source of lutein: chemistry, biosynthesis, and carotenogenesis. Adv Biochem Eng

Biotechnol. <u>https://doi.org/10.1007/10\_2015\_331</u>

- 8. Enamala MK, Enamala S, Chavali M, Donepudi J, Yadavalli R, Kolapalli B, Aradhyula TV, Velpuri J, Kuppam C (2018) Production of biofuels from microalgae - a review on cultivation, harvesting, lipid extraction, and numerous applications of microalgae. Renew Sust Energ Rev 94:49–68. https://doi.org/10.1016/j.rser.2018.05.012
- 9. Zhang BY, Geng YH, Li ZK, Hu HJ, Li YG (2009) Production of astaxanthin from Haematococcus in open pond by two-stage growth one-step process. Aquaculture. 295:275–281. https://doi.org/10.1016/j.aquaculture.2009.06. 043
- 10. Zhang Y, Ye Y, Ding W, Mao X, Li Y, Gerken H, Liu J (2020) Astaxanthin is ketolated from zeaxanthin independent of fatty acid synthesis in Chromochloris zofingiensis. Plant Physiol 183:883–897.

https://doi.org/10.1104/pp.20.00325

**11.** Brotosudarmo THP, Limantara L, Setiyono E, Heriyanto (2020) Structures of astaxanthin and their consequences for therapeutic application. Int. J. Food Sci

- 12. Wang B, Zarka A, Trebst A, Boussiba S (2003) Astaxanthin accumulation in Haematococcus pluvialis (Chlorophyceae) as an active photoprotective process under high irradiance. J Phycol 39:1116–1124. https://doi.org/10.1111/j.0022-3646.2003.03-043.x
- 13. Kobayashi M (2003) Astaxanthin biosynthesis enhanced by reactive oxygen species in the green alga Haematococcus pluvialis.
  Biotechnol Bioprocess Eng 8:322–330
- 14. Raman R, Mohamad SE (2012) Astaxanthin production by freshwater microalgae chlorella sorokiniana and marine microalgae Tetraselmis sp. Pakistan J Biol Sci 15:1182– 1186.

https://doi.org/10.3923/pjbs.2012.1182.1186

- 15. Khalili Z, Jalili H, Noroozi M, Amrane A, Ashtiani FR (2020) Linoleic-acid-enhanced astaxanthin content of Chlorella sorokiniana (Chlorophyta) under normal and light shock conditions. Phycologia. 59:54–62. https://doi.org/10.1080/00318884.2019.1670 012
- 16. Poonkum W, Powtongsook S, Pavasant P(2015) Astaxanthin induction in microalga *H*.

*pluvialis* with flat panel airlift photobioreactors under indoor and outdoor conditions. Prep Biochem Biotechnol. <u>https://doi.org/10.1080/10826068.2013.8678</u> <u>71</u>

- 17. Yadavalli R, S RR, Rao CS (2012) Lipid accumulation studies in Chlorella pyrenoidosa using customized photobioreactor- effect of nitrogen source, light intensity and mode of operation. Int J Eng Res Appl 2:2446–2453
- 18. Yin-Nin Ma R, Chen F (2001) Induction of astaxanthin formation by reactive oxygen species in mixotrophic culture of Chlorococcum sp. Biotechnol Lett 23:519–523. <u>https://doi.org/10.1023/A:1010370401235</u>
- **19.** Yadavalli R, Rao CS, Chandrakanth D, et al (2010) Effect of different culture media on cell concentrations of Chlorella pyrenoidosa under photoautotrophic conditions
- 20. Inbaraj BS, Lu H, Hung CF, Wu WB, Lin CL, Chen BH (2008) Determination of carotenoids and their esters in fruits of Lycium barbarum Linnaeus by HPLC-DAD-APCI-MS. J Pharm Biomed Anal 47:812–818. https://doi.org/10.1016/j.jpba.2008.04.001
- 21. Amorim-Carrilho KT, Cepeda A, Fente C,

Regal P (2014) Review of methods for analysis of carotenoids. TrAC - Trends Anal Chem

- 22. Yuan J, Fan L, Latasa P, et al (1999) Analysis of total astaxanthin in algae meal prepared from Haematococcus pluvialis. Aquasearch Inc 1:1–13
- 23. Elumalai S, Santhose BI, Kanna GR (2014) Extraction of carotenoid and thin layer chromatography (TLC), GC-MS , FT-IR and HPLC analysis of pharmaceutically important pigment astaxanthin from a new strain of Haematococcus pluvialis. Wkly Sci Res J
- 24. Yadavalli R, Ratnapuram H, Motamarry S, Reddy CN, Ashokkumar V, Kuppam C (2020) Simultaneous production of flavonoids and lipids from Chlorella vulgaris and Chlorella pyrenoidosa. Biomass Convers Biorefinery. <u>https://doi.org/10.1007/s13399-020-01044-x</u>
- 25. BLIGH EG, DYER WJ (1959) A rapid method of total lipid extraction and purification. Can J Biochem Physiol 37:911–917. https://doi.org/10.1139/059-099
- 26. Yadavalli R, Ramgopal RS, Rao CS (2013) Lipid productivity of Chlorella pyrenoidosa in a customized lab scale photobioreactor under stress conditions. Int J ChemTech Res

- 27. Lee JY, Yoo C, Jun SY, Ahn CY, Oh HM (2010) Comparison of several methods for effective lipid extraction from microalgae. Bioresour Technol 101:S75–S77. https://doi.org/10.1016/j.biortech.2009.03.05.
  8
- 28. Yadavalli R, Peasari JR, Mamindla P, Praveenkumar, Mounika S, Ganugapati J (2018) Phytochemical screening and in silico studies of flavonoids from Chlorella pyrenoidosa. Informatics Med Unlocked 10:89–99.

https://doi.org/10.1016/j.imu.2017.12.009

- 29. Baviskar JW, Khandelwal SR (2015) Original research article extraction , detection and identification of flavonoids from microalgae: an emerging secondary metabolite. Int J Curr Microbiol Appl Sci
- 30. Liu J, Sun Z, Gerken H, Liu Z, Jiang Y, Chen F
  (2014) Chlorella zofingiensis as an alternative
  microalgal producer of astaxanthin: biology
  and industrial potential. Mar Drugs 12:3487–
  3515
- 31. Chai S, Shi J, Huang T, Guo Y, Wei J, Guo M, Li L, Dou S, Liu L, Liu G (2018) Characterization of chlorella sorokiniana growth properties in monosaccharide-

supplemented batch culture. PLoS One 13:e0199873.

https://doi.org/10.1371/journal.pone.0199873

- 32. Li Y, Huang J, Sandmann G, Chen F (2009) High-light and sodium chloride stress differentially regulate the biosynthesis of astaxanthin in Chlorella zofingiensis (Chlorophyceae). J Phycol 45:635–641. https://doi.org/10.1111/j.1529-8817.2009.00689.x
- 33. Ip PF, Chen F (2005) Employment of reactive oxygen species to enhance astaxanthin formation in Chlorella zofingiensis in heterotrophic culture. Process Biochem 40:3491–3496.
  https://doi.org/10.1016/j.procbio.2005.02.01
  4.
- 34. Lam MK, Lee KT (2012) Microalgae biofuels: a critical review of issues, problems and the way forward. Biotechnol Adv 30:673–690
- 35. Qiu B, Li Y (2006) Photosynthetic acclimation and photoprotective mechanism of Haematococcus pluvialis (Chlorophyceae) during the accumulation of secondary carotenoids at elevated irradiation.
  Phycologia. 45:117–126.
  https://doi.org/10.2216/04-99.1

- **36.** Han D, Li Y, Hu Q (2013) Astaxanthin in microalgae: pathways, functions and biotechnological implications. Algae
- 37. Zhekisheva M, Boussiba S, Khozin-Goldberg I, Zarka A, Cohen Z (2002) Accumulation of oleic acid in Haematococcus pluvialis (Chlorophyceae) under nitrogen starvation or high light is correlated with that of astaxanthin esters. J Phycol 38:325–331. https://doi.org/10.1046/j.1529-8817.2002.01107.x

38. Chang C Sen, Chang CL, Lai GH (2013) Reactive oxygen species scavenging activities in a chemiluminescence model and neuroprotection in rat pheochromocytoma cells by astaxanthin, beta-carotene, and canthaxanthin. Kaohsiung J Med Sci https://doi.org/10.1016/j.kjms.2012.12.002, 29, 412, 421

39. Shim SJ, Hong ME, Chang WS, Sim SJ (2020) Repeated-batch production of omega-3 enriched biomass of Chlorella sorokiniana via calcium-induced homeoviscous adaptation. Bioresour Technol 303:122944. https://doi.org/10.1016/j.biortech.2020.1229
44. 40. Holtin K, Kuehnle M, Rehbein J, Schuler P, Nicholson G, Albert K (2009) Determination of astaxanthin and astaxanthin esters in the microalgae Haematococcus pluvialis by LC-(APCI)MS and characterization of predominant carotenoid isomers by NMR spectroscopy. Anal Bioanal Chem 395:1613– 1622. https://doi.org/10.1007/s00216-009-2837-2

# Acknowledgments

Y.R. and C.N.R. would like to thank the Management and Principal of CBIT for constant support and encouragement in carrying out this work.

# Funding

The present work was funded by the Department of Biotechnology, Government of India, under the research grant # BT/PR13125/PBD/26/448/2015.

# Author information

Authors and Affiliations

Department of Biotechnology, Chaitanya Bharathi Institute of Technology (Autonomous), Gandipet, Hyderabad, Telangana State, 500075, India Rajasri Yadavalli & C. Nagendranatha Reddy Department of Biotechnology, Sreenidhi Institute of Science and Technology (Autonomous), Yamnampet, Ghatkesar, Hyderabad, Telangana State, India Rajasri Yadavalli, Hariprasad Ratnapuram & John Reddy Peasari

Department of Chemical Technology, Chulalongkorn University, Bangkok, Thailand Veeramuthu Ashokkumar

Green Processing, Bioremediation and Alternative Energies Research Group, Faculty of Environment and Labour Safety, Ton Duc Thang University, Ho Chi Minh City, Vietnam Chandrasekhar Kuppam

Correspondence to <u>Chandrasekhar Kuppam</u>.

Ethics declarations

Conflict of interest

The authors declare that they have no conflict of interest.

# Additional information

Publisher's note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

# Highlights

• *Chlorella sorokiniana* is found as a potential microalgal species for the production of astaxanthin.

• The addition of ROS to the growth medium produced astaxanthin in the stress phase.

• Simultaneous lipid and astaxanthin production were favoured in the mixotrophic mode of cultivation, encouraging biorefinery concept when scaled up

# Rights and permissions

## **Reprints and Permissions**

# About this article

## Cite this article

Yadavalli, R., Ratnapuram, H., Peasari, J.R. *et al.* Simultaneous production of astaxanthin and lipids from *Chlorella sorokiniana* in the presence of reactive oxygen species: a biorefinery approach. *Biomass Conv. Bioref.* **12**, 881–889 (2022). https://doi.org/10.1007/s13399-021-01276-5 Received Revised Accepted 19 October 2020 29 December 02 January 2021 2020

Published Issue Date 12 January 2021 March 2022

# DOI

https://doi.org/10.1007/s13399-021-01276-5

## Keywords

Carotenogenesis Scavenging activity

Astaxanthin Lipid content

Chlorella sorokiniana Transesterification

BG11 Airlift bioreactor

Not logged in - 202.65.141.230

AICTE Electrical & Electronics & Computer Science Engineering (3000684219) - CBIT-Library & Information Centre Hyderabad (3000950898)

## **SPRINGER NATURE**

© 2022 Springer Nature Switzerland AG. Part of Springer Nature.



| For Authors (/authors)   |
|--|
| For Reviewers (/reviewers)   |
| For Editors (/editors)   |
| <u>For Librarians (/librarians)</u>  |
| For Publishers (/publishing_services)  |
| <u>For Societies (/societies)</u>  |
| For Conference Organizers (/conference_organizers)   |
| l de la constante de |
| <u>Open Access Policy (/openaccess)</u>  |
| Institutional Open Access Program (/ioap)  |
| Special Issues Guidelines (/special_issues_guidelines)   |
| <u>Editorial Process (/editorial_process)</u>  |
| Research and Publication Ethics (/ethics)  |
| Article Processing Charges (/apc)  |
| <u>Awards (/awards)</u>  |
| <u>Testimonials (/testimonials)</u>  |
|  |
| Search   |
|  |

## Advanced Search

<u>Journals (/about/journals)</u> / <u>Metabolites (/journal/metabolites)</u> / <u>Volume 12 (/2218-1989/12)</u> / <u>Issue 1 (/2218-1989/12/1)</u> / <u>10.3390/metabo12010012</u> /



(/journal/metabolites)

Submit to this Journal (https://susy.mdpi.com/user/manuscripts/upload? form%5Bjournal\_id%5D%3D112)

Review for this Journal (https://susy.mdpi.com/volunteer/journals/review)

Edit a Special Issue (/journalproposal/sendproposalspecialissue/metabolites)

► Article Menu

**Article Menu** 



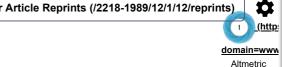
Jose Lorenzo Rodriguez

| Subscribe SciFeed (/2218-            |                                |    |     |
|--------------------------------------|--------------------------------|----|-----|
| <u>1989/12/1/12/scifeed_display)</u> |                                |    |     |
| Related Info Links                   |                                | ~  |     |
|                                      |                                |    |     |
| M                                    | ore by Authors Links           | ~  |     |
| A                                    | rticle Views                   | 22 | 228 |
| Citations 3                          |                                |    |     |
| <u>Ta</u>                            | ble of Contents                | ^  |     |
| •                                    | Abstract                       |    |     |
|                                      | Introduction                   |    |     |
| •                                    | Perishable Food Ecosystem and  |    |     |
|                                      | <u>Microbiota</u>              |    |     |
| •                                    | Classification of Antifungal   |    |     |
|                                      | Metabolites Found in Food      |    |     |
|                                      | <u>Habitats</u>                |    |     |
| •                                    | Mode of Action for Various     |    |     |
|                                      | <u>Metabolites</u>             |    |     |
| •                                    | Applications Oriented Studies  |    |     |
|                                      | from Laboratory to Pilot Scale |    |     |
| •                                    | Major Challenges and Future    |    |     |
|                                      | <u>Prospects</u>               |    |     |
| •                                    | <u>Conclusions</u>             |    |     |
| •                                    | Author Contributions           |    |     |
| •                                    | <u>Funding</u>                 |    |     |
| •                                    | Acknowledgments                |    |     |
|                                      | Conflicts of Interest          |    |     |
| •                                    | <u>References</u>              |    |     |
|                                      |                                |    |     |

Κ

Order Article Reprints (/2218-1989/12/1/12/reprints)

Open Access Review



## Antifungal Metabolites as Food Bio-Preservative: Innovation, Share **Outlook, and Challenges**



<u>Help</u>

77

~

ৎ ≡

Cite <sup>∞</sup> MDPI <u>(/)</u> Bishwambhar Mishra (https://sciprofiles.com/profile/182580) <sup>1,†</sup> ⊠ (mailto:please\_login (https://orcid.org/0000-0002-6648-0575),

🛢 Awdhesh Kumar Mishra (https://sciprofiles.com/profile/366384) <sup>2,†</sup> 🖂 (mailto:please

aroup

(https://orcid.org/0000-0002-3312-3264),

bγ

- 🌡 Sanjay Kumar (https://sciprofiles.com/profile/1981357) <sup>3</sup> <sup>[</sup> (mailto:please\_login) <sup>●</sup> (https://orcid.org/0000-0002-3110-0982),
- 🗶 Sanjeeb Kumar Mandal (https://sciprofiles.com/profile/1981294) <sup>1</sup> 🖸 (mailto:please login),
- A Lakshmayya NSV (https://sciprofiles.com/profile/author/bFI4U3RKN2hqbTJZYTBLV25T 44  $1 \ \square$  (mailto:please login), Comment
- 🌒 Vijay Kumar (https://sciprofiles.com/profile/106856) <sup>2,4</sup> 🖂 (mailto:please\_login) 🌻 (https://orcid.org/0000-0002-8035-9181),
- Swang-Hyun Baek (https://sciprofiles.com/profile/102108)<sup>2,\*</sup> (mailto:please login) and
- Sugal Kishore Mohanta (https://sciprofiles.com/profile/1867112)<sup>5,\*</sup> <sup>∞</sup> (mailto:please login)
- <sup>1</sup> Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad 500075, India
- <sup>2</sup> Department of Biotechnology, Yeungnam University, Gyeongsan 38541, Gyeongsangbuk-do, Korea
- <sup>3</sup> Department of Biotechnology, National Institute of Technology, Tadepalligudem, Andhra Pradesh 534101, India
- <sup>4</sup> Department of Orthopedics Surgery, Johns Hopkins University School of Medicine, Baltimore, MD 21205, USA
- <sup>5</sup> Department of Applied Biology, University of Science and Technology Meghalaya, Ri-Bhoi 793101. India
- \* Authors to whom correspondence should be addressed.
- <sup>†</sup> These authors contributed equally to this work.

# Metabolites 2022, 12(1), 12; https://doi.org/10.3390/metabo12010012 (https://doi.org/10.3390/metabo12010012)

Received: 13 December 2021 / Revised: 21 December 2021 / Accepted: 21 December 2021 / Published: 23 December 2021

(This article belongs to the Section Food Metabolomics (/journal/metabolites/sections/foodmetabolomics))

Download

**Browse Figures** 

(/metabolites/metabolites-12-

00012/article\_deploy/html/images/metabolites-12-00012-g001.png) (/metabolites/metabolites-

12-00012/article deploy/html/images/metabolites-12-00012-g002.png)

(/metabolites/metabolites-12-00012/article deploy/html/images/metabolites-12-00012-

g003.png) (/metabolites/metabolites-12-00012/article\_deploy/html/images/metabolites-12-

00012-g004,png) (/metabolites/metabolites-12-00012/article\_deploy/html/images/metabolites-

12-00012-g005.png)

Versions Notes (/2218-1989/12/1/12/notes)

 $\heartsuit \equiv$ 

## Abstract

Perishable food spoilage caused by fungi is a major cause of discomfort for food producers. Food sensory abnormalities range from aesthetic degeneration to significant aroma, color, or consistency alterations due to this spoilage. Bio-preservation is the use of natural or controlled bacteria or antimicrobials to enhance the quality and safety of food. It has the ability to harmonize and rationalize the required safety requirements with conventional preservation methods and food production safety and quality demands. Even though synthetic preservatives could fix such issues, there is indeed a significant social need for "clean label" foods. As a result, consumers are now seeking foods that are healthier, less processed, and safer. The implementation of antifungal compounds has gotten a lot of attention in recent decades. As a result, the identification and characterization of such antifungal agents has made promising advances. The present state of information on antifungal molecules, their modes of activity, connections with specific target fungi varieties, and uses in food production systems are summarized in this review.

Keywords: anti-fungal (/search?q=anti-fungal); bio-preservation (/search?q=bio-preservation); food spoilage (/search?q=food+spoilage); perishable foods (/search?q=perishable+foods); shelf life (/search?q=shelf+life)

#### 1. Introduction

The world's population is expected to reach 9.7 billion people by 2050 [1]. With the growing population, food waste and deterioration must be significantly reduced. As a result, the food business is confronting significant hurdles in meeting present and future demand. Aside from challenges such as food warehousing and distribution infrastructure, climate change impacts, and water resilience, there is far too much food waste, which encompasses livestock and crop illness.

To some extent, the food industry provides a solution through the use of admixtures such as artificial preservatives, which allow manufacturers to meet customer demands for diverse array, ease of access, price, convenience, and delivery performance while reducing the amplitude of technological treatments that results in quality losses [2]. On the other hand, consumers are not atypical in their condemnation of some food additives. Moreover, awareness among consumers about food safety and hygiene and their rejection of chemical additives has prompted research into the use of beneficial microorganisms and their metabolites as viable natural preservatives for storage stability and improved food safety.

Managing foodborne pathogens in a wide range of food items is a significant concern for the food business, which could be solved by strategically using bio-compounds or bio-preservatives. Fungi can potentially pose important challenges during the processing of food. Deteriorative fungus plays a key role in the deterioration of perishables such as sauces, sweetened beverages, and cheese. Fungi are a common cause of food decomposition. The bulk of fungal species are saprobic,

meaning they have adapted to obtain their nutrients from dead organic waste. These fungi are chemoheterotrophic, meaning they each have a set of extracellular enzymes capable of dissolving structured biopolymers during vegetative decomposition in a complex ecosystem. In food, fungi follow a similar pattern. Canonical fungal ecology, on the other hand, frequently assesses decomposition and nutrient status in complex polycultures, whilst in food processed for shelf life extension and stability, the microbial population is greatly eroded, which, when blended with commodity use performance, increases the likelihood of contamination reliant on a single main competitor [3].

Recognition of precise spoilage fungi has stepped forward substantially since the 1990s because of the arrival of molecular strategies and global taxonomic consensus. For example, identifying a restrained subset of fungi responsible for food spoilage in a particular product permits the improvement of centered prevention and intervention techniques that lessen food waste [4]. Toxicants of microbial origin, as well as disease-causing pathogens such as *Salmonella*. *Staphylococcus aureus*, *Escherichia coli*, *Bacillus cereus*, *Aspergillus niger*, and *Clostridium perfringens*, might very well pose a serious health risk to consumers [5], with admixtures posing an even greater risk [5]. Consequently, adopting naturally occurring substances not only prevents and limits the spread of undesirable bacteria but it will also enhance food quality and safety and reaffirm buyers' faith in the trustworthiness of their food [6].

Bio-preservatives are naturally occurring substances derived from plants, animals, and microbes that prolong the shelf life of food [7]. These substances suppress pathogenic organisms in food to a bare minimum or even eradicate them entirely while also improving food function and quality. Many of these chemicals are antimicrobials as well as antioxidants, and they tear down cell membranes and disrupt biosynthetic bacteria pathways [8]. The major elements of antifungal metabolites and their methods of action, interactions with their target fungi types, and their uses in food systems are highlighted in this concentrated study. The extent of prospective research directions, as well as main hurdles, are also summarized.

#### 2. Perishable Food Ecosystem and Microbiota

Perishables are foods that decay, deteriorate, or become unhealthy to eat if not properly stored or devoured promptly after purchase. These foods include meat, seafood, dairy products such as milk and cheese, poultry, as well as fruits and vegetables. Once the food's usual state alters adversely, it is said to have deteriorated [9]. It could be a difference in the scent, taste, mouthfeel, or appearance of the food. The most prominent causes of rotting food are bacteria, molds, and yeasts.

#### 2.1. Fungal Spoiler of Foods

The heterogeneity of fungus and yeast as culinary spoilers has been studied in many studies and food commodities. For example, fungal species, such as *Saccharomyces cerevisiae* in fermented products, *Penicillium camemberti* in mold-ripened cheeses, and *Aspergillus oryzae* in soy sauce, are not necessarily harmful to food production, and some are even required to provide the appropriate organoleptic features [**10**]. However, it is also worth remembering that a common fungus species found in fermented products can turn out to be a narrative surprise in another product.

Due to changes in pH, carbohydrates, surface, and resistance that create ideal conditions for fungal spoilers, fruits and vegetables are particularly sensitive to mold growth throughout the maturation phase. For example, fungi cause observable signs on postharvest crops, such as discoloration and tissue abscess formation. Citrus, berry, stone, pome, tropical, and solanaceous fruits all become spoiled due to their presence. In addition, fruit and vegetable fungal diseases have been extensively studied [11]. Rhizomes and other vegetables such as crucifers, cucurbits, bulbs, and legumes are less susceptible to fungal illnesses than fruits, possibly because their pH is more favorable to bacterial pathogens [12]. In addition, many of the most common postharvest illnesses are caused by fungal species from the *Penicillium*, *Monilinia*, *Botrytis*, *Alternaria*, *Rhizopus*, *Fusarium*, *Aspergillus*, *Gloeosporium*, *Geotrichum*, and *Mucor* genera [13].

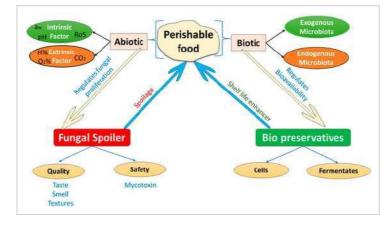
Fish and milk are less prone to fungal deterioration than other animal-derived meals and raw materials, but bacterial spoilage is significantly affected. Even if the bacterial deterioration is predominated, fungal spoilage can develop in meat, especially during refrigeration [14]. Notwithstanding the need for more excellent research, black patches have been found in *Penicillium*. Clostridium, and Aureobasidium species, while *Thamnidium* spp. can generate 'whiskers' on carcasses. Yeast from the *Candida*, *Cryptococcus*, and *Yarrowia* species have been found on moist, packed foods, causing off-flavors and cosmetic flaws, including slime and stains [15].

#### 2.2. Antifungal Microorganisms in Foods

As already mentioned, bio-preservation is gaining traction as a technique of improving food quality and safety in response to the widespread desire for less refined foods free from preservatives [16]. In recent years, many antifungal strains from a variety of microbial species have been found. They have been detected in vegetables, fruits, meat, cereals, milk and other food-related products. In addition, researchers have recently extended the isolation of new bioprotective cultures to different settings, including deep-sea and Arctic soil samples, so as to identify microorganisms potentially releasing new antifungal chemicals [17].

Antifungal activity levels and the spectrum of inhibited fungal targets differ greatly depending on the examined species and strain to strain within a species, necessitating the use of screening procedures to identify efficient antifungal microorganisms (**Figure 1**). For example, there was up to 75% difference across five *Lactobacillus casei* strains assessed for their ability to suppress the growth of four spoilage molds [**18**]. In another study, just a few *Lactobacillus plantarum* isolates out of 88 investigated showed a wide range of fungal inhibition [**19**]. In another investigation, only a few *L. plantarum* isolates out of 88 examined demonstrated a broad spectrum of fungus inhibition [**20**]. Another study found that 55 yeast isolates from the skin of grape varieties (*Aureobasidium pullulans, Cryptococcus magnus, Candida zeylanoides, Pseudozyma aphidis, Candida sake, Hanseniaspora uvarum, Rhodotorula mucilaginosa*) could hinder *Aspergillus tubingensis* cell growth, with a 58% inhibition.





 $\equiv$ 

**Figure 1.** Schematic representation of perishable food ecosystem and their interaction between food spoilers and bio-preservatives.

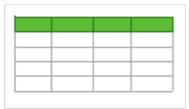
## 3. Classification of Antifungal Metabolites Found in Food Habitats

Metabolites that can control the fungal infection or disease are categorized as antifungal metabolites. These metabolites are produced and accumulated by a wide range of bacterial and fungal species, actinomycetes, and plants. Several genera of lactic acid bacteria (LAB) have been reported to produce various antifungal compounds, viz. phenyllactic acids, fatty acids, organic acids, reuterin, cyclic dipeptides, diacetyl, hydrogen peroxide, lactones, and alcohols [**21**]. There are various groups of antifungal metabolites found in food habitats, as follows.

#### 3.1. Organic Acids

Organic acids have been utilized for several years to prevent microbial growth in food products such as bread and sausages [22,23], milk and milk-based products [24], meat and poultry products [25], and fruits and vegetables [26,27]. A few examples of major organic acids used as antifungal agents which target various fungal species are described in **Table 1**.

Table 1. Major organic acids as an antifungal agent and targeted fungal strain.

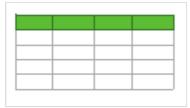


## 3.2. Phenyllactic Acid (PLA)

Phenyllactic acid is a natural bioactive compound, having a broad-spectrum inhibitory activity against a few bacteria (*Enterococcus* spp., *Listeria monocytes*, *Salmonella* spp., *Staphylococcus aureus*, etc.), fungi, molds, and yeast (*Candida* and *Rhodotorula* spp.) [**36**]. Typically, PLA is obtained from LAB such as *Lactobacillus*, *Weissella*, and *Leuconostoc* through phenylalanine metabolism. In this process, aromatic aminotransferase enzyme transaminates phenylalanine to phenylpyruvic acid (PPA), which is further reduced to PLA by lactate dehydrogenase enzyme [**37**,**38**]. LAB inhibits undesirable microbial and fungal growth by reducing the pH level in the system. Hence,

PLA produced by LAB improves food safety with increased shelf life of food products, which subsequently positively impacts consumers' health. Therefore, PLA has been widely accepted as a natural preservative in the food industry [**39**,**40**]. A few examples related to the sources of PLA and their antifungal activity against a broad spectrum of microbes along with the associated food products are described in **Table 2**.

**Table 2.** Phenyllactic acid-producing source and its targeted fungal strain.



#### 3.3. Fatty Acids

Fatty acids are accumulated by a broad spectrum of microbes (such as bacteria, actinomycetes, and fungi) as well as plants. Various literature has revealed that fatty acids have been used as an active antimicrobial agent against a wide range of food spoilage bacteria, molds, and yeast [58,59,60]. A study [61] highlighted the correlations between the configurations of hydroxy unsaturated fatty acids (HUFA) and their associated antifungal activities. This study also exhibited that the 18-carbon unsaturated fatty acid chains having the hydroxyl group in the center's proximity showed intense antifungal activity [61]. Similarly, Souza et al. [62] explained the antifungal activity against *Candida* species concerning change in the structure of aliphatic fatty acids. They also described that the structure of each fatty acid strongly affects its antifungal activity. The antifungal activity is strongly affected by the carbon chain length; for example, an increase in carbon chain length fatty acids usually reveal the maximum antifungal activity [62]. Furthermore, the hydroxyl group was found to be essential for antifungal activity. It was also reported that the capric and lauric acids had shown the best anti-*Candida* results.

Elsherbiny et al. **[63]** studied the anti-*Penicillium* effect of β-aminobutyric acid (BABA) in orange fruit. They reported that the concentration of BABA plays a crucial role in the inhibition of fungal growth; for example, growth of fungal strain was significantly inhibited by 125 mM of BABA. Pinilla et al. **[64]** examined the antifungal property of oleic acid through liposomes of oleic acid (OA) and phosphatidylcholine (PC) encapsulating garlic extract (GE). It showed great potential for controlling fungal growth in wheat bread. *Lactobacillus* sp. RM accumulate 6-octadecenoic acid and hexadecanoic acid as a secondary metabolite, which is reported as an effective antifungal agent against mycelia of *Aspergillus parasiticus* **[65]**. 3-Hydroxy-5-dodecenoic acid causes severe damage to the surface of *Bacillus cereus* and leads to a decrease in the endospore size of the cell. Solano et al. **[58]** reported that the intermediate concentration of lauric acid exhibited strong antifungal activity against *Collectotrichum tamarilloi*.

#### 3.4. Reuterin

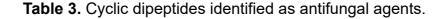
Reuterin (3-hydroxy propionaldehyde or 3-HPA) is a non-proteinaceous and water-soluble antimicrobial agent produced by *Lactobacillus reuteri* [**66**]. Other genera of bacteria have produced it, including *Citrobacter*, *Bacillus*, *Klebsiella*, *Enterobacter*, and *Clostridium* [**67**]. Reuterin was reported

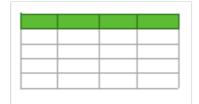
to be produced during the anaerobic metabolism of glycerol (Vollenweider and Lacroix, 2004). Reuterin can work over a broad range of pH and remain active in the presence of various enzymes [68]. Therefore, reuterin was reported as a potential antibacterial and antifungal agent against a broad spectrum of microbes and utilized as a food preservative in the food industry [69]. Several inhibitory activities of reuterin have been investigated against a broad spectrum of microbes. However, the studies related to the antifungal activity of reuterin are limited as the inhibiting lead molecules present in reuterin have not yet been investigated so far.

A study on minimum fungicidal activity and inhibitory activity of reuterin against a group of fungi and yeast species reported that the reuterin produced by *Lactobacillus reuteri* ATCC 53608 showed the inhibition of growth of food spoilage microorganisms at a concentration of 11 mM or less. Additionally, reuterin also exhibited a fungicidal activity (99.9%) at concentrations equal to or below 16.6 mM [67]. At the same time, another study reported that the reuterin was an effective antimicrobial agent against *Lactobacillus delbrueckii* sp. *Bulgaricus*, *Penicillium expansum*, *Listeria monocytogenes*, *Staphylococcus aureus*, and *Escherichia coli* DH5α microorganisms. There are few microorganisms that are highly resistant (*Lactobacillus reuteri* ATCC 53608), and few are susceptible (*E. coli* DH5α) to reuterin [69].

## 3.5. Cyclic Dipeptides (CDP)

Cyclic dipeptides are the secondary metabolites that have been isolated from several species of bacteria [70], such as *Bacillus cereus* subsp. *thuringiensis* [71], *Lactobacillus plantarum* [72], and *Bacillus velezensis* AR1 [73]. CDPs are active at higher temperatures and resistant to denaturation by hydrolytic enzymes [74]. Individual CDPs worked as bio-effectors, whereas pooled CDPs have shown potential bioactive properties against numerous pathogens. In addition to that, the combination of CDPs in the presence or absence of antibiotics may exert collaborative antimicrobial properties [75]. As an antimicrobial function, CDPs may decrease the mycelial growth, alter the nuclear DNA functionally and structurally, make the mold membrane porous, inhibit ergosterol synthesis, alter the osmotic equilibrium, and initiate the oxidative apoptotic stress [76]. Thus far, various studies have been conducted to identify the newer CDPs as potential antifungal agents and antibacterial agents. Recent investigations on CDPs as having potential antifungal agents are described in Table 3.





#### 3.6. Miscellaneous Antifungal Compounds

Although organic acids, phenyllactic acid, fatty acids, reuterin, and cyclic dipeptides are the major antifungal compounds synthesized and accumulated by a range of microbial strains associated with food habitat, a few other compounds of microbial origin (such as nisin, lactocin, divergicin and hydrogen peroxide) were also reported as potential antifungal agents [87]. In addition to that, some other antifungal compounds are also being reported to be accumulated as well as plants. Caffeic

acid and rosmarinic acid extracted from *Lamiaceae* herbs showed strong antifungal activity against the *Fusarium oxysporum* f. sp. *Cyclaminis* [88]. Essential oils are volatile substances and are naturally produced by plants as secondary metabolites. These are known for their antifungal, insecticidal, and antibacterial properties. The essential oils extracted from spices (garlic and clove) showed antimicrobial activity against fungal pathogens such as *Candida albicans*, *C. catenulate*, *C. acutus*, *C. apicola*, *C. tropicalis*, *C. inconspicua*, *Trigonopsis variabilis*, *Rhodotorula rubra*, and *Saccharomyces cerevisiae* [89].

## 4. Mode of Action for Various Metabolites

As mentioned in the previous section, we have many diversified categories of antifungal metabolites ranging from organic acids to modified PLA, along with several substances such as reuterin, cyclic dipeptides, etc. Though they prove their efficacy and efficiency in various ways, they might involve chemical treatment at some of the other stages. Although they have limited side effects, they could be significant in the long run and with prolonged usage. Although biosynthesis proves to be a promising alternative for these chemical substances, this approach may not exactly resemble the chemical counterpart of the same. However, we can overcome this barrier by looking onto natural derivatives rather than a natural way of synthesizing the chemical components. This section highlights several aspects of biosynthesis, derivation as well as mechanisms [**90,91**].

## 4.1. Citric Acid and Phenyllactic Acid

Among the many organic acids (which are generally weak acids), citric acid shows as high as 80% antifungal properties. Citric acid can be biosynthesized using fungal fermentation, either liquid surface fermentation or submerged fermentation. The ability of citric acid to inhibit mycelial growth proves its efficacy as an antifungal agent (**Figure 2**) [92]. Because of their solubility, flavor-enhancing qualities, and low toxicity, organic acids are commonly utilized as antibacterial or acidulant preservatives in the food industry. Sorbic acid and its sodium, potassium, and calcium salts are widely used as powerful antifungal and antibacterial agents, extending the shelf life of food goods.

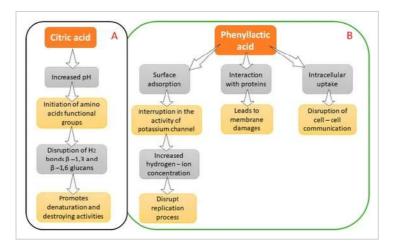


Figure 2. Mechanism of organic acids ((A) for Citric acid; (B) Phenyllactic acid) as biopreservatives. Organic acids producing bacteria comprise the larger class of LAB (lactic acid bacteria), which have been used in the food industry for a long time. Organic acids are extensively synthesized from lactic acid bacterial species such as, *Pediococcus acidilactici* which can be cultivated in labs or even found in traditional Chinese medicines [93]. The whole class of LAB shows a wide range of mechanisms depending upon the species used as an antifungal agent. This broad spectrum includes increased oxidative stress and cell permeability, enzyme inhibition, proton gradient interference, etc. [94,95]. Phenyllactic acids (PLA) (also called 3-Phenyl lactic acid or 2-Hydroxy-3-Phenylpropionic acid) inhibited *Penicillium roqueforti, Aspergillus ochraceus, Fusarium graminearum, Penicillium expansum, Aspergillus niger, Monilia sitophila, Aspergillus flavus, Penicillium verrucosum, Penicillium citrinum,* and other fungi [96]. In a study, PLA had a minimum inhibitory concentration (MIC) of 6.5–12.0 mg/mL against fungus [20]. The mechanism of the antifungal activity of PLA is poorly understood. Various researchers have suggested that PLA interferes with the proton gradient and inhibits cellular enzymes, often coactively working with other metabolites [97]. PLA's antifungal activities are thought to be inhibiting fungal radial growth and sporulation. PLA also inhibited the development and sporulation of fungal radicals on malt extract agar [98].

### 4.2. Essential Oils and Phytochemicals

Essential oils are the substances released by plants as a defense mechanism against extraneous factors. They can be easily extracted from various parts of plants such as flowers, stems, roots, leaves, etc. They have also been used as perfumery agents for centuries. Though the number of EOs produced by plants is relatively high, it would be a sophisticated process to characterize every EO, synthesis, and mechanism. Therefore, a few of them have been summarized in **Figure 3** below [**99**].

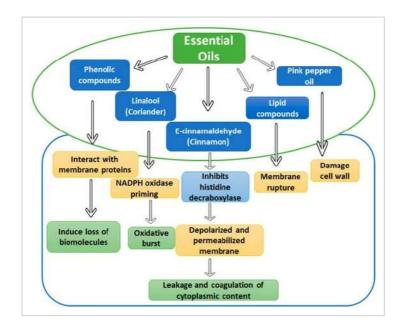
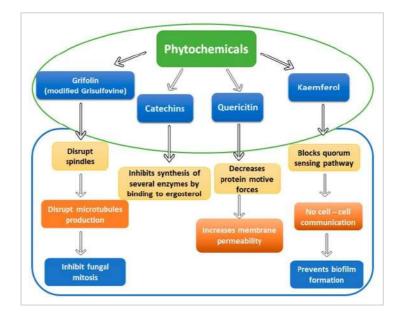
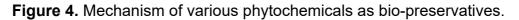


Figure 3. Mechanism of various essential oils as bio-preservatives.

Terpenes are the most diverse category of chemical compounds identified in plant extracts, with significant antifungal action that can be boosted synergistically by the presence of additional phytochemicals (**Figure 4**). Grifolin, a sesquiterpene chemical derived from the fruiting bodies of the fungus *Albatrellus dispansus*, inhibits the mycelial growth of plant pathogenic fungi such as *Sclerotinina sclerotiorum*, as well as spore germination on *Fusarium graminearum*, *Pyricularia oryzae* 

and Gloeosporium fructigenum [**100**]. Catechins were shown to rupture the fungal membrane by binding to the ergosterol layer and inhibiting the intracellular and extracellular enzymes [**101**]. On the other hand, Quercetin proves its antifungal activity by decreasing protein motive forces, thereby increasing membrane permeability [**102**]. Kaemferol works by blocking the QS pathway, which leads to failure of the cell-to-cell communication which ultimately prevents biofilm formation [**103**].





### 4.3. Azoles

Azoles are another class of excellent antifungal agents, which target the fungal cell membrane by acting as competitive inhibitors for CYP51 (a cytochrome P450 enzyme). CYP51 plays a vital role in ergosterol biosynthesis (which is the main component of the fungal cell wall). In addition, the class of azoles includes various sub-components acting as potential antifungal agents that can be categorized based upon their targeting molecules (**Figure 5**) [**104**].

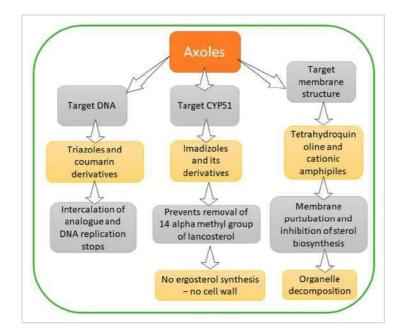


Figure 5. Mechanism of azoles as bio-preservatives.

### 5. Applications Oriented Studies from Laboratory to Pilot Scale

Conventional suspensions prepared from phytocompounds have antifungal effects. The antifungal range of a nanoemulsion made by ultrasonication using *Cleome viscosa* essential oil and Triton-x-100 was studied. Essential oil nanoemulsion (EONE) was evaluated with foodborne pathogenic *Candida albicans* at a minimum inhibitory and fungicidal dosage. The MIC and MFC values for *C. albicans* isolates ranged from 16.5 to 33 mL/mL, with a considerable reduction in biofilm. Fourier transformed infrared spectroscopy corroborated the shift in compositional fingerprinting, and spectroscopic analysis revealed a drop in chitin levels in cell walls. In *C. albicans* cells, EONE and its biologically active compounds cause massive damage [**105**].

Several techniques have proven that the primary components of EOs have antioxidant, antibacterial, and antifungal effects. Tea tree oil, lemon oil, cinnamon oil, clove oil, and thyme oil, among other EOs from local plants, have positively influenced antibacterial and antioxidant activity, along with expanded cereal shelf lives and enhanced food security. In addition, terpenes and volatile aromatic chemicals, for example, are important EO categories that help food hygiene without affecting quality. For example, EOs might be utilized as an additional preservative to extend the shelf life of grains and cereals because of their numerous effects, including antioxidant and antibacterial properties [**106**].

The antifungal and anti-aflatoxigenic activities of 5'-hydroxy-aurapten (5'-HA) on A. flavus isolated from nuts (Lotus lalambensis) were investigated. In this study, 5'-HA demonstrated a higher antifungal potential against A. flavus, having a minimum inhibitory concentration of 62.5 mg/L. It was found that 5'-HA had reduced conidia germination for A. flavus by 60% at a dose of 40 mg/mL in the early (A, B, C), middle (L, M, N), and late (P, Q, W) stages of the aflatoxin biosynthesis pathway. Moreover, 5'-HA also inhibited the synthesis of aflatoxins, AFB1 and AFB2, by 50% and 23.3%, respectively. 5'-HA increased the efficacy of enzymatic antioxidants CAT (Catalase) and SOD (Superoxide dismutase) by 56.25% and 66.66%, respectively. The anti-aflatoxigenic mechanism of 5'-HA is thought to work by increasing the expression profile of the transcription factors atfA and atfB by 2- and 2.5-fold, respectively [107]. Sodium lignosulfonate was found to be an antifungal compound due to its fungistatic activity against M. circinelloides, A. amoenus, and P. solitum. These strains were obtained from spoiled alfalfa hay (Medicago sativa). Sodium lignosulfonate (NaL) had superior preservation properties for the ground high-moisture hay as a substrate [108]. In comparison to spoiled hay, sodium lignosulfonate and PRP had a protective effect against hay proteolysis at a concentration of 0.5%, as assessed by a decrease in ammoniacal nitrogen (NH<sub>3</sub>-N). Preservatives can prevent plant proteins from deteriorating, retaining their biological worth, according to these studies.

Natamycin is an antifungal medicine with poor solubility that is used in food products to address the base of cheese and sausages. This use does not risk the customer's safety. For beverage preservation, a highly soluble natamycin–cyclodextrin integral membrane was created. This approach results in high drug concentrations that are dangerously above the acceptable limit. In addition to assessing an adequate daily natamycin food intake, researchers must investigate natamycin's impact on the intestinal bacteria as a reservoir for tolerance, which results from the amount of feces in one's system to be abnormally high. Foods having natamycin, introduced and blended uniformly, such as yoghurt, and even the administration of cyclodextrin intercalation to drinks and wine, all contribute to natamycin levels and fecal *Candida* spp. drug exposure. *Candida* spp.

have established natamycin tolerance in the bowels of persons who have been treated with natamycia for fungal diseases. As a consequence, it is impossible to figure out the likelihood that using natamycin to keep yoghurt and beverages promotes *Candida* spp. polyene tolerance [**109**].

The bioactivity of Lactobacillus brevis AM7 during fermentation with bread hydrolysate was evaluated against the fungus (20% to 70%). Using Liquid Chromatography, nine antifungal compounds (with 10–17 amino acid residues and masses spanning 1083.6 to 1980.7 Da) were investigated, all of which were expressed in wheat protein sequences. Bread hydrolysate fermented by L. brevis AM7, non-fermented bread hydrolysate, and a slurry composed of water and bread combination were all used to make bread and compared with conventional wheat bread. Compared to the other pieces of bread, those fermenting hydrolysate (18 and 22% of the dough weight) had the maximum mold-free shelf life, extending up to 10 days until mold appeared. Moreover, the fermentation hydrolysate had the fewest adverse influences on bread texture, demonstrating ▶ biotechnology's beneficial impact and potential [22]. The essential oil of Thymus algeriensis was studied as a possible soft cheese preservative. We devised a novel method for determining the essential oil's ability to preserve soft cheese. During 30 days of storage at 4 °C with 25 L of essential oil introduced, there was no contamination of *Penicillium aurantiogriseum*. Minimum inhibitory concentrations for antifungals varied from 0.01 to 0.04 mg/mL range. According to the data, the oil was active with a half-maximal inhibitory activity of 0.132 mg/mL. The volatile components in the oil were determined by using gas chromatography, gas chromatography-mass spectrometry, and nuclear magnetic resonance spectrometry. The most frequent constituent in the oil was discovered to be carvacrol, which made up 80.9% of the overall amount, followed by p-cymene (7.7%) [110].

Both people and the environment are put at risk by chemical preservatives and fungicides. Biopreservatives, such as lactic acid bacteria (LAB), on the other hand, are efficient, secure, and biodegradable, as well as add adequate beneficial health effects. The antifungal activity of strain RM1 was the highest amongst 23 rod-shaped LAB isolates collected from Egyptian traditionally fermented milk (Rayeb). Strain RM1 was distinguished from genetically similar Lactobacillus species by 16S rRNA phylogenetic analysis and distinctive phenotypic traits, indicating that it is a distinct species whereby the name *Lactobacillus* sp. RM1 is suggested. *Lactobacillus* sp. RM1 cell-free supernatant (CFS) has considerable and broad antifungal effects, mostly against toxigenic fungi and pathogenic bacteria.

Lactobacillus spp. RM1 has antifungal capabilities and the ability to prolong the shelf life of wheat grains, implying that it could be used as a natural food preservative [65]. Antimicrobial substances generated or expelled by LAB can counteract foodborne illnesses, making it a possible alternative to artificial preservatives [111]. Natural preservatives such as LAB are effective, safe, and biodegradable, with added health advantages. LAB is also frequently used as a bio-preservative to increase the shelf life of food products while in storage [112,113]. Organic acids, short-chain fatty acids, hydrogen peroxide, reuterin, diacetyl, bacteriocins, and bacteriocin-like inhibitory compounds are some of the antifungal substances produced by LAB [19,65,114], *Lactococcus lactis* spp. *lactis* ATCC 19435 inhibits fungal growth and ochratoxin A synthesis in fungal growth conditions [115,116]. Antifungal compounds found in LAB have been proven effective in decreasing yeasts and molds that degrade food [117]. Therefore, to eliminate toxic fungus and increase the quality, safety, and shelf life of food and agricultural products, it is critical to look for natural, food-grade antifungal chemicals from LAB.

## 6. Mappphallenges and Future Prospects

During the recent decade, tremendous progress has been made in the field of antifungal biopreservatives. Certain constraints and knowledge gaps, however, must still be addressed. It is also worth noting that commercial cultures are scarce, presumably because the antifungal activity of any given strain is influenced by a variety of physical and chemical factors, the food manufacturing methods, and the strains' ability to generate chemicals in situ in the food product. Health impacts and other safety problems are also key considerations that have yet to be explored for all antifungal strains. For example, safety studies should be included as a routine practice when ascribing an antifungal strain. Such analyses should provide an examination of procured resistance to antibiotics and possible biogenic amine production in compliance with safety considerations. Even though sensory and safety evaluations for antifungal strains are commonly incomplete, trying to highlight the need for further substantiation to protect the safety of using such substances in food matrices, the antifungal bio-additives mentioned are now perfectly suited to a wide range of environments, as demonstrated by their diversified in vivo and in vitro food packaging applications [118,119,120].

Creating new ready-to-use antifungal combinations, such as Gerez et al. [**121**] antifungal slurry, would significantly benefit food manufacturers and provide an alternate method for addressing consumer expectations. In addition, extraction and refinement methods must be standardized and quick, sensitive, repeatable, and cost-effective techniques created. In addition, the development of sensitive and quick isolation processes could lead to the discovery of new antifungal chemicals in the future. Transcriptomic methods may become a viable strategy for determining the molecular targets of antifungal compounds generated from bacteria as more genome sequences become accessible. The effects of diverse antifungal drugs should be determined using microarray or other 'omics' technologies, as most of these targets are unknown. Future research should improve our understanding of the genetic mechanisms and metabolic pathways of antifungal synthesis [**122**].

## 7. Conclusions

An alternative to chemical preservation was highlighted due to rising consumer demands of less processed and more natural foodstuffs while maintaining quality, hygiene, and shelf life. In this perspective, bacteria and fungus and their by-products are natural bioprotective agents that might be used in food to combat fungal deterioration and respond to consumer preferences and legislation. In terms of applicability, the disparity between the series of studies and the number of available microbial cultures shows that more work is needed to make their use in food products easier. Among the most important features is in situ research using tailored fungal targets for antifungal effectiveness testing and confirmation. Prior to sale, the bioprotective microorganisms' safety, sensory properties' neutrality, and activity constancy must all be assessed. While antifungal medications have been extensively investigated and generally demonstrated to operate cooperatively, there is still a dearth of understanding about the entire picture of which components are implicated and how they work.

### **Author Contributions**

Conceptualization, B.M. and Y.K.M.; original draft preparation, B.M., A.K.M., S.K. and S.K.M.; writing review and editing, A.K.M., S.K., L.N. and V.K.; visualization, B.M. and L.N.; supervision, K.-H.B. All authors have read and agreed to the published version of the manuscript.

## $\equiv$

## Funding

This research was funded by PJ015726, Rural Development Administration, Korea.

## Acknowledgments

This work was carried out with the support of the Cooperative Research Program for Agriculture Science and Technology Development (Project No. PJ015726), RDA, Korea.

## **Conflicts of Interest**

The authors declare no conflict of interest.

## References

- Newbold, K.B. Population Growth. In International Encyclopedia of Geography, 15 Volume Set: People, the Earth, Environment and Technology; Richardson, D., Castree, N., Goodchild, M.F., Kobayashi, A., Liu, W., Marston, R.A., Eds.; Major Reference Works; Wiley Online Library: Hoboken, NJ, USA, 2017; pp. 1–6. ISBN 978-0-470-65963-2. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Population+Growth&author=Newbold,+K.B.&publication\_year=2017&pages=1%E2 %80%936)]
- Saltmarsh, M.; Insall, L. Food additives and why they are used. In *Essential Guide to Food Additives*, 4th ed.; Saltmarsh, M., Ed.; The Royal Society of Chemistry: Cambridge, UK, 2013; pp. 1–13. ISBN 978-1-84973-560-5. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Food+additives+and+why+they+are+used&author=Saltmarsh,+M.&author=Insall,+L.&publication\_year=2013&pages=1%E2%80%9313)]
- Setälä, H.; McLean, M.A. Decomposition rate of organic substrates in relation to the species diversity of soil saprophytic fungi. *Oecologia* 2004, *139*, 98–107. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Decomposition+rate+of+organic+substrates+in+relation+to+the+species+diversity +of+soil+saprophytic+fungi&author=Set%C3%A4I%C3%A4,+H.&author=McLean,+M.A. &publication\_year=2004&journal=Oecologia&volume=139&pages=98%E2%80%93107& doi=10.1007/s00442-003-1478-y&pmid=14740289)] [CrossRef (https://doi.org/10.1007/s00442-003-1478-y)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/14740289)]

- 4 Filtenborg, O.; Frisvad, J.C.; Thrane, U. Moulds in food spoilage. Int. J. Food Microbiol. 1996, 33, 85–102. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Moulds+in+food+spoilage&author=Filtenborg,+O.&author=Frisvad,+J.C.&author=T hrane,+U.&publication\_year=1996&journal=Int.+J.+Food+Microbiol.&volume=33&pages =85%E2%80%93102&doi=10.1016/0168-1605(96)01153-1)] [CrossRef (https://doi.org/10.1016/0168-1605(96)01153-1)]
- 5. Nummer, B.A.; Shrestha, S.; Smith, J. V Survival of Salmonella in a high sugar, low wateractivity, peanut butter flavored candy fondant. *Food Control* 2012, 27, 184–187. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=V+Survival+of+Salmonella+in+a+high+sugar,+low+wateractivity,+peanut+butter+flavored+candy+fondant&author=Nummer,+B.A.&author=Shres
- tha,+S.&author=Smith,+J.&publication\_year=2012&journal=Food+Control&volume=27& pages=184%E2%80%93187&doi=10.1016/j.foodcont.2011.11.037)]
   [CrossRef (https://doi.org/10.1016/j.foodcont.2011.11.037)]
- Salaheen, S.; Peng, M.; Biswas, D. Replacement of conventional antimicrobials and preservatives in food production to improve consumer safety and enhance health benefits. In *Microbial Food Safety and Preservation Techniques*; Rai, V.R., Bai, J.A., Eds.; CRC Press: Boca Raton, FL, USA, 2015; pp. 311–314. ISBN 9780429168291. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Replacement+of+conventional+antimicrobials+and+preservatives+in+food+produ ction+to+improve+consumer+safety+and+enhance+health+benefits&author=Salaheen, +S.&author=Peng,+M.&author=Biswas,+D.&publication\_year=2015&pages=311%E2%80 %93314)]

- Pisoschi, A.M.; Pop, A.; Georgescu, C.; Turcuş, V.; Olah, N.K.; Mathe, E. An overview of natural antimicrobials role in food. *Eur. J. Med. Chem.* 2018, *143*, 922–935. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=An+overview+of+natural+antimicrobials+role+in+food&author=Pisoschi,+A.M.&au thor=Pop,+A.&author=Georgescu,+C.&author=Turcu%C5%9F,+V.&author=Olah,+N.K.&a uthor=Mathe,+E.&publication\_year=2018&journal=Eur.+J.+Med.+Chem.&volume=143&p ages=922%E2%80%93935&doi=10.1016/j.ejmech.2017.11.095&pmid=29227932)]
  [CrossRef (https://doi.org/10.1016/j.ejmech.2017.11.095)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/29227932)]
- 8. Burt, S. Essential oils: Their antibacterial properties and potential applications in foods—A Int. J. Food Microbiol. 2004. 94, review. 223–253. Google Scholar (https://scholar.google.com/scholar lookup? title=Essential+oils:+Their+antibacterial+properties+and+potential+applications+in+foo ds%E2%80%94A+review&author=Burt,+S.&publication\_year=2004&journal=Int.+J.+Foo d+Microbiol.&volume=94&pages=223%E2%80%93253&doi=10.1016/j.ijfoodmicro.2004.0 3.022)] [CrossRef (https://doi.org/10.1016/j.ijfoodmicro.2004.03.022)]

- J.; Nutter, D.W. Environmental implications of perishables storage and retailin. Renew. Energy Sustain. Rev. 2020. 133. 110070. [Google Scholar (https://scholar.google.com/scholar lookup?  $Q \equiv$ title=Environmental+implications+of+perishables+storage+and+retailin&author=Burek, +J.&author=Nutter,+D.W.&publication year=2020&journal=Renew.+Sustain.+Energy+Re v.&volume=133&pages=110070&doi=10.1016/j.rser.2020.110070)] [CrossRef (https://doi.org/10.1016/j.rser.2020.110070)]
- 10. Snyder, A.B.; Churey, J.J.; Worobo, R.W. Association of fungal genera from spoiled processed foods with physicochemical food properties and processing conditions. *Food Microbiol.* 2019, 83, 211–218. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Association+of+fungal+genera+from+spoiled+processed+foods+with+physicoche mical+food+properties+and+processing+conditions&author=Snyder,+A.B.&author=Chu rey,+J.J.&author=Worobo,+R.W.&publication\_year=2019&journal=Food+Microbiol.&vol ume=83&pages=211%E2%80%93218&doi=10.1016/j.fm.2019.05.012)] [CrossRef (https://doi.org/10.1016/j.fm.2019.05.012)]
- Leyva Salas, M.; Mounier, J.; Valence, F.; Coton, M.; Thierry, A.; Coton, E. Antifungal microbial agents for food biopreservation—A review. *Microorganisms* 2017, *5*, 37. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+microbial+agents+for+food+biopreservation%E2%80%94A+review&aut hor=Leyva+Salas,+M.&author=Mounier,+J.&author=Valence,+F.&author=Coton,+M.&aut hor=Thierry,+A.&author=Coton,+E.&publication\_year=2017&journal=Microorganisms&v olume=5&pages=37&doi=10.3390/microorganisms5030037)] [CrossRef (https://doi.org/10.3390/microorganisms5030037)][Green Version (https://www.mdpi.com/2076-2607/5/3/37/pdf)]
- Pennington, J.A.T.; Fisher, R.A. Classification of fruits and vegetables. J. Food Compos. Anal. 2009, 22, S23–S31. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Classification+of+fruits+and+vegetables&author=Pennington,+J.A.T.&author=Fish er,+R.A.&publication\_year=2009&journal=J.+Food+Compos.+Anal.&volume=22&pages =S23%E2%80%93S31&doi=10.1016/j.jfca.2008.11.012)] [CrossRef (https://doi.org/10.1016/j.jfca.2008.11.012)]
- 13. Abbas, E.; Osman, A.; Sitohy, M. Biochemical control of Alternaria tenuissima infecting postharvest fig fruit by chickpea vicilin. J. Sci. Food Agric. 2020, 100, 2889–2897. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Biochemical+control+of+Alternaria+tenuissima+infecting+postharvest+fig+fruit+b y+chickpea+vicilin&author=Abbas,+E.&author=Osman,+A.&author=Sitohy,+M.&publicat ion\_year=2020&journal=J.+Sci.+Food+Agric.&volume=100&pages=2889%E2%80%9328 97&doi=10.1002/jsfa.10314)] [CrossRef (https://doi.org/10.1002/jsfa.10314)]

- 1 Majumdar, A.; Pradhan, N.; Sadasivan, J.; Acharya, A.; Ojha, N.; Babu, S.; Bose, S. Food degradation and foodborne diseases: A microbial approach. In *Microbial Contamination and Food Degradation*; Elsevier: Amsterdam, The Netherlands, 2018; pp. 109–148. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Food+degradation+and+foodborne+diseases:+A+microbial+approach&author=Maj umdar,+A.&author=Pradhan,+N.&author=Sadasivan,+J.&author=Acharya,+A.&author=O jha,+N.&author=Babu,+S.&author=Bose,+S.&publication\_year=2018&pages=109%E2%8 0%93148)]
- 15. Odeyemi, O.A.; Alegbeleye, O.O.; Strateva, M.; Stratev, D. Understanding spoilage microbial community and spoilage mechanisms in foods of animal origin. *Compr. Rev. food Sci. food Saf.* 2020, *19*, 311–331. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Understanding+spoilage+microbial+community+and+spoilage+mechanisms+in+fo ods+of+animal+origin&author=Odeyemi,+O.A.&author=Alegbeleye,+O.O.&author=Stratev,+M.&author=Stratev,+D.&publication\_year=2020&journal=Compr.+Rev.+food+Sci.+f ood+Saf.&volume=19&pages=311%E2%80%93331&doi=10.1111/1541-4337.12526)]
  [CrossRef (https://doi.org/10.1111/1541-4337.12526)][Green Version (https://onlinelibrar y.wiley.com/doi/pdfdirect/10.1111/1541-4337.12526)]
- Señorans, F.J.; Ibáñez, E.; Cifuentes, A. New trends in food processing. *Crit. Rev. Food Sci. Nutr.* 2003, 43, 507–526. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=New+trends+in+food+processing&author=Se%C3%B1orans,+F.J.&author=Ib%C3 %A1%C3%B1ez,+E.&author=Cifuentes,+A.&publication\_year=2003&journal=Crit.+Rev.+ Food+Sci.+Nutr.&volume=43&pages=507%E2%80%93526&doi=10.1080/1040869039024 6341)] [CrossRef (https://doi.org/10.1080/10408690390246341)]
- Sayed, A.M.; Hassan, M.H.A.; Alhadrami, H.A.; Hassan, H.M.; Goodfellow, M.; Rateb, M.E. Extreme environments: Microbiology leading to specialized metabolites. *J. Appl. Microbiol.* 2020, *128*, 630–657. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Extreme+environments:+Microbiology+leading+to+specialized+metabolites&autho r=Sayed,+A.M.&author=Hassan,+M.H.A.&author=Alhadrami,+H.A.&author=Hassan,+H.M .&author=Goodfellow,+M.&author=Rateb,+M.E.&publication\_year=2020&journal=J.+App I.+Microbiol.&volume=128&pages=630%E2%80%93657&doi=10.1111/jam.14386)] [CrossRef (https://doi.org/10.1111/jam.14386)][Green Version (https://sfamjournals.onlin elibrary.wiley.com/doi/pdfdirect/10.1111/jam.14386)]
- Rouse, S.; Harnett, D.; Vaughan, A.; Sinderen, D. van Lactic acid bacteria with potential to eliminate fungal spoilage in foods. *J. Appl. Microbiol.* 2008, *104*, 915–923. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=van+Lactic+acid+bacteria+with+potential+to+eliminate+fungal+spoilage+in+foods &author=Rouse,+S.&author=Harnett,+D.&author=Vaughan,+A.&author=Sinderen,+D.&p ublication\_year=2008&journal=J.+Appl.+Microbiol.&volume=104&pages=915%E2%80% 93923&doi=10.1111/j.1365-2672.2007.03619.x&pmid=17976175)] [CrossRef (https://doi.org/10.1111/j.1365-2672.2007.03619.x)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/17976175)]

E.J.; Chang, H.C. Purification of a new antifungal compound produced by *Lactobacillus* plantarum AF1 isolated from kimchi. Int. J. Food Microbiol. 2010, 139, 56–63. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Purification+of+a+new+antifungal+compound+produced+by+Lactobacillus+planta rum+AF1+isolated+from+kimchi&author=Yang,+E.J.&author=Chang,+H.C.&publication \_year=2010&journal=Int.+J.+Food+Microbiol.&volume=139&pages=56%E2%80%9363&d oi=10.1016/j.ijfoodmicro.2010.02.012)] [CrossRef (https://doi.org/10.1016/j.ijfoodmicro.2010.02.012)]

20. Prema, P.; Smila, D.; Palavesam, A.; Immanuel, G. Production and characterization of an antifungal compound (3-phenyllactic acid) produced by *Lactobacillus plantarum* strain. *Food Bioprocess Technol.* 2010, 3, 379–386. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Production+and+characterization+of+an+antifungal+compound+(3-phenyllactic+acid)+produced+by+Lactobacillus+plantarum+strain&author=Prema,+P.&

author=Smila,+D.&author=Palavesam,+A.&author=Immanuel,+G.&publication\_year=201 0&journal=Food+Bioprocess+Technol.&volume=3&pages=379%E2%80%93386&doi=10. 1007/s11947-008-0127-1)] [CrossRef (https://doi.org/10.1007/s11947-008-0127-1)]

 Sadiq, F.A.; Yan, B.; Tian, F.; Zhao, J.; Zhang, H.; Chen, W. Lactic acid bacteria as antifungal and anti-mycotoxigenic agents: A comprehensive review. *Compr. Rev. Food Sci. Food Saf.* 2019, 18, 1403–1436. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Lactic+acid+bacteria+as+antifungal+and+antimycotoxigenic+agents:+A+comprehensive+review&author=Sadiq,+F.A.&author=Yan,+B .&author=Tian,+F.&author=Zhao,+J.&author=Zhang,+H.&author=Chen,+W.&publication\_ year=2019&journal=Compr.+Rev.+Food+Sci.+Food+Saf.&volume=18&pages=1403%E2 %80%931436&doi=10.1111/1541-4337.12481&pmid=33336904)] [CrossRef (https://doi.org/10.1111/1541-4337.12481)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/33336904)][Green Version (https://onlinelibrary.w

iley.com/doi/pdfdirect/10.1111/1541-4337.12481)]

22. Nionelli, L.; Wang, Y.; Pontonio, E.; Immonen, M.; Rizzello, C.G.; Maina, H.N.; Katina, K.; Coda, R. Antifungal effect of bioprocessed surplus bread as ingredient for bread-making: Identification of active compounds and impact on shelf-life. *Food Control* 2020, *118*, 107437. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+effect+of+bioprocessed+surplus+bread+as+ingredient+for+breadmaking:+Identification+of+active+compounds+and+impact+on+shelflife&author=Nionelli,+L.&author=Wang,+Y.&author=Pontonio,+E.&author=Immonen,+M. &author=Rizzello,+C.G.&author=Maina,+H.N.&author=Katina,+K.&author=Coda,+R.&pu blication\_year=2020&journal=Food+Control&volume=118&pages=107437&doi=10.1016/j .foodcont.2020.107437)] [CrossRef (https://doi.org/10.1016/j.foodcont.2020.107437)] Alvarez, M.; Andrade, M.J.; García, C.; Rondán, J.J.; Núñez, F. Effects of preservative agents on quality attributes of dry-cured fermented sausages. *Foods* 2020, *9*, 1505. [Google Scholar (https://scholar.google.com/scholar\_lookup?
Q = title=Effects+of+preservative+agents+on+quality+attributes+of+dry-cured+fermented+sausages&author=%C3%81lvarez,+M.&author=Andrade,+M.J.&autho

r=Garc%C3%ADa,+C.&author=Rond%C3%A1n,+J.J.&author=N%C3%BA%C3%B1ez,+F. &publication\_year=2020&journal=Foods&volume=9&pages=1505&doi=10.3390/foods91 01505&pmid=33096605)] [CrossRef (https://doi.org/10.3390/foods9101505)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/33096605)]

Salas, M.L.; Lemaitre, M.; Garric, G.; Harel-Oger, M.; Lê, S.; Mounier, J.; Valence-Bertel, F.; Coton, E.; Thierry, A. Antifungal lactic acid bacteria combinations as biopreservation tool in dairy products. In Proceedings of the 5ième Rencontre Nutrition Alimnetation Métabolisme Santé, Rennes, France, 23 October 2019. [Google Scholar (https://scholar.google.com/scholar lookup?

title=Antifungal+lactic+acid+bacteria+combinations+as+biopreservation+tool+in+dairy +products&conference=Proceedings+of+the+5i%C3%A8me+Rencontre+Nutrition+Alim netation+M%C3%A9tabolisme+Sant%C3%A9&author=Salas,+M.L.&author=Lemaitre,+M .&author=Garric,+G.&author=Harel-

Oger,+M.&author=L%C3%AA,+S.&author=Mounier,+J.&author=Valence-Bertel,+F.&author=Coton,+E.&author=Thierry,+A.&publication\_year=2019)]

25. Mani-López, E.; García, H.S.; López-Malo, A. Organic acids as antimicrobials to control Salmonella in meat and poultry products. *Food Res. Int.* 2012, 45, 713–721. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Organic+acids+as+antimicrobials+to+control+Salmonella+in+meat+and+poultry+p roducts&author=Mani-

L%C3%B3pez,+E.&author=Garc%C3%ADa,+H.S.&author=L%C3%B3pez-Malo,+A.&publication\_year=2012&journal=Food+Res.+Int.&volume=45&pages=713%E2 %80%93721&doi=10.1016/j.foodres.2011.04.043)] [CrossRef (https://doi.org/10.1016/j.foodres.2011.04.043)]

Crowley, S.; Mahony, J.; van Sinderen, D. Broad-spectrum antifungal-producing lactic acid bacteria and their application in fruit models. *Folia Microbiol.* 2013, *58*, 291–299. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=Broad-spectrum+antifungal-producing+lactic+acid+bacteria+and+their+application+in+fruit+models&author=Crowl ey,+S.&author=Mahony,+J.&author=van+Sinderen,+D.&publication\_year=2013&journal=Folia+Microbiol.&volume=58&pages=291%E2%80%93299&doi=10.1007/s12223-012-0209-3&pmid=23160868)] [CrossRef (https://doi.org/10.1007/s12223-012-0209-3)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/23160868)]

27 Buehler, A.J.; Martin, N.H.; Boor, K.J.; Wiedmann, M. Evaluation of biopreservatives in Greek yogurt to inhibit yeast and mold spoilage and development of a yogurt spoilage predictive model. J. Dairy Sci. 2018, 101, 10759–10774. [Google Scholar] (https://scholar.google.com/scholar\_lookup?

title=Evaluation+of+biopreservatives+in+Greek+yogurt+to+inhibit+yeast+and+mold+sp oilage+and+development+of+a+yogurt+spoilage+predictive+model&author=Buehler,+A .J.&author=Martin,+N.H.&author=Boor,+K.J.&author=Wiedmann,+M.&publication\_year= 2018&journal=J.+Dairy+Sci.&volume=101&pages=10759%E2%80%9310774&doi=10.316 8/jds.2018-15082&pmid=30268624)] [CrossRef (https://doi.org/10.3168/jds.2018-15082)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/30268624)][Green Version (http://www.j ournalofdairyscience.org/article/S0022030218308993/pdf)]

- 28. Schwenninger, S.M.; Lacroix, C.; Truttmann, S.; Jans, C.; Spoerndli, C.; Bigler, L.; Meile, L. Characterization of low-molecular-weight antiyeast metabolites produced by a food-protective Lactobacillus-Propionibacterium coculture. *J. Food Prot.* 2008, *71*, 2481–2487. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=Characterization+of+low-molecular-weight+antiyeast+metabolites+produced+by+a+food-protective+Lactobacillus-Propionibacterium+coculture&author=Schwenninger,+S.M.&author=Lacroix,+C.&author =Truttmann,+S.&author=Jans,+C.&author=Spoerndli,+C.&author=Bigler,+L.&author=Me ile,+L.&publication\_year=2008&journal=J.+Food+Prot.&volume=71&pages=2481%E2%8 0%932487&doi=10.4315/0362-028X-71.12.2481)] [CrossRef (https://doi.org/10.4315/0362-028X-71.12.2481)]
- Wang, Z.; Zhong, T.; Chen, K.; Du, M.; Chen, G.; Chen, X.; Wang, K.; Zalán, Z.; Takács, K.; Kan, J. Antifungal activity of volatile organic compounds produced by *Pseudomonas fluorescens* ZX and potential biocontrol of blue mold decay on postharvest citrus. *Food Control* 2021, *120*, 107499. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+activity+of+volatile+organic+compounds+produced+by+Pseudomonas +fluorescens+ZX+and+potential+biocontrol+of+blue+mold+decay+on+postharvest+citr us&author=Wang,+Z.&author=Zhong,+T.&author=Chen,+K.&author=Du,+M.&author=Ch en,+G.&author=Chen,+X.&author=Wang,+K.&author=Zal%C3%A1n,+Z.&author=Tak%C3 %A1cs,+K.&author=Kan,+J.&publication\_year=2021&journal=Food+Control&volume=1 20&pages=107499&doi=10.1016/j.foodcont.2020.107499)] [CrossRef (https://doi.org/10.1016/j.foodcont.2020.107499)]

30 Sun Y.; Wang, Y.; Han, L.R.; Zhang, X.; Feng, J.T. Antifungal activity and action mode of curninic acid from the seeds of *Curninum cyrninum* L. against *Fusarium oxysporum* f. sp. niveum (FON) causing Fusarium wilt on watermelon. *Molecules* 2017, 22, 2053. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+activity+and+action+mode+of+curninic+acid+from+the+seeds+of+Curninum+cyrninum+L.+against+Fusarium+oxysporum+f.+sp.+niveum+

(FON)+causing+Fusarium+wilt+on+watermelon&author=Sun,+Y.&author=Wang,+Y.&author=Han,+L.R.&author=Zhang,+X.&author=Feng,+J.T.&publication\_year=2017&journal= Molecules&volume=22&pages=2053&doi=10.3390/molecules22122053)] [CrossRef (https://doi.org/10.3390/molecules22122053)][Green Version (https://www.mdpi.com/142 0-3049/22/12/2053/pdf)]

31. Luz, C.; Carbonell, R.; Quiles, J.M.; Torrijos, R.; de Melo Nazareth, T.; Mañes, J.; Meca, G. Antifungal activity of peracetic acid against toxigenic fungal contaminants of maize and barley at the postharvest stage. *LWT* **2021**, *148*, 111754. [**Google Scholar** (https://scholar.google.com/scholar lookup?

title=Antifungal+activity+of+peracetic+acid+against+toxigenic+fungal+contaminants+of +maize+and+barley+at+the+postharvest+stage&author=Luz,+C.&author=Carbonell,+R. &author=Quiles,+J.M.&author=Torrijos,+R.&author=de+Melo+Nazareth,+T.&author=Ma %C3%B1es,+J.&author=Meca,+G.&publication\_year=2021&journal=LWT&volume=148& pages=111754&doi=10.1016/j.lwt.2021.111754)] [CrossRef (https://doi.org/10.1016/j.lwt.2021.111754)]

32. Haddoudi, I.; Cabrefiga, J.; Mora, I.; Mhadhbi, H.; Montesinos, E.; Mrabet, M. Biological control of Fusarium wilt caused by *Fusarium equiseti* in *Vicia faba* with broad spectrum antifungal plant-associated *Bacillus* spp. *Biol. Control* 2021, *160*, 104671. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Biological+control+of+Fusarium+wilt+caused+by+Fusarium+equiseti+in+Vicia+fab a+with+broad+spectrum+antifungal+plant-

associated+Bacillus+spp.&author=Haddoudi,+I.&author=Cabrefiga,+J.&author=Mora,+I. &author=Mhadhbi,+H.&author=Montesinos,+E.&author=Mrabet,+M.&publication\_year=2 021&journal=Biol.+Control&volume=160&pages=104671&doi=10.1016/j.biocontrol.2021. 104671)] [CrossRef (https://doi.org/10.1016/j.biocontrol.2021.104671)]

 Salas, M.L.; Mounier, J.; Maillard, M.-B.; Valence, F.; Coton, E.; Thierry, A. Identification and quantification of natural compounds produced by antifungal bioprotective cultures in dairy products. *Food Chem.* 2019, 301, 125260. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Identification+and+quantification+of+natural+compounds+produced+by+antifung al+bioprotective+cultures+in+dairy+products&author=Salas,+M.L.&author=Mounier,+J. &author=Maillard,+M.-

B.&author=Valence,+F.&author=Coton,+E.&author=Thierry,+A.&publication\_year=2019& journal=Food+Chem.&volume=301&pages=125260&doi=10.1016/j.foodchem.2019.12526 0)] [CrossRef (https://doi.org/10.1016/j.foodchem.2019.125260)] Adedokun, E.O.; Rather, I.A.; Bajpai, V.K.; Park, Y.-H. Biocontrol efficacy of Lactobacillus fermentum YML014 against food spoilage moulds using the tomato puree model. Front. Life Sci. 2016, 9, 64–68. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Biocontrol+efficacy+of+Lactobacillus+fermentum+YML014+against+food+spoilag e+moulds+using+the+tomato+puree+model&author=Adedokun,+E.O.&author=Rather,+I .A.&author=Bajpai,+V.K.&author=Park,+Y.-

H.&publication\_year=2016&journal=Front.+Life+Sci.&volume=9&pages=64%E2%80%93 68&doi=10.1080/21553769.2015.1084951)] [CrossRef (https://doi.org/10.1080/21553769.2015.1084951)]

Alía, A.; Andrade, M.J.; Rodríguez, A.; Reyes-Prieto, M.; Bernáldez, V.; Córdoba, J.J.
 Identification and control of moulds responsible for black spot spoilage in dry-cured ham. *Meat Sci.* 2016, 122, 16–24. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Identification+and+control+of+moulds+responsible+for+black+spot+spoilage+in+ dry-

cured+ham&author=Al%C3%ADa,+A.&author=Andrade,+M.J.&author=Rodr%C3%ADgu ez,+A.&author=Reyes-

Prieto,+M.&author=Bern%C3%A1Idez,+V.&author=C%C3%B3rdoba,+J.J.&publication\_y ear=2016&journal=Meat+Sci.&volume=122&pages=16%E2%80%9324&doi=10.1016/j.me atsci.2016.07.007&pmid=27468139)] [CrossRef (https://doi.org/10.1016/j.meatsci.2016.07.007)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/27468139)]

- 36. Jung, S.; Hwang, H.; Lee, J.-H. Effect of lactic acid bacteria on phenyllactic acid production in kimchi. Food Control 2019. 106. 106701. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Effect+of+lactic+acid+bacteria+on+phenyllactic+acid+production+in+kimchi&auth or=Jung,+S.&author=Hwang,+H.&author=Lee,+J.-H.&publication year=2019&journal=Food+Control&volume=106&pages=106701&doi=10 .1016/j.foodcont.2019.06.027)] [CrossRef (https://doi.org/10.1016/j.foodcont.2019.06.027)]
- Xu, J.-J.; Sun, J.-Z.; Si, K.-L.; Guo, C.-F. 3-Phenyllactic acid production by *Lactobacillus crustorum* strains isolated from naturally fermented vegetables. *LWT* 2021, 111780. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=3-Phenyllactic+acid+production+by+Lactobacillus+crustorum+strains+isolated+from+nat urally+fermented+vegetables&author=Xu,+J.-J.&author=Sun,+J.-Z.&author=Si,+K.-L.&author=Guo,+C.-

F.&publication\_year=2021&journal=LWT&pages=111780&doi=10.1016/j.lwt.2021.111780)] [CrossRef (https://doi.org/10.1016/j.lwt.2021.111780)] <sup>36</sup> Guan, J.; Han, C.; Guan, Y.; Zhang, S.; Yun, J.; Yao, S. Optimizational production of phenyllactic acid by a *Lactobacillus buchneri* strain via uniform design with overlay sampling methodology. *Chin. J. Chem. Eng.* **2019**, 27, 418–425. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Optimizational+production+of+phenyllactic+acid+by+a+Lactobacillus+buchneri+st rain+via+uniform+design+with+overlay+sampling+methodology&author=Guan,+J.&aut hor=Han,+C.&author=Guan,+Y.&author=Zhang,+S.&author=Yun,+J.&author=Yao,+S.&p ublication\_year=2019&journal=Chin.+J.+Chem.+Eng.&volume=27&pages=418%E2%80 %93425&doi=10.1016/j.cjche.2018.04.005)] [CrossRef (https://doi.org/10.1016/j.cjche.2018.04.005)]

- Amiri, S.; Aghamirzaei, M.; Mostashari, P.; Sarbazi, M.; Tizchang, S.; Madahi, H. The impact of biotechnology on dairy industry. In *Microbial Biotechnology in Food and Health*; Ray, R.C., Ed.; Academic Press: Cambridge, UK, 2021; pp. 53–79. ISBN 9780128198131. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=The+impact+of+biotechnology+on+dairy+industry&author=Amiri,+S.&author=Agh amirzaei,+M.&author=Mostashari,+P.&author=Sarbazi,+M.&author=Tizchang,+S.&author=Madahi,+H.&publication\_year=2021&pages=53%E2%80%9379)]
- Chaudhari, S.S.; Gokhale, D. V Phenyllactic acid: A potential antimicrobial compound in lactic acid bacteria. J. Bacteriol. Mycol. Open Access 2016, 2, 121–125. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=V+Phenyllactic+acid:+A+potential+antimicrobial+compound+in+lactic+acid+bacter ia&author=Chaudhari,+S.S.&author=Gokhale,+D.&publication\_year=2016&journal=J.+B acteriol.+Mycol.+Open+Access&volume=2&pages=121%E2%80%93125)]
- 41. Jung, S.; Woo, C.; Fugaban, J.I.I.; Vazquez Bucheli, J.E.; Holzapfel, W.H.; Todorov, S.D. Bacteriocinogenic potential of *Bacillus amyloliquefaciens* isolated from Kimchi, a traditional Korean fermented cabbage. *Probiotics Antimicrob. Proteins* 2021, *13*, 1195–1212. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Bacteriocinogenic+potential+of+Bacillus+amyloliquefaciens+isolated+from+Kimc hi,+a+traditional+Korean+fermented+cabbage&author=Jung,+S.&author=Woo,+C.&auth or=Fugaban,+J.I.I.&author=Vazquez+Bucheli,+J.E.&author=Holzapfel,+W.H.&author=To dorov,+S.D.&publication\_year=2021&journal=Probiotics+Antimicrob.+Proteins&volume =13&pages=1195%E2%80%931212&doi=10.1007/s12602-021-09772-w)] [CrossRef (https://doi.org/10.1007/s12602-021-09772-w)]
- Huang, C.-H.; Chen, W.-C.; Gao, Y.-H.; Hsiao, H.-I.; Pan, C.-L. Production of phenyllactic acid from Porphyra residues by Lactic Acid bacterial fermentation. *Processes* 2021, *9*, 678.
  [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Production+of+phenyllactic+acid+from+Porphyra+residues+by+Lactic+Acid+bact erial+fermentation&author=Huang,+C.-H.&author=Chen,+W.-C.&author=Gao,+Y.-H.&author=Hsiao,+H.-I.&author=Pan,+C.-

L.&publication\_year=2021&journal=Processes&volume=9&pages=678&doi=10.3390/pr9 040678)] [CrossRef (https://doi.org/10.3390/pr9040678)]

- 43 Dung, V.K.; Ngoc, N.N.; Dung, L.S.; Hien, V.T.N. Collection of phenyllactic acid from a strain of Lactobacillus sp. and application in agricultural products preservation. Vietnam. J. Food Control 2021, 4, 22–33. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Collection+of+phenyllactic+acid+from+a+strain+of+Lactobacillus+sp.+and+applic ation+in+agricultural+products+preservation&author=Dung,+V.K.&author=Ngoc,+N.N.& author=Dung,+L.S.&author=Hien,+V.T.N.&publication\_year=2021&journal=Vietnam.+J.+ Food+Control&volume=4&pages=22%E2%80%9333)]
- 44. Pradhan, S.; Ananthanarayan, L.; Prasad, K.; Bhatnagar-Mathur, P. Anti-fungal activity of lactic acid bacterial isolates against aflatoxigenic fungi inoculated on peanut kernels. *LWT* 2021, 143, 111104. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Anti-
- fungal+activity+of+lactic+acid+bacterial+isolates+against+aflatoxigenic+fungi+inoculat ed+on+peanut+kernels&author=Pradhan,+S.&author=Ananthanarayan,+L.&author=Pra sad,+K.&author=Bhatnagar-

Mathur,+P.&publication\_year=2021&journal=LWT&volume=143&pages=111104&doi=10. 1016/j.lwt.2021.111104)] [CrossRef (https://doi.org/10.1016/j.lwt.2021.111104)]

45. Zhao, Y.; Wu, C.; Zhu, Y.; Zhou, C.; Xiong, Z.; Eweys, A.S.; Zhou, H.; Dong, Y.; Xiao, X. Metabolomics strategy for revealing the components in fermented barley extracts with *Lactobacillus plantarum* dy-1. *Food Res. Int.* **2021**, *139*, 109808. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Metabolomics+strategy+for+revealing+the+components+in+fermented+barley+ext racts+with+Lactobacillus+plantarum+dy-

1&author=Zhao,+Y.&author=Wu,+C.&author=Zhu,+Y.&author=Zhou,+C.&author=Xiong,+ Z.&author=Eweys,+A.S.&author=Zhou,+H.&author=Dong,+Y.&author=Xiao,+X.&publicat ion\_year=2021&journal=Food+Res.+Int.&volume=139&pages=109808&doi=10.1016/j.foo dres.2020.109808&pmid=33509451)] [CrossRef (https://doi.org/10.1016/j.foodres.2020.109808)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/33509451)]

46. Chen, H.; Ju, H.; Wang, Y.; Du, G.; Yan, X.; Cui, Y.; Yuan, Y.; Yue, T. Antifungal activity and mode of action of Lactic acid bacteria isolated from Kefir against *Penicillium expansum. Food Control* 2021, 108274. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+activity+and+mode+of+action+of+Lactic+acid+bacteria+isolated+from +Kefir+against+Penicillium+expansum&author=Chen,+H.&author=Ju,+H.&author=Wang ,+Y.&author=Du,+G.&author=Yan,+X.&author=Cui,+Y.&author=Yuan,+Y.&author=Yue,+T. &publication\_year=2021&journal=Food+Control&pages=108274&doi=10.1016/j.foodcon t.2021.108274)] [CrossRef (https://doi.org/10.1016/j.foodcont.2021.108274)]

/alencia-Hernandez, L.J.; Lopez-Lopez, K.; Gomez-Lopez, E.D.; SERNACOCK, L.; Aguilar, SN. In-vitro assessment for the control of Fusarium species using a lactic acid bacterium isolated from yellow pitahaya (Selenicereus megalanthus (K. Schum. Ex Vaupel Moran)). J. Integr. Agric. 2021. 20. 159–167. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=Invitro+assessment+for+the+control+of+Fusarium+species+using+a+lactic+acid+bacteri um+isolated+from+yellow+pitahaya+(Selenicereus+megalanthus+ (K.+Schum.+Ex+Vaupel+Moran))&author=Valencia-Hernandez,+L.J.&author=Lopez-Lopez,+K.&author=Gomez-Lopez,+E.D.&author=SERNACOCK,+L.&author=Aguilar,+C.N.&publication\_year=2021&j ournal=J.+Integr.+Agric.&volume=20&pages=159%E2%80%93167&doi=10.1016/S2095-

3119(20)63284-1)] [CrossRef (https://doi.org/10.1016/S2095-3119(20)63284-1)]

- Alaoui, K.; Chafik, Z.; Arabi, M.; Abouloifa, H.; Asehraou, A.; Chaoui, J.; Kharmach, E.-Z. In 48. vitro antifungal activity of Lactobacillus against potato Late blight *Phytophthora infestans*. 2021, 7725–7733. Mater. Today Proc. 45, [Google Scholar (https://scholar.google.com/scholar lookup? title=In+vitro+antifungal+activity+of+Lactobacillus+against+potato+Late+blight+Phytop hthora+infestans&author=Alaoui,+K.&author=Chafik,+Z.&author=Arabi,+M.&author=Ab ouloifa,+H.&author=Asehraou,+A.&author=Chaoui,+J.&author=Kharmach,+E.-Z.&publication year=2021&journal=Mater.+Today+Proc.&volume=45&pages=7725%E2 %80%937733&doi=10.1016/j.matpr.2021.03.338)] [CrossRef (https://doi.org/10.1016/j.matpr.2021.03.338)]
- Abouloifa, H.; Gaamouche, S.; Rokni, Y.; Hasnaoui, I.; Bellaouchi, R.; Ghabbour, N.; Karboune, S.; Brasca, M.; D'Hallewin, G.; Ben Salah, R.; et al. Antifungal activity of probiotic Lactobacillus strains isolated from natural fermented green olives and their application as food bio-preservative. *Biol. Control* 2021, *152*, 104450. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Antifungal+activity+of+probiotic+Lactobacillus+strains+isolated+from+natural+fer mented+green+olives+and+their+application+as+food+bio-

preservative&author=Abouloifa,+H.&author=Gaamouche,+S.&author=Rokni,+Y.&author =Hasnaoui,+I.&author=Bellaouchi,+R.&author=Ghabbour,+N.&author=Karboune,+S.&au thor=Brasca,+M.&author=D%E2%80%99Hallewin,+G.&author=Ben+Salah,+R.&publicati on\_year=2021&journal=Biol.+Control&volume=152&pages=104450&doi=10.1016/j.bioco ntrol.2020.104450)] [CrossRef (https://doi.org/10.1016/j.biocontrol.2020.104450)]

- 50 Makki, G.M.; Kozak, S.M.; Jencarelli, K.G.; Alcaine, S.D. Evaluation of the efficacy of commercial protective cultures to inhibit mold and yeast in cottage cheese. J. Dairy Sci. 2021, 104, 2709–2718. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Evaluation+of+the+efficacy+of+commercial+protective+cultures+to+inhibit+mold+ and+yeast+in+cottage+cheese&author=Makki,+G.M.&author=Kozak,+S.M.&author=Jenc arelli,+K.G.&author=Alcaine,+S.D.&publication\_year=2021&journal=J.+Dairy+Sci.&volu me=104&pages=2709%E2%80%932718&doi=10.3168/jds.2020-19136&pmid=33455745)] [CrossRef (https://doi.org/10.3168/jds.2020-19136)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/33455745)]
- Schmidt, M.; Lynch, K.M.; Zannini, E.; Arendt, E.K. Fundamental study on the improvement of --51. the antifungal activity of *Lactobacillus reuteri* R29 through increased production of phenyllactic acid and reuterin. Food Control 2018, 88. 139-148. [Google Scholar (https://scholar.google.com/scholar lookup? title=Fundamental+study+on+the+improvement+of+the+antifungal+activity+of+Lactoba cillus+reuteri+R29+through+increased+production+of+phenyllactic+acid+and+reuterin &author=Schmidt,+M.&author=Lynch,+K.M.&author=Zannini,+E.&author=Arendt,+E.K.& publication\_year=2018&journal=Food+Control&volume=88&pages=139%E2%80%93148 &doi=10.1016/j.foodcont.2017.11.041)] [CrossRef (https://doi.org/10.1016/j.foodcont.2017.11.041)]
  - 52. Bustos, A.Y.; de Valdez, G.F.; Gerez, C.L. Optimization of phenyllactic acid production by Pediococcus acidilactici CRL 1753. Application of the formulated bio-preserver culture in 2018, 137–143. bread. Biol. Control 123. [Google Scholar (https://scholar.google.com/scholar lookup? title=Optimization+of+phenyllactic+acid+production+by+Pediococcus+acidilactici+CRL +1753.+Application+of+the+formulated+biopreserver+culture+in+bread&author=Bustos,+A.Y.&author=de+Valdez,+G.F.&author=Ge rez,+C.L.&publication year=2018&journal=Biol.+Control&volume=123&pages=137%E2 %80%93143&doi=10.1016/j.biocontrol.2018.05.017)] [CrossRef (https://doi.org/10.1016/j.biocontrol.2018.05.017)]
  - 53. Luz, C.; D'Opazo, V.; Quiles, J.M.; Romano, R.; Mañes, J.; Meca, G. Biopreservation of tomatoes using fermented media by lactic acid bacteria. LWT 2020, 130, 109618. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Biopreservation+of+tomatoes+using+fermented+media+by+lactic+acid+bacteria& author=Luz,+C.&author=D%E2%80%99Opazo,+V.&author=Quiles,+J.M.&author=Roman o,+R.&author=Ma%C3%B1es,+J.&author=Meca,+G.&publication\_year=2020&journal=L WT&volume=130&pages=109618&doi=10.1016/j.lwt.2020.109618)] [CrossRef (https://doi.org/10.1016/j.lwt.2020.109618)]

- Ning, Y.; Liu, D.; Yan, A.; Wang, Z.; Wang, S.; Miao, M.; Zhu, H.; Jia, Y. Metabolic mechanism of phenyllactic acid naturally occurring in Chinese pickles. *Food Chem.* 2015, *186*, 265–270. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Metabolic+mechanism+of+phenyllactic+acid+naturally+occurring+in+Chinese+pic kles&author=Li,+X.&author=Ning,+Y.&author=Liu,+D.&author=Yan,+A.&author=Wang,+Z.&author=Wang,+S.&author=Miao,+M.&author=Zhu,+H.&author=Jia,+Y.&publication\_y ear=2015&journal=Food+Chem.&volume=186&pages=265%E2%80%93270&doi=10.1016 /j.foodchem.2015.01.145&pmid=25976820)] [CrossRef (https://doi.org/10.1016/j.foodchem.2015.01.145)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/25976820)]
- Quattrini, M.; Liang, N.; Fortina, M.G.; Xiang, S.; Curtis, J.M.; Gänzle, M. Exploiting synergies of sourdough and antifungal organic acids to delay fungal spoilage of bread. *Int. J. Food Microbiol.* 2019, *302*, 8–14. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Exploiting+synergies+of+sourdough+and+antifungal+organic+acids+to+delay+fun gal+spoilage+of+bread&author=Quattrini,+M.&author=Liang,+N.&author=Fortina,+M.G. &author=Xiang,+S.&author=Curtis,+J.M.&author=G%C3%A4nzle,+M.&publication\_year =2019&journal=Int.+J.+Food+Microbiol.&volume=302&pages=8%E2%80%9314&doi=10. 1016/j.ijfoodmicro.2018.09.007)] [CrossRef (https://doi.org/10.1016/j.ijfoodmicro.2018.09.007)]

56. Dallagnol, A.M.; Bustos, A.Y.; Martos, G.I.; de Valdez, G.F.; Gerez, C.L. Antifungal and antimycotoxigenic effect of *Lactobacillus plantarum* CRL 778 at different water activity values. Microbiol. 2019, Rev. Argent. 51, 164–169. Google Scholar (https://scholar.google.com/scholar lookup? title=Antifungal+and+antimycotoxigenic+effect+of+Lactobacillus+plantarum+CRL+778+ at+different+water+activity+values&author=Dallagnol,+A.M.&author=Bustos,+A.Y.&auth or=Martos,+G.I.&author=de+Valdez,+G.F.&author=Gerez,+C.L.&publication year=2019& journal=Rev.+Argent.+Microbiol.&volume=51&pages=164%E2%80%93169&doi=10.1016/ j.ram.2018.04.004)] [CrossRef (https://doi.org/10.1016/j.ram.2018.04.004)]

 Ruggirello, M.; Nucera, D.; Cannoni, M.; Peraino, A.; Rosso, F.; Fontana, M.; Cocolin, L.; Dolci, P. Antifungal activity of yeasts and lactic acid bacteria isolated from cocoa bean fermentations. *Food Res. Int.* 2019, *115*, 519–525. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Antifungal+activity+of+yeasts+and+lactic+acid+bacteria+isolated+from+cocoa+be an+fermentations&author=Ruggirello,+M.&author=Nucera,+D.&author=Cannoni,+M.&au thor=Peraino,+A.&author=Rosso,+F.&author=Fontana,+M.&author=Cocolin,+L.&author= Dolci,+P.&publication\_year=2019&journal=Food+Res.+Int.&volume=115&pages=519%E 2%80%93525&doi=10.1016/j.foodres.2018.10.002)] [CrossRef (https://doi.org/10.1016/j.foodres.2018.10.002)] Solano, R.J.; Sierra, C.A.; Murillo, M.Á. Antifungal activity of LDPE/lauric acid films against Collectotrichum tamarilloi. Food Packag. Shelf Life 2020, 24, 100495. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+activity+of+LDPE/lauric+acid+films+against+Colletotrichum+tamarilloi &author=Solano,+R.J.&author=Sierra,+C.A.&author=Murillo,+M.%C3%81.&publication\_ year=2020&journal=Food+Packag.+Shelf+Life&volume=24&pages=100495&doi=10.1016 /j.fpsl.2020.100495)] [CrossRef (https://doi.org/10.1016/j.fpsl.2020.100495)]

- 59. Ouiddir, M.; Bettache, G.; Salas, M.L.; Pawtowski, A.; Donot, C.; Brahimi, S.; Mabrouk, K.; Coton, E.; Mounier, J. Selection of Algerian lactic acid bacteria for use as antifungal bioprotective cultures and application in dairy and bakery products. Food Microbiol. 2019, 82, 160-170. [Google Scholar (https://scholar.google.com/scholar lookup? title=Selection+of+Algerian+lactic+acid+bacteria+for+use+as+antifungal+bioprotective +cultures+and+application+in+dairy+and+bakery+products&author=Ouiddir,+M.&autho r=Bettache,+G.&author=Salas,+M.L.&author=Pawtowski,+A.&author=Donot,+C.&author =Brahimi,+S.&author=Mabrouk,+K.&author=Coton,+E.&author=Mounier,+J.&publication year=2019&journal=Food+Microbiol.&volume=82&pages=160%E2%80%93170&doi=10. 1016/j.fm.2019.01.020&pmid=31027770)] [CrossRef (https://doi.org/10.1016/j.fm.2019.01.020)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/31027770)]
- Garnier, L.; Penland, M.; Thierry, A.; Maillard, M.-B.; Jardin, J.; Coton, M.; Salas, M.L.; Coton, E.; Valence, F.; Mounier, J. Antifungal activity of fermented dairy ingredients: Identification of antifungal compounds. *Int. J. Food Microbiol.* 2020, 322, 108574. [Google Scholar (https://scholar.google.com/scholar\_lookup?)

title=Antifungal+activity+of+fermented+dairy+ingredients:+Identification+of+antifungal +compounds&author=Garnier,+L.&author=Penland,+M.&author=Thierry,+A.&author=Ma illard,+M.-

B.&author=Jardin,+J.&author=Coton,+M.&author=Salas,+M.L.&author=Coton,+E.&auth or=Valence,+F.&author=Mounier,+J.&publication\_year=2020&journal=Int.+J.+Food+Micr obiol.&volume=322&pages=108574&doi=10.1016/j.ijfoodmicro.2020.108574&pmid=3215 1821)] [CrossRef (https://doi.org/10.1016/j.ijfoodmicro.2020.108574)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/32151821)]

61. Liang, N.; Dacko, A.; Tan, A.K.; Xiang, S.; Curtis, J.M.; Gänzle, M.G. Structure-function relationships of antifungal monohydroxy unsaturated fatty acids (HUFA) of plant and bacterial Food Res. Int. 2020, 134, 109237. [Google origin. Scholar (https://scholar.google.com/scholar lookup?title=Structurefunction+relationships+of+antifungal+monohydroxy+unsaturated+fatty+acids+ (HUFA)+of+plant+and+bacterial+origin&author=Liang,+N.&author=Dacko,+A.&author=T an,+A.K.&author=Xiang,+S.&author=Curtis,+J.M.&author=G%C3%A4nzle,+M.G.&public ation year=2020&journal=Food+Res.+Int.&volume=134&pages=109237&doi=10.1016/j.f oodres.2020.109237)] [CrossRef (https://doi.org/10.1016/j.foodres.2020.109237)]

ouza, J.L.S.; da Silva, A.F.; Carvalho, P.H.A.; Pacheco, B.S.; Pereira, C.M.P.; Lund, R.G. Aliphatic fatty acids and esters: Inhibition of growth and exoenzyme production of Candida, and their cytotoxicity in vitro: Anti-candida effect and cytotoxicity of fatty acids and esters. Arch. Oral Biol. 2014. 59. 880-886. Google Scholar (https://scholar.google.com/scholar lookup? title=Aliphatic+fatty+acids+and+esters:+Inhibition+of+growth+and+exoenzyme+produc tion+of+Candida,+and+their+cytotoxicity+in+vitro:+Anticandida+effect+and+cytotoxicity+of+fatty+acids+and+esters&author=Souza,+J.L.S.&au thor=da+Silva,+A.F.&author=Carvalho,+P.H.A.&author=Pacheco,+B.S.&author=Pereira,+ C.M.P.&author=Lund,+R.G.&publication year=2014&journal=Arch.+Oral+Biol.&volume= 59&pages=880%E2%80%93886&doi=10.1016/j.archoralbio.2014.05.017)] [CrossRef (https://doi.org/10.1016/j.archoralbio.2014.05.017)]

 Elsherbiny, E.A.; Dawood, D.H.; Safwat, N.A. Antifungal action and induction of resistance by β-aminobutyric acid against *Penicillium digitatum* to control green mold in orange fruit. *Pestic. Biochem. Physiol.* **2021**, *171*, 104721. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+action+and+induction+of+resistance+by+%CE%B2aminobutyric+acid+against+Penicillium+digitatum+to+control+green+mold+in+orange+ fruit&author=Elsherbiny,+E.A.&author=Dawood,+D.H.&author=Safwat,+N.A.&publicatio

n\_year=2021&journal=Pestic.+Biochem.+Physiol.&volume=171&pages=104721&doi=10. 1016/j.pestbp.2020.104721)] [CrossRef (https://doi.org/10.1016/j.pestbp.2020.104721)]

- Pinilla, C.M.B.; Thys, R.C.S.; Brandelli, A. Antifungal properties of phosphatidylcholine-oleic 64. acid liposomes encapsulating garlic against environmental fungal in wheat bread. Int. J. Food Microbiol. 2019. 293. 72-78. [Google Scholar (https://scholar.google.com/scholar lookup? title=Antifungal+properties+of+phosphatidylcholineoleic+acid+liposomes+encapsulating+garlic+against+environmental+fungal+in+wheat+ bread&author=Pinilla,+C.M.B.&author=Thys,+R.C.S.&author=Brandelli,+A.&publication \_year=2019&journal=Int.+J.+Food+Microbiol.&volume=293&pages=72%E2%80%9378&d oi=10.1016/j.ijfoodmicro.2019.01.006)] [CrossRef (https://doi.org/10.1016/j.ijfoodmicro.2019.01.006)]
- 65. Shehata, M.G.; Badr, A.N.; El Sohaimy, S.A.; Asker, D.; Awad, T.S. Characterization of antifungal metabolites produced by novel lactic acid bacterium and their potential application as food biopreservatives. *Ann. Agric. Sci.* 2019, 64, 71–78. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Characterization+of+antifungal+metabolites+produced+by+novel+lactic+acid+bact erium+and+their+potential+application+as+food+biopreservatives&author=Shehata,+M. G.&author=Badr,+A.N.&author=El+Sohaimy,+S.A.&author=Asker,+D.&author=Awad,+T. S.&publication\_year=2019&journal=Ann.+Agric.+Sci.&volume=64&pages=71%E2%80% 9378&doi=10.1016/j.aoas.2019.05.002)] [CrossRef

(https://doi.org/10.1016/j.aoas.2019.05.002)]

- 66 Sahu, M.; Dwivedi, V. Studies on Lactobacillus bacteriocin for production and characterization against some pathogenic and food spoilage bacteria. *Int. J. Curr. Res. Acad. Rev.* 2021, 9, 1– 12. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Studies+on+Lactobacillus+bacteriocin+for+production+and+characterization+agai nst+some+pathogenic+and+food+spoilage+bacteria&author=Sahu,+M.&author=Dwived i,+V.&publication\_year=2021&journal=Int.+J.+Curr.+Res.+Acad.+Rev.&volume=9&pages =1%E2%80%9312)]
- 67. Vimont, A.; Fernandez, B.; Ahmed, G.; Fortin, H.-P.; Fliss, I. Quantitative antifungal activity of reuterin against food isolates of yeasts and moulds and its potential application in yogurt. *Int. J. Food Microbiol.* 2019, 289, 182–188. [Google Scholar (https://scholar.google.com/scholar\_lookup?
  - title=Quantitative+antifungal+activity+of+reuterin+against+food+isolates+of+yeasts+an d+moulds+and+its+potential+application+in+yogurt&author=Vimont,+A.&author=Ferna ndez,+B.&author=Ahmed,+G.&author=Fortin,+H.-

P.&author=Fliss,+I.&publication\_year=2019&journal=Int.+J.+Food+Microbiol.&volume=2 89&pages=182%E2%80%93188&doi=10.1016/j.ijfoodmicro.2018.09.005&pmid=30253311

)] [CrossRef (https://doi.org/10.1016/j.ijfoodmicro.2018.09.005)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/30253311)]

 EI-Ziney, M.G.; van den Tempel, T.; Debevere, J.; Jakobsen, M. Application of Reuterin produced by *Lactobacillus reuteri* 12002 for meat decontamination and preservation. *J. Food Prot.* 1999, 62, 257–261. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Application+of+Reuterin+produced+by+Lactobacillus+reuteri+12002+for+meat+de contamination+and+preservation&author=EI-

Ziney,+M.G.&author=van+den+Tempel,+T.&author=Debevere,+J.&author=Jakobsen,+M. &publication\_year=1999&journal=J.+Food+Prot.&volume=62&pages=257%E2%80%932 61&doi=10.4315/0362-028X-62.3.257&pmid=10090245)] [CrossRef (https://doi.org/10.4315/0362-028X-62.3.257)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/10090245)]

69. Ortiz-Rivera, Y.; Sánchez-Vega, R.; Gutiérrez-Méndez, N.; León-Félix, J.; Acosta-Muñiz, C.; Sepulveda, D.R. Production of reuterin in a fermented milk product by *Lactobacillus reuteri*: Inhibition of pathogens, spoilage microorganisms, and lactic acid bacteria. J. Dairy Sci. 2017, 100. 4258-4268. (https://scholar.google.com/scholar lookup? [Google Scholar title=Production+of+reuterin+in+a+fermented+milk+product+by+Lactobacillus+reuteri: +Inhibition+of+pathogens,+spoilage+microorganisms,+and+lactic+acid+bacteria&auth or=Ortiz-Rivera,+Y.&author=S%C3%A1nchez-Vega,+R.&author=Guti%C3%A9rrez-M%C3%A9ndez,+N.&author=Le%C3%B3n-F%C3%A9lix,+J.&author=Acosta-Mu%C3%B1iz,+C.&author=Sepulveda,+D.R.&publication year=2017&journal=J.+Dairy+ Sci.&volume=100&pages=4258%E2%80%934268&doi=10.3168/jds.2016-11534)] [CrossRef (https://doi.org/10.3168/jds.2016-11534)][Green Version (http://www.journalof dairyscience.org/article/S0022030217302473/pdf)]

7 Mishra, K.A.; Choi, J.; Choi, S.-J.; Baek, K.-H. Cyclodipeptides: An overview of their biosynthesis and biological activity. *Molecules* 2017, 22, 1796. [Google Scholar (https://scholar.google.com/scholar\_lookup?
C = title=Cyclodipeptides:+An+overview+of+their+biosynthesis+and+biological+activity&au thor=Mishra,+K.A.&author=Choi,+J.&author=Choi,+S.-J.&author=Baek,+K.-H.&publication\_year=2017&journal=Molecules&volume=22&pages=1796&doi=10.3390/molecules22101796)] [CrossRef (https://doi.org/10.3390/molecules22101796)][Green Ver sion (https://www.mdpi.com/1420-3049/22/10/1796/pdf)]

- Kumar, S.N.; Nambisan, B.; Mohandas, C. Purification and identification of two antifungal cyclic dipeptides from *Bacillus cereus* subsp. thuringiensis associated with a rhabditid entomopathogenic nematode especially against *Fusarium oxysporum. J. Enzyme Inhib. Med. Chem.* 2014, 29, 190–197. [Google Scholar (https://scholar.google.com/scholar\_lookup?] title=Purification+and+identification+of+two+antifungal+cyclic+dipeptides+from+Bacill us+cereus+subsp.+thuringiensis+associated+with+a+rhabditid+entomopathogenic+ne matode+especially+against+Fusarium+oxysporum&author=Kumar,+S.N.&author=Namb isan,+B.&author=Mohandas,+C.&publication\_year=2014&journal=J.+Enzyme+Inhib.+Me d.+Chem.&volume=29&pages=190%E2%80%93197&doi=10.3109/14756366.2013.765414
  &pmid=23402421)] [CrossRef (https://doi.org/10.3109/14756366.2013.765414)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/23402421)][Green Version (https://www.tandfonli ne.com/doi/pdf/10.3109/14756366.2013.765414?needAccess=true)]
- Kwak, M.-K.; Liu, R.; Kim, M.-K.; Moon, D.; Kim, A.H.; Song, S.-H.; Kang, S.-O. Cyclic dipeptides from lactic acid bacteria inhibit the proliferation of pathogenic fungi. *J. Microbiol.* 2014, 52, 64–70. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Cyclic+dipeptides+from+lactic+acid+bacteria+inhibit+the+proliferation+of+pathog enic+fungi&author=Kwak,+M.-K.&author=Liu,+R.&author=Kim,+M.-K.&author=Moon,+D.&author=Kim,+A.H.&author=Song,+S.-H.&author=Kang,+S.-O.&publication\_year=2014&journal=J.+Microbiol.&volume=52&pages=64%E2%80%937 0&doi=10.1007/s12275-014-3520-7)] [CrossRef (https://doi.org/10.1007/s12275-014-3520-7)]
- 73. Bayisa, R.A.; Cho, J.Y.; Kim, K.Y. Purification and identification of a new antifungal dipeptide from *Bacillus velezensis* AR1 culture supernatant. *Pest Manag. Sci.* 2021, 77, 775–779.
  [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Purification+and+identification+of+a+new+antifungal+dipeptide+from+Bacillus+ve lezensis+AR1+culture+supernatant&author=Bayisa,+R.A.&author=Cho,+J.Y.&author=Ki m,+K.Y.&publication\_year=2021&journal=Pest+Manag.+Sci.&volume=77&pages=775%E 2%80%93779&doi=10.1002/ps.6078)] [CrossRef (https://doi.org/10.1002/ps.6078)]

7)]

- A.; Rees, E.R.; McCarley, S.; Sica, V.P.; Oberlies, N.H. Characterization and isolation of peptide metabolites of an antifungal bacterial isolate identified as *Bacillus amyloliquefaciens* subspecies plantarum strain FZB42. *J. Microbiol. Biotechnol. Food Sci.* 2021, 2021, 1309–1313. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Characterization+and+isolation+of+peptide+metabolites+of+an+antifungal+bacteri al+isolate+identified+as+Bacillus+amyloliquefaciens+subspecies+plantarum+strain+FZ B42&author=Adibi,+A.&author=Rees,+E.R.&author=McCarley,+S.&author=Sica,+V.P.&au thor=Oberlies,+N.H.&publication\_year=2021&journal=J.+Microbiol.+Biotechnol.+Food+Sci.&volume=2021&pages=1309%E2%80%931313&doi=10.15414/jmbfs.2017.6.6.1309-1313)][Green Version (htt ps://www.jmbfs.org/wp-content/uploads/2017/05/jmbfs-1111-adibi.pdf)]
- 75. Deepa, S.; Sathish, T.; Vinithkumar, N.V.; Limna Mol, V.P.; Kirubagaran, R. Distribution and diversity of macrofoulers in the coastal areas of Port Blair, Andaman and Nicobar Islands. Int. J. Environ. Res. 2015, 9, 1315–1324. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Distribution+and+diversity+of+macrofoulers+in+the+coastal+areas+of+Port+Blair, +Andaman+and+Nicobar+Islands&author=Deepa,+S.&author=Sathish,+T.&author=Vinit hkumar,+N.V.&author=Limna+Mol,+V.P.&author=Kirubagaran,+R.&publication\_year=201 5&journal=Int.+J.+Environ.+Res.&volume=9&pages=1315%E2%80%931324)]

- 76. Sellamani, M.; Kalagatur, N.K.; Siddaiah, C.; Mudili, V.; Krishna, K.; Natarajan, G.; Rao Putcha, V.L. Antifungal and zearalenone inhibitory activity of *Pediococcus pentosaceus* isolated from dairy products on *Fusarium graminearum*. *Front. Microbiol.* 2016, 7, 890. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+and+zearalenone+inhibitory+activity+of+Pediococccus+pentosaceus+is olated+from+dairy+products+on+Fusarium+graminearum&author=Sellamani,+M.&auth or=Kalagatur,+N.K.&author=Siddaiah,+C.&author=Mudili,+V.&author=Krishna,+K.&auth or=Natarajan,+G.&author=Rao+Putcha,+V.L.&publication\_year=2016&journal=Front.+Mi crobiol.&volume=7&pages=890&doi=10.3389/fmicb.2016.00890&pmid=27379035)] [CrossRef (https://doi.org/10.3389/fmicb.2016.00890)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/27379035)]
- 77. Gajbhiye, M.; Kapadnis, B. Lactococcus lactis subsp. cremoris of plant origin produces antifungal Cyclo-(Leu-Pro) and tetradecanoic acid. Indian J. Microbiol. 2021, 61, 74–80.
   [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Lactococcus+lactis+subsp.+cremoris+of+plant+origin+produces+antifungal+Cycl o-(Leu-

Pro)+and+tetradecanoic+acid&author=Gajbhiye,+M.&author=Kapadnis,+B.&publication \_year=2021&journal=Indian+J.+Microbiol.&volume=61&pages=74%E2%80%9380&doi=1 0.1007/s12088-020-00917-z)] [CrossRef (https://doi.org/10.1007/s12088-020-00917-z)] 76 Tanaka, E.; Hosoe, T.; Degawa, Y.; Kolařík, M. Revision of the genus Aciculosporium (Cravicipitaceae) with a description of a new species on wavyleaf basketgrass, and prolinecontaining cyclic dipeptide production by A. take. *Mycoscience* 2021, MYC527. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Revision+of+the+genus+Aciculosporium+

(Clavicipitaceae)+with+a+description+of+a+new+species+on+wavyleaf+basketgrass,+a nd+proline-

containing+cyclic+dipeptide+production+by+A.+take&author=Tanaka,+E.&author=Hoso e,+T.&author=Degawa,+Y.&author=Kola%C5%99%C3%ADk,+M.&publication\_year=2021 &journal=Mycoscience&pages=MYC527&doi=10.47371/mycosci.2021.01.002)] [CrossRef (https://doi.org/10.47371/mycosci.2021.01.002)]

**4** 79.

Qader, M.M.; Hamed, A.A.; Soldatou, S.; Abdelraof, M.; Elawady, M.E.; Hassane, A.S.I.;
Belbahri, L.; Ebel, R.; Rateb, M.E. Antimicrobial and antibiofilm activities of the fungal metabolites isolated from the marine endophytes *Epicoccum nigrum* M13 and *Alternaria alternata* 13A. *Mar. Drugs* 2021, 19, 232. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Antimicrobial+and+antibiofilm+activities+of+the+fungal+metabolites+isolated+fro m+the+marine+endophytes+Epicoccum+nigrum+M13+and+Alternaria+alternata+13A&a uthor=Qader,+M.M.&author=Hamed,+A.A.&author=Soldatou,+S.&author=Abdelraof,+M. &author=Elawady,+M.E.&author=Hassane,+A.S.I.&author=Belbahri,+L.&author=Ebel,+R. &author=Rateb,+M.E.&publication\_year=2021&journal=Mar.+Drugs&volume=19&pages =232&doi=10.3390/md19040232&pmid=33924262)] [CrossRef (https://doi.org/10.3390/md19040232)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/33924262)]

 Yu, H.; Wang, J.; Li, X.; Quan, C. Effect of the environmental factors on diketopiperazine cyclo (Pro-Phe) production and antifungal activity of Bacillus amyloliquefaciens Q-426. *Biologia* 2021, 76, 1789–1795. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Effect+of+the+environmental+factors+on+diketopiperazine+cyclo+(Pro-Phe)+production+and+antifungal+activity+of+Bacillus+amyloliquefaciens+Q-426&author=Yu,+H.&author=Wang,+J.&author=Li,+X.&author=Quan,+C.&publication\_ye ar=2021&journal=Biologia&volume=76&pages=1789%E2%80%931795&doi=10.1007/s11 756-021-00722-z)] [CrossRef (https://doi.org/10.1007/s11756-021-00722-z)] <sup>8</sup> Fig.; Zhang, H.; Wu, W.; Li, H.; An, Z.; Zhou, F. C7-prenylation of tryptophan-containing cyclic dipeptides by 7-dimethylallyl tryptophan synthase significantly increases the anticancer and antimicrobial activities. *Molecules* 2020, 25, 3676. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=C7-prenylation+of+tryptophan-containing+cyclic+dipeptides+by+7-

dimethylallyl+tryptophan+synthase+significantly+increases+the+anticancer+and+antim icrobial+activities&author=Liu,+R.&author=Zhang,+H.&author=Wu,+W.&author=Li,+H.& author=An,+Z.&author=Zhou,+F.&publication\_year=2020&journal=Molecules&volume=2 5&pages=3676&doi=10.3390/molecules25163676&pmid=32806659)] [CrossRef (https://doi.org/10.3390/molecules25163676)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/32806659)]

82. Ebrahimi, M.; Sadeghi, A.; Mortazavi, S.A. The use of cyclic dipeptide producing LAB with potent anti-aflatoxigenic capability to improve techno-functional properties of clean-label bread. Ann. Microbiol. 2020, 70, 24. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=The+use+of+cyclic+dipeptide+producing+LAB+with+potent+anti-

aflatoxigenic+capability+to+improve+techno-functional+properties+of+cleanlabel+bread&author=Ebrahimi,+M.&author=Sadeghi,+A.&author=Mortazavi,+S.A.&publi cation\_year=2020&journal=Ann.+Microbiol.&volume=70&pages=24&doi=10.1186/s1321 3-020-01571-y)] [CrossRef (https://doi.org/10.1186/s13213-020-01571-y)]

 Qiu, S.; Avula, B.; Guan, S.; Ravu, R.R.; Wang, M.; Zhao, J.; Khan, I.A.; Hinchee, M.; Li, X.-C. Identification of fusaricidins from the antifungal microbial strain *Paenibacillus* sp. MS2379 using ultra-high performance liquid chromatography coupled to quadrupole time-of-flight mass spectrometry. *J. Chromatogr. A* 2019, *1586*, 91–100. [Google Scholar (https://scholar.google.com/scholar\_lookup?)

title=Identification+of+fusaricidins+from+the+antifungal+microbial+strain+Paenibacillu s+sp.+MS2379+using+ultra-

high+performance+liquid+chromatography+coupled+to+quadrupole+time-of-

flight+mass+spectrometry&author=Qiu,+S.&author=Avula,+B.&author=Guan,+S.&autho r=Ravu,+R.R.&author=Wang,+M.&author=Zhao,+J.&author=Khan,+I.A.&author=Hinchee ,+M.&author=Li,+X.-

C.&publication\_year=2019&journal=J.+Chromatogr.+A&volume=1586&pages=91%E2%8 0%93100&doi=10.1016/j.chroma.2018.12.007&pmid=30558848)] [CrossRef (https://doi.org/10.1016/j.chroma.2018.12.007)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/30558848)]

206 / 426

8 Kwak, M.-K.; Liu, R.; Kang, S.-O. Antimicrobial activity of cyclic dipeptides produced by Lactobacillus plantarum LBP-K10 against multidrug-resistant bacteria, pathogenic fungi, and influenza A virus. Food Control 2018, 85, 223–234. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Antimicrobial+activity+of+cyclic+dipeptides+produced+by+Lactobacillus+plantaru m+LBP-K10+against+multidrug-

resistant+bacteria,+pathogenic+fungi,+and+influenza+A+virus&author=Kwak,+M.-K.&author=Liu,+R.&author=Kang,+S.-

O.&publication\_year=2018&journal=Food+Control&volume=85&pages=223%E2%80%93 234&doi=10.1016/j.foodcont.2017.10.001)] [CrossRef (https://doi.org/10.1016/j.foodcont.2017.10.001)]

**4** 85.

 Borthwick, A.D.; Da Costa, N.C. 2,5-diketopiperazines in food and beverages: Taste and bioactivity. *Crit. Rev. Food Sci. Nutr.* 2017, 57, 718–742. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=2,5diketopiperazines+in+food+and+beverages:+Taste+and+bioactivity&author=Borthwick, +A.D.&author=Da+Costa,+N.C.&publication\_year=2017&journal=Crit.+Rev.+Food+Sci.+

Nutr.&volume=57&pages=718%E2%80%93742&doi=10.1080/10408398.2014.911142)] [CrossRef (https://doi.org/10.1080/10408398.2014.911142)]

 Kumar, N.; Mohandas, C.; Nambisan, B.; Kumar, D.R.S.; Lankalapalli, R.S. Isolation of proline-based cyclic dipeptides from *Bacillus* sp. N strain associated with rhabitid entomopathogenic nematode and its antimicrobial properties. *World J. Microbiol. Biotechnol.* 2013, 29, 355–364. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Isolation+of+proline-

based+cyclic+dipeptides+from+Bacillus+sp.+N+strain+associated+with+rhabitid+ento mopathogenic+nematode+and+its+antimicrobial+properties&author=Kumar,+N.&autho r=Mohandas,+C.&author=Nambisan,+B.&author=Kumar,+D.R.S.&author=Lankalapalli,+ R.S.&publication\_year=2013&journal=World+J.+Microbiol.+Biotechnol.&volume=29&pa ges=355%E2%80%93364&doi=10.1007/s11274-012-1189-9)] [CrossRef (https://doi.org/10.1007/s11274-012-1189-9)]

87. Dover, S.E.; Aroutcheva, A.A.; Faro, S.; Chikindas, M.L. Natural antimicrobials and their role in vaginal health: A short review. *Int. J. Probiotics Prebiotics* **2008**, *3*, 219. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Natural+antimicrobials+and+their+role+in+vaginal+health:+A+short+review&autho r=Dover,+S.E.&author=Aroutcheva,+A.A.&author=Faro,+S.&author=Chikindas,+M.L.&pu blication\_year=2008&journal=Int.+J.+Probiotics+Prebiotics&volume=3&pages=219&pmi d=20657710)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/20657710)]

- Ahmad, H.; Matsubara, Y. Suppression of anthracnose in strawberry using water extracts of lamiaceae herbs and identification of antifungal metabolites. *Hortic. J.* 2020, *89*, 359–366.

  [Google
  Scholar

  (https://scholar.google.com/scholar\_lookup?

  title=Suppression+of+anthracnose+in+strawberry+using+water+extracts+of+lamiaceae

  +herbs+and+identification+of+antifungal+metabolites&author=Ahmad,+H.&author=Mat

  subara,+Y.&publication\_year=2020&journal=Hortic.+J.&volume=89&pages=359%E2%80

  %93366&doi=10.2503/hortj.UTD-165)]
- Arora, D.S.; Kaur, J. Antimicrobial activity of spices. Int. J. Antimicrob. Agents 1999, 12, 257–262. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antimicrobial+activity+of+spices&author=Arora,+D.S.&author=Kaur,+J.&publicatio n\_year=1999&journal=Int.+J.+Antimicrob.+Agents&volume=12&pages=257%E2%80%93 262&doi=10.1016/S0924-8579(99)00074-6)] [CrossRef (https://doi.org/10.1016/S0924-8579(99)00074-6)]
- 90. Crowley, S.; Mahony, J.; van Sinderen, D. Current perspectives on antifungal lactic acid bacteria as natural bio-preservatives. *Trends Food Sci. Technol.* 2013, 33, 93–109. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Current+perspectives+on+antifungal+lactic+acid+bacteria+as+natural+bio-preservatives&author=Crowley,+S.&author=Mahony,+J.&author=van+Sinderen,+D.&pu blication\_year=2013&journal=Trends+Food+Sci.+Technol.&volume=33&pages=93%E2% 80%93109&doi=10.1016/j.tifs.2013.07.004)] [CrossRef (https://doi.org/10.1016/j.tifs.2013.07.004)]
- 91. Gajbhiye, M.H.; Kapadnis, B.P. Antifungal-activity-producing lactic acid bacteria as biocontrol agents in plants. *Biocontrol Sci. Technol.* 2016, 26, 1451–1470. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=Antifungal-activity-producing+lactic+acid+bacteria+as+biocontrol+agents+in+plants&author=Gajbhiye,+M. H.&author=Kapadnis,+B.P.&publication\_year=2016&journal=Biocontrol+Sci.+Technol.& volume=26&pages=1451%E2%80%931470&doi=10.1080/09583157.2016.1213793)] [CrossRef (https://doi.org/10.1080/09583157.2016.1213793)][Green Version (http://www.t andfonline.com/doi/pdf/10.1080/09583157.2016.1213793?needAccess=true)]
- 92. Li, J.; Wang, W.; Xu, S.X.; Magarvey, N.A.; McCormick, J.K. Lactobacillus reuteri-produced cyclic dipeptides quench agr-mediated expression of toxic shock syndrome toxin-1 in staphylococci. Proc. Natl. Acad. Sci. USA 2011, 108, 3360–3365. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=Lactobacillus+reuteri-produced+cyclic+dipeptides+quench+agr-

mediated+expression+of+toxic+shock+syndrome+toxin-

1+in+staphylococci&author=Li,+J.&author=Wang,+W.&author=Xu,+S.X.&author=Magar vey,+N.A.&author=McCormick,+J.K.&publication\_year=2011&journal=Proc.+Natl.+Acad. +Sci.+USA&volume=108&pages=3360%E2%80%933365&doi=10.1073/pnas.1017431108 &pmid=21282650)] [CrossRef (https://doi.org/10.1073/pnas.1017431108)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/21282650)][Green Version (http://www.pnas.org/ content/108/8/3360.full.pdf)] Provide and the second stress of the second stress of the second stress of the second stress conditions. Food Microbiol. 2015, 48, 109–115. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antilisterial+activity+of+bacteriocinogenic+Pediococcus+acidilactici+HA6111-2+and+Lactobacillus+plantarum+ESB+202+grown+under+pH+and+osmotic+stress+co nditions&author=Engelhardt,+T.&author=Albano,+H.&author=Kisk%C3%B3,+G.&author

=Moh%C3%A1csi-

 Farkas,+C.&author=Teixeira,+P.&publication\_year=2015&journal=Food+Microbiol.&volu

 me=48&pages=109%E2%80%93115&doi=10.1016/j.fm.2014.11.015&pmid=25790998)]

 [CrossRef
 (https://doi.org/10.1016/j.fm.2014.11.015)]

 [PubMed]

- (https://www.ncbi.nlm.nih.gov/pubmed/25790998)]
- Rhoads, D.M.; Umbach, A.L.; Subbaiah, C.C.; Siedow, J.N. Mitochondrial reactive oxygen 94. species. Contribution to oxidative stress and interorganellar signaling. Plant Physiol. 2006, 141, 357-366. Scholar (https://scholar.google.com/scholar lookup? Google title=Mitochondrial+reactive+oxygen+species.+Contribution+to+oxidative+stress+and+i nterorganellar+signaling&author=Rhoads,+D.M.&author=Umbach,+A.L.&author=Subbai ah,+C.C.&author=Siedow,+J.N.&publication\_year=2006&journal=Plant+Physiol.&volum e=141&pages=357%E2%80%93366&doi=10.1104/pp.106.079129&pmid=16760488)] [CrossRef (https://doi.org/10.1104/pp.106.079129)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/16760488)][Green Version (http://www.plantphysi ol.org/content/141/2/357.full.pdf)]
  - 95. Desbois, A.P.; Smith, V.J. Antibacterial free fatty acids: Activities, mechanisms of action and biotechnological potential. *Appl. Microbiol. Biotechnol.* 2010, 85, 1629–1642. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antibacterial+free+fatty+acids:+Activities,+mechanisms+of+action+and+biotechn ological+potential&author=Desbois,+A.P.&author=Smith,+V.J.&publication\_year=2010& journal=Appl.+Microbiol.+Biotechnol.&volume=85&pages=1629%E2%80%931642&doi= 10.1007/s00253-009-2355-3&pmid=19956944)] [CrossRef (https://doi.org/10.1007/s00253-009-2355-3&pmid=19956944)] [CrossRef (https://doi.org/10.1007/s00253-009-2355-3)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/19956944)][Green Version (https://research-repository.st-andrews.ac.uk/bitstream/10023/1193/1/DesboisSmithAppl iedMicro85-revisions.pdf)]
  - 96. Rajanikar, R.V.; Nataraj, B.H.; Naithani, H.; Ali, S.A.; Panjagari, N.R.; Behare, P. V Phenyllactic Acid: A green compound for food biopreservation. *Food Control* 2021, *128*, 108184. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=V+Phenyllactic+Acid:+A+green+compound+for+food+biopreservation&author=Raj anikar,+R.V.&author=Nataraj,+B.H.&author=Naithani,+H.&author=Ali,+S.A.&author=Panj agari,+N.R.&author=Behare,+P.&publication\_year=2021&journal=Food+Control&volume =128&pages=108184&doi=10.1016/j.foodcont.2021.108184)] [CrossRef (https://doi.org/10.1016/j.foodcont.2021.108184)]

Advan, S.; Pradhan, D. Antifungal Lactic Acid Bacteria (LAB): Potential use in food systems. In Novel Strategies to Improve Shelf-Life and Quality of Foods; Mishra, S.K., Goyal, M.R., Eds.; Apple Academic Press: New York, NY, USA, 2020; pp. 73–94. ISBN 100301027X. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+Lactic+Acid+Bacteria+ (LAB):+Potential+use+in+food+systems&author=Kadyan,+S.&author=Pradhan,+D.&pub lication year=2020&pages=73%E2%80%9394)]

98. Svanström, Å.; Boveri, S.; Boström, E.; Melin, P. The lactic acid bacteria metabolite phenyllactic acid inhibits both radial growth and sporulation of filamentous fungi. *BMC Res. Notes* 2013, *6*, 464. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=The+lactic+acid+bacteria+metabolite+phenyllactic+acid+inhibits+both+radial+gro wth+and+sporulation+of+filamentous+fungi&author=Svanstr%C3%B6m,+%C3%85.&aut hor=Boveri,+S.&author=Bostr%C3%B6m,+E.&author=Melin,+P.&publication\_year=2013 &journal=BMC+Res.+Notes&volume=6&pages=464&doi=10.1186/1756-0500-6-464&pmid=24229396)] [CrossRef (https://doi.org/10.1186/1756-0500-6-464&pmid=24229396)] [CrossRef (https://doi.org/10.1186/

99. Singh, O.; Khanam, Z.; Misra, N.; Srivastava, M.K. Chamomile (*Matricaria chamomilla* L.): An overview. Pharmacogn. Rev. 2011, 5, 82. [Google Scholar (https://scholar.google.com/scholar lookup?title=Chamomile+ (Matricaria+chamomilla+L.):+An+overview&author=Singh,+O.&author=Khanam,+Z.&aut hor=Misra,+N.&author=Srivastava,+M.K.&publication\_year=2011&journal=Pharmacogn. +Rev.&volume=5&pages=82&doi=10.4103/0973-7847.79103&pmid=22096322)] [CrossRef (https://doi.org/10.4103/0973-7847.79103)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/22096322)][Green Version (https://www.ncbi.nlm. nih.gov/pmc/articles/PMC3210003/pdf)]

100. Liu, L.-Y.; Li, Z.-H.; Ding, Z.-H.; Dong, Z.-J.; Li, G.-T.; Li, Y.; Liu, J.-K. Meroterpenoid pigments from the basidiomycete Albatrellus ovinus. J. Nat. Prod. 2013, 76, 79–84. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Meroterpenoid+pigments+from+the+basidiomycete+Albatrellus+ovinus&author=Li u,+L.-Y.&author=Li,+Z.-H.&author=Ding,+Z.-H.&author=Dong,+Z.-J.&author=Li,+G.-

T.&author=Li,+Y.&author=Liu,+J.-

K.&publication\_year=2013&journal=J.+Nat.+Prod.&volume=76&pages=79%E2%80%938 4&doi=10.1021/np300751m)] [CrossRef (https://doi.org/10.1021/np300751m)] 101 Gupta, P.; Gupta, S.; Sharma, M.; Kumar, N.; Pruthi, V.; Poluri, K.M. Effectiveness of phytoactive molecules on transcriptional expression, biofilm matrix, and cell wall components of *Candida glabrata* and its clinical isolates. *ACS Omega* 2018, 3, 12201–12214. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Effectiveness+of+phytoactive+molecules+on+transcriptional+expression,+biofilm +matrix,+and+cell+wall+components+of+Candida+glabrata+and+its+clinical+isolates&a uthor=Gupta,+P.&author=Gupta,+S.&author=Sharma,+M.&author=Kumar,+N.&author=P ruthi,+V.&author=Poluri,+K.M.&publication\_year=2018&journal=ACS+Omega&volume= 3&pages=12201%E2%80%9312214&doi=10.1021/acsomega.8b01856)] [CrossRef (https://doi.org/10.1021/acsomega.8b01856)][Green Version (https://pubs.acs.org/doi/pd f/10.1021/acsomega.8b01856)]

102. Zillich, O.V.; Schweiggert-Weisz, U.; Eisner, P.; Kerscher, M. Polyphenols as active ingredients for cosmetic products. Int. J. Cosmet. Sci. 2015, 37, 455–464. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Polyphenols+as+active+ingredients+for+cosmetic+products&author=Zillich,+O.V. &author=Schweiggert-Weisz,+U.&author=Eisner,+P.&author=Kerscher,+M.&publication\_year=2015&journal=In t+1+Cosmet+Sci. %volume=27% pages=455% E2% 90% 024648 doi=10.4111/joe.12248)]

t.+J.+Cosmet.+Sci.&volume=37&pages=455%E2%80%93464&doi=10.1111/ics.12218)] [CrossRef (https://doi.org/10.1111/ics.12218)]

- 103. Ivanova, A.; Ivanova, K.; Tzanov, T. Inhibition of quorum-sensing: A new paradigm in controlling bacterial virulence and biofilm formation. In *Biotechnological Applications of Quorum Sensing Inhibitors*; Kalia, V.C., Ed.; Springer: Singapore, 2018; pp. 3–21. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=Inhibition+of+quorum-sensing:+A+new+paradigm+in+controlling+bacterial+virulence+and+biofilm+formation &author=Ivanova,+A.&author=Ivanova,+K.&author=Tzanov,+T.&publication\_year=2018& pages=3%E2%80%9321)]
- 104. Tjia, J.A. Journey into C. albicans Biofilms: Proteomic and Functional Genomic Approaches to Uncovering Mechanisms of Adherence; University of Toronto: Toronto, ON, Canada, 2016.
   [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Journey+into+C.+albicans+Biofilms:+Proteomic+and+Functional+Genomic+Appro aches+to+Uncovering+Mechanisms+of+Adherence&author=Tjia,+J.A.&publication\_yea r=2016)]
- 105. Krishnamoorthy, R.; Gassem, M.A.; Athinarayanan, J.; Periyasamy, V.S.; Prasad, S.; Alshatwi, A.A. Antifungal activity of nanoemulsion from *Cleome viscosa* essential oil against foodborne pathogenic *Candida albicans*. *Saudi J. Biol. Sci.* 2021, *28*, 286–293. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+activity+of+nanoemulsion+from+Cleome+viscosa+essential+oil+again st+foodborne+pathogenic+Candida+albicans&author=Krishnamoorthy,+R.&author=Gas sem,+M.A.&author=Athinarayanan,+J.&author=Periyasamy,+V.S.&author=Prasad,+S.&author=Alshatwi,+A.A.&publication\_year=2021&journal=Saudi+J.+Biol.+Sci.&volume=28 &pages=286%E2%80%93293&doi=10.1016/j.sjbs.2020.10.001)] [CrossRef (https://doi.org/10.1016/j.sjbs.2020.10.001)]

Bhavaniramya, S.; Vishnupriya, S.; Al-Aboody, M.S.; Vijayakumar, R.; Baskaran, D. Role of essential oils in food safety: Antimicrobial and antioxidant applications. *Grain Oil Sci. Technol.* 2019, 2, 49–55. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Role+of+essential+oils+in+food+safety:+Antimicrobial+and+antioxidant+applicati ons&author=Bhavaniramya,+S.&author=Vishnupriya,+S.&author=Al-Aboody,+M.S.&author=Vijayakumar,+R.&author=Baskaran,+D.&publication\_year=2019& journal=Grain+Oil+Sci.+Technol.&volume=2&pages=49%E2%80%9355&doi=10.1016/j.g aost.2019.03.001)] [CrossRef (https://doi.org/10.1016/j.gaost.2019.03.001)]

107. Ali, E.M.; Alkuwayti, M.A.; Aldayel, M.F.; Abdallah, B.M. Coumarin derivative, 5'-hydroxy-auraptene, extracted from *Lotus lalambensis*, displays antifungal and anti-aflatoxigenic activities against *Aspergillus flavus*. *J. King Saud Univ.-Sci.* 2021, 33, 101216. [Google Scholar (https://scholar.google.com/scholar\_lookup?)

title=Coumarin+derivative,+5%E2%80%B2-hydroxyauraptene,+extracted+from+Lotus+lalambensis,+displays+antifungal+and+antiaflatoxigenic+activities+against+Aspergillus+flavus&author=Ali,+E.M.&author=Alkuway ti,+M.A.&author=Aldayel,+M.F.&author=Abdallah,+B.M.&publication\_year=2021&journal =J.+King+Saud+Univ.-

Sci.&volume=33&pages=101216&doi=10.1016/j.jksus.2020.10.013)] [CrossRef (https://doi.org/10.1016/j.jksus.2020.10.013)]

108. Reyes, D.C.; Annis, S.L.; Rivera, S.A.; Leon-Tinoco, A.Y.; Wu, C.; Perkins, L.B.; Perry, J.J.; Ma, Z.X.; Knight, C.W.; Castillo, M.S.; et al. In vitro screening of technical lignins to determine their potential as hay preservatives. *J. Dairy Sci.* 2020, 103, 6114–6134. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=In+vitro+screening+of+technical+lignins+to+determine+their+potential+as+hay+pr eservatives&author=Reyes,+D.C.&author=Annis,+S.L.&author=Rivera,+S.A.&author=Le on-

Tinoco,+A.Y.&author=Wu,+C.&author=Perkins,+L.B.&author=Perry,+J.J.&author=Ma,+Z. X.&author=Knight,+C.W.&author=Castillo,+M.S.&publication\_year=2020&journal=J.+Dai ry+Sci.&volume=103&pages=6114%E2%80%936134&doi=10.3168/jds.2019-17764)] [CrossRef (https://doi.org/10.3168/jds.2019-17764)]

109. Dalhoff, A.A.H.; Levy, S.B. Does use of the polyene natamycin as a food preservative jeopardise the clinical efficacy of amphotericin B? A word of concern. Int. J. Antimicrob. Agents 2015, 45, 564–567. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Does+use+of+the+polyene+natamycin+as+a+food+preservative+jeopardise+the+c linical+efficacy+of+amphotericin+B?

+A+word+of+concern&author=Dalhoff,+A.A.H.&author=Levy,+S.B.&publication\_year=2 015&journal=Int.+J.+Antimicrob.+Agents&volume=45&pages=564%E2%80%93567&doi= 10.1016/j.ijantimicag.2015.02.011)] [CrossRef

(https://doi.org/10.1016/j.ijantimicag.2015.02.011)][Green Version ()]

ukvicki, D.; Giweli, A.; Stojkovic, D.; Vujisic, L.; Tesevic, V.; Nikolic, M.; Sokovic, M.; Marin, R. Cheese supplemented with Thymus algeriensis oil, a potential natural food preservative. J. Dairy Sci. 2018, 101, 3859-3865. [Google Scho<u>la</u>r (https://scholar.google.com/scholar lookup? title=Cheese+supplemented+with+Thymus+algeriensis+oil,+a+potential+natural+food+ preservative&author=Bukvicki,+D.&author=Giweli,+A.&author=Stojkovic,+D.&author=V ujisic,+L.&author=Tesevic,+V.&author=Nikolic,+M.&author=Sokovic,+M.&author=Marin, +P.D.&publication year=2018&journal=J.+Dairy+Sci.&volume=101&pages=3859%E2%8 0%933865&doi=10.3168/jds.2017-13714&pmid=29477526)] [CrossRef (https://doi.org/10.3168/jds.2017-13714)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/29477526)][Green Version (http://www.journalofd

airyscience.org/article/S0022030218301486/pdf)]

111. Nebbia, S.; Lamberti, C.; Lo Bianco, G.; Cirrincione, S.; Laroute, V.; Cocaign-Bousquet, M., Cavallarin, L.; Giuffrida, M.G.; Pessione, E. Antimicrobial potential of food Lactic Acid Bacteria: Bioactive peptide decrypting from and bacteriocin production. caseins Microorganisms 2021, 9. 65. [Google Scholar (https://scholar.google.com/scholar\_lookup?

title=Antimicrobial+potential+of+food+Lactic+Acid+Bacteria:+Bioactive+peptide+decry pting+from+caseins+and+bacteriocin+production&author=Nebbia,+S.&author=Lambert i,+C.&author=Lo+Bianco,+G.&author=Cirrincione,+S.&author=Laroute,+V.&author=Coc aign-

Bousquet,+M.&author=Cavallarin,+L.&author=Giuffrida,+M.G.&author=Pessione,+E.&pu blication\_year=2021&journal=Microorganisms&volume=9&pages=65&doi=10.3390/micr oorganisms9010065)] [CrossRef (https://doi.org/10.3390/microorganisms9010065)]

- 112. Shehata, M.G.; Badr, A.N.; El Sohaimy, S.A. Novel antifungal bacteriocin from *Lactobacillus paracasei* KC39 with anti-mycotoxigenic properties. *Biosci. Res.* 2018, 15, 4171–4183.
  [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Novel+antifungal+bacteriocin+from+Lactobacillus+paracasei+KC39+with+anti-mycotoxigenic+properties&author=Shehata,+M.G.&author=Badr,+A.N.&author=El+Soha imy,+S.A.&publication\_year=2018&journal=Biosci.+Res.&volume=15&pages=4171%E2 %80%934183)]
- 113. Ahmad Rather, I.; Seo, B.J.; Rejish Kumar, V.J.; Choi, U.; Choi, K.; Lim, J.H.; Park, Y. Isolation and characterization of a proteinaceous antifungal compound from Lactobacillus plantarum YML 007 and its application as a food preservative. Lett. Appl. Microbiol. 2013, 57, 69-76. Google Scholar (https://scholar.google.com/scholar lookup? title=lsolation+and+characterization+of+a+proteinaceous+antifungal+compound+from+ Lactobacillus+plantarum+YML+007+and+its+application+as+a+food+preservative&auth or=Ahmad+Rather,+I.&author=Seo,+B.J.&author=Rejish+Kumar,+V.J.&author=Choi,+U. &author=Choi,+K.&author=Lim,+J.H.&author=Park,+Y.&publication year=2013&journal =Lett.+Appl.+Microbiol.&volume=57&pages=69%E2%80%9376&doi=10.1111/lam.12077& pmid=23565693)] [CrossRef (https://doi.org/10.1111/lam.12077)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/23565693)]

- 11 Pure E.H.; Yang, E.J.; Woo, E.R.; Chang, H.C. Purification and characterization of antifungal compounds from *Lactobacillus plantarum* HD1 isolated from kimchi. *Food Microbiol.* 2014, 41, 19–26. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Purification+and+characterization+of+antifungal+compounds+from+Lactobacillus +plantarum+HD1+isolated+from+kimchi&author=Ryu,+E.H.&author=Yang,+E.J.&author =Woo,+E.R.&author=Chang,+H.C.&publication\_year=2014&journal=Food+Microbiol.&vo lume=41&pages=19%E2%80%9326&doi=10.1016/j.fm.2014.01.011)] [CrossRef (https://doi.org/10.1016/j.fm.2014.01.011)]
- 115. Badr, A.N.; Abdel-Fatah, S.M.; Sree, Y.H.A.; Amra, H.A. Mycotoxigenic fungi and mycotoxins in Egyptian barley under climate changes. *Res. J. Environ. Toxicol.* 2017, *11*, 1–10. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Mycotoxigenic+fungi+and+mycotoxins+in+Egyptian+barley+under+climate+chang es&author=Badr,+A.N.&author=Abdel Eatab +S M & author=Sroo +Y H A & author=Amra +H A & publication\_yoar=2017&iournal

Fatah,+S.M.&author=Sree,+Y.H.A.&author=Amra,+H.A.&publication\_year=2017&journal =Res.+J.+Environ.+Toxicol.&volume=11&pages=1%E2%80%9310&doi=10.3923/rjet.2017 .1.10)] [CrossRef (https://doi.org/10.3923/rjet.2017.1.10)][Green Version (https://scialert.n et/qredirect.php?doi=rjet.2017.1.10&linkid=pdf)]

116. Badr, A.N.; Nada, F.; Shehata, M.G.; Amra, H.A. Anti-mycotic and anti-mycotoxigenic properties of Egyptian dill. J. Appl. Sci. 2017, 17, 184–195. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=Anti-mycotic+and+anti-mycotoxigenic+properties+of+Egyptian+dill&author=Badr,+A.N.&author=Nada,+F.&auth or=Shehata,+M.G.&author=Amra,+H.A.&publication\_year=2017&journal=J.+Appl.+Sci.& volume=17&pages=184%E2%80%93195&doi=10.3923/jas.2017.184.195)] [CrossRef (https://doi.org/10.3923/jas.2017.184.195)][Green Version (https://scialert.net/qredirect.php?doi=jas.2017.184.195&linkid=pdf)]

117. Schnürer, J.; Magnusson, J. Antifungal lactic acid bacteria as biopreservatives. *Trends Food* Sci. Technol. 2005, 16, 70–78. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antifungal+lactic+acid+bacteria+as+biopreservatives&author=Schn%C3%BCrer,+ J.&author=Magnusson,+J.&publication\_year=2005&journal=Trends+Food+Sci.+Technol .&volume=16&pages=70%E2%80%9378&doi=10.1016/j.tifs.2004.02.014)] [CrossRef (https://doi.org/10.1016/j.tifs.2004.02.014)]

118. Manso, S.; Becerril, R.; Nerín, C.; Gómez-Lus, R. Influence of pH and temperature variations on vapor phase action of an antifungal food packaging against five mold strains. *Food Control* 2015, 47, 20–26. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Influence+of+pH+and+temperature+variations+on+vapor+phase+action+of+an+ant ifungal+food+packaging+against+five+mold+strains&author=Manso,+S.&author=Becer ril,+R.&author=Ner%C3%ADn,+C.&author=G%C3%B3mez-Lus,+R.&publication\_year=2015&journal=Food+Control&volume=47&pages=20%E2%80 %9326&doi=10.1016/j.foodcont.2014.06.014)]

(https://doi.org/10.1016/j.foodcont.2014.06.014)]

Solano, A.C.V.; de Rojas Gante, C. Two different processes to obtain antimicrobial packaging containing natural oils. *Food Bioprocess Technol.* 2012, *5*, 2522–2528. [Google Scholar (https://scholar.google.com/scholar\_lookup?
Q =
title=Two+different+processes+to+obtain+antimicrobial+packaging+containing+natural +oils&author=Solano,+A.C.V.&author=de+Rojas+Gante,+C.&publication\_year=2012&jou roal=Ecod+Pioprocess+Technol & volume=58 pages=2522% E2% 90% 9225288 doi=10.100

rnal=Food+Bioprocess+Technol.&volume=5&pages=2522%E2%80%932528&doi=10.100 7/s11947-011-0626-3)] [CrossRef (https://doi.org/10.1007/s11947-011-0626-3)][Green Vers ion (https://link.springer.com/content/pdf/10.1007%2Fs11947-011-0626-3.pdf)]

120. Becerril, R.; Manso, S.; Nerin, C.; Gómez-Lus, R. Antimicrobial activity of Lauroyl Arginate Ethyl (LAE), against selected foodborne bacteria. *Food Control* 2013, *32*, 404–408. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Antimicrobial+activity+of+Lauroyl+Arginate+Ethyl+ (LAE),+against+selected+foodborne+bacteria&author=Becerril,+R.&author=Manso,+S.& author=Nerin,+C.&author=G%C3%B3mez-Lus,+R.&publication\_year=2013&journal=Food+Control&volume=32&pages=404%E2%8 0%93408&doi=10.1016/j.foodcont.2013.01.003)] [CrossRef (https://doi.org/10.1016/j.foodcont.2013.01.003)]

121. Gerez, C.L.; Torino, M.I.; Obregozo, M.D.; de Valdez, G.F. A ready-to-use antifungal starter culture improves the shelf life of packaged bread. *J. Food Prot.* 2010, 73, 758–762. [Google Scholar (https://scholar.google.com/scholar\_lookup?title=A+ready-to-use+antifungal+starter+culture+improves+the+shelf+life+of+packaged+bread&author=Gerez,+C.L.&author=Torino,+M.I.&author=Obregozo,+M.D.&author=de+Valdez,+G.F.&pu blication\_year=2010&journal=J.+Food+Prot.&volume=73&pages=758%E2%80%93762& doi=10.4315/0362-028X-73.4.758&pmid=20377968)] [CrossRef (https://doi.org/10.4315/0362-028X-73.4.758)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/20377968)]

122. Domínguez, Á.; Muñoz, E.; López, M.C.; Cordero, M.; Martínez, J.P.; Viñas, M. Transcriptomics as a tool to discover new antibacterial targets. *Biotechnol. Lett.* 2017, 39, 819–828. [Google Scholar (https://scholar.google.com/scholar\_lookup? title=Transcriptomics+as+a+tool+to+discover+new+antibacterial+targets&author=Dom %C3%ADnguez,+%C3%81.&author=Mu%C3%B1oz,+E.&author=L%C3%B3pez,+M.C.&au thor=Cordero,+M.&author=Mart%C3%ADnez,+J.P.&author=Vi%C3%B1as,+M.&publicati on\_year=2017&journal=Biotechnol.+Lett.&volume=39&pages=819%E2%80%93828&doi =10.1007/s10529-017-2319-0&pmid=28289911)] [CrossRef (https://doi.org/10.1007/s10529-017-2319-0)] [PubMed (https://www.ncbi.nlm.nih.gov/pubmed/28289911)]

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

© 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article

distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/ (https://creativecommons.org/licenses/by/4.0/)).

೦ ≡

## Share and Cite

# 🖸 (mailto:?

&subject=From%20MDPI%3A%20%22Antifungal%20Metabolites%20as%20Food%20Bio-Preservative%3A%20Innovation%2C%20Outlook%2C%20and%20Challenges"&body=https://w ww.mdpi.com/1419592%3A%0A%0AAntifungal%20Metabolites%20as%20Food%20Bio-Preservative%3A%20Innovation%2C%20Outlook%2C%20and%20Challenges%0A%0AAbstrac t%3A%20Perishable%20food%20spoilage%20caused%20by%20fungi%20is%20a%20major%2 Ocause%20of%20discomfort%20for%20food%20producers.%20Food%20sensory%20abnorma lities%20range%20from%20aesthetic%20degeneration%20to%20significant%20aroma%2C%2 0color%2C%20or%20consistency%20alterations%20due%20to%20this%20spoilage.%20Biopreservation%20is%20the%20use%20of%20natural%20or%20controlled%20bacteria%20or%2 0antimicrobials%20to%20enhance%20the%20guality%20and%20safety%20of%20food.%20lt% 20has%20the%20ability%20to%20harmonize%20and%20rationalize%20the%20required%20sa fety%20requirements%20with%20conventional%20preservation%20methods%20and%20food %20production%20safety%20and%20quality%20demands.%20Even%20though%20synthetic %20preservatives%20could%20fix%20such%20issues%2C%20there%20is%20indeed%20a%2 0significant%20social%20need%20for%20%26ldguo%3Bclean%20label%26rdguo%3B%20foo ds.%20As%20a%20result%2C%20consumers%20are%20now%20seeking%20foods%20that% 20are%20healthier%2C%20less%20processed%2C%20and%20safer.%20The%20implementati on%20of%20antifungal%20compounds%20has%20gotten%20a%20lot%20of%20attention%20i n%20recent%20decades.%20As%20a%20result%2C%20the%20identification%20and%20char acterization%20of%20such%20antifungal%20agents%20has%20made%20promising%20adva nces.%20The%20present%20state%20of%20information%20on%20antifungal%20molecules% 2C%20their%20modes%20of%20activity%2C%20connections%20with%20specific%20target% 20fungi%20varieties%2C%20and%20uses%20in%20food%20production%20systems%20are% 20summarized%20in%20this%20review.) 20(https://twitter.com/intent/tweet?) text=Antifungal+Metabolites+as+Food+Bio-

Preservative%3A+Innovation%2C+Outlook%2C+and+Challenges&hashtags=mdpimetabolites &url=https%3A%2F%2Fwww.mdpi.com%2F1419592&via=MDPIOpenAccess) () http://www.linkedin.com/shareArticle?

mini=true&url=https%3A%2F%2Fwww.mdpi.com%2F1419592&title=Antifungal%20Metabolites %20as%20Food%20Bio-

Preservative%3A%20Innovation%2C%20Outlook%2C%20and%20Challenges%26source%3Dh ttps%3A%2F%2Fwww.mdpi.com%26summary%3DPerishable%20food%20spoilage%20cause d%20by%20fungi%20is%20a%20major%20cause%20of%20discomfort%20for%20food%20pro ducers.%20Food%20sensory%20abnormalities%20range%20from%20aesthetic%20degenerati on%20to%20significant%20aroma%2C%20color%2C%20or%20consistency%20alterations%2

0due%20to%20this%20spoilage.%20Bio-preservation%20%5B...%5D)

# (https://www.facebook.com/sharer.php?u=https://www.mdpi.com/1419592) (https://www.reddit.com/submit?url=https://www.mdpi.com/1419592) (https://www.mendeley.com/import/?url=https://www.mdpi.com/1419592)

# **MDPI and ACS Style**

Mishra, B.; Mishra, A.K.; Kumar, S.; Mandal, S.K.; NSV, L.; Kumar, V.; Baek, K.-H.; Mohanta, Y.K. Antifungal Metabolites as Food Bio-Preservative: Innovation, Outlook, and Challenges. *Metabolites* **2022**, *12*, 12. https://doi.org/10.3390/metabo12010012

ৎ ≡

## AMA Style

Mishra B, Mishra AK, Kumar S, Mandal SK, NSV L, Kumar V, Baek K-H, Mohanta YK. Antifungal Metabolites as Food Bio-Preservative: Innovation, Outlook, and Challenges. *Metabolites*. 2022; (1):12. https://doi.org/10.3390/metabo12010012

# Chicago/Turabian Style

Mishra, Bishwambhar, Awdhesh Kumar Mishra, Sanjay Kumar, Sanjeeb Kumar Mandal, Lakshmayya NSV, Vijay Kumar, Kwang-Hyun Baek, and Yugal Kishore Mohanta. 2022. "Antifungal Metabolites as Food Bio-Preservative: Innovation, Outlook, and Challenges" *Metabolites* 12, no. 1: 12. https://doi.org/10.3390/metabo12010012

## **Find Other Styles**

Type a publisher, journal or format name

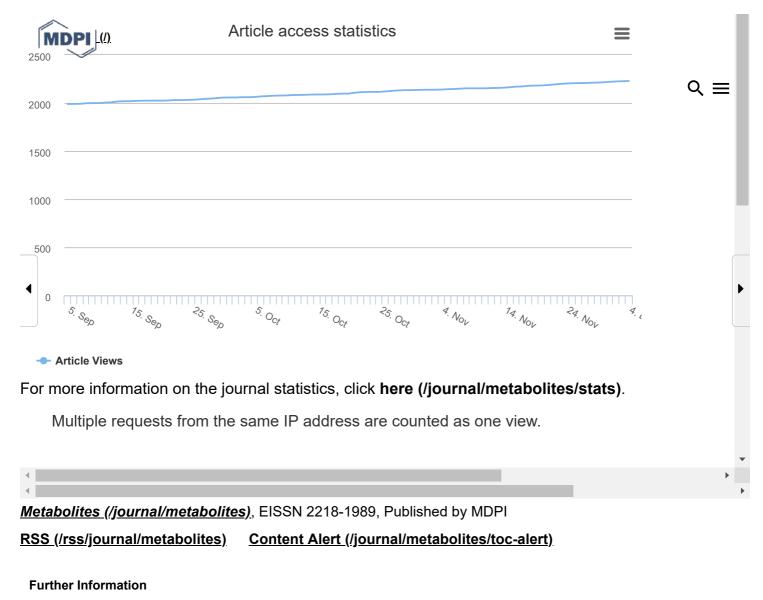
Note that from the first issue of 2016, MDPI journals use article numbers instead of page numbers. See further details **here (https://www.mdpi.com/about/announcements/784)**.

# **Article Metrics**

## Citations

| Crossref | Scopus                      | PubMed   | Google<br>Scholar |
|----------|-----------------------------|----------|-------------------|
| 3        | 3 (https://w                | 1 (https |                   |
|          | partnerID=HzOxlinkname=pubm |          |                   |
|          |                             | F        | Preservative%3/   |

## **Article Access Statistics**



Article Processing Charges (/apc) Pay an Invoice (/about/payment) Open Access Policy (/openaccess) Contact MDPI (/about/contact) Jobs at MDPI (https://careers.mdpi.com)

Guidelines For Authors (/authors) For Reviewers (/reviewers) For Editors (/editors) For Librarians (/librarians) For Publishers (/publishing\_services) For Societies (/societies) For Conference Organizers (/conference\_organizers) MDPI Initiatives Sciforum (https://sciforum.net) MDPI Books (https://www.mdpi.com/books) Preprints (https://www.preprints.org) Scilit (https://www.scilit.net) SciProfiles (https://sciprofiles.com) Encyclopedia (https://encyclopedia.pub) JAMS (https://jams.pub) Proceedings Series (/about/proceedings)

Follow MDPI

LinkedIn (https://www.linkedin.com/company/mdpi) Facebook (https://www.facebook.com/MDPIOpenAccessPublishing) Twitter (https://twitter.com/MDPIOpenAccess)



# Subscribe to receive issue release notifications and newsletters from MDPI journals

Select options

Enter your email address...

Subscribe

© 1996-2022 MDPI (Basel, Switzerland) unless otherwise stated

Disclaimer Terms and Conditions (/about/terms-and-conditions) Privacy Policy (/about/privacy)

 $Q \equiv$ 



(Home.aspx)

# **Research Journal of Pharmacy and Technology**

(Home.aspx)

ISSN

0974-360X (Online) 0974-3618 (Print)

HOME ~ (HOME.ASPX) PAST ISSUES (PASTISSUES.ASPX)

EDITORIAL BOARD (EDITORIAL BUARDILASPOICE (Submit Anticlesspx) MORE ~

# Applications of Microbial bioflocculants for Environmental remediation: An Overview (AbstractView.aspx?PID=2022-15-4-81) (https://scholar.google.co.in/scholar? q=Applications of Microbial bioflocculants for Environmental remediation: An Overview)

Author(s): Nilanjana Das (search.aspx?key=Nilanjana Das), Ashwini Prabhakar Shende (search.aspx? key=Ashwini Prabhakar Shende), Keerthana G (search.aspx?key=Keerthana G), Sanjeeb Kumar Mandal (search.aspx?key=Sanjeeb Kumar Mandal)

Email(s): nilanjanamitra@vit.ac.in (mailto:nilanjanamitra@vit.ac.in)

DOI: 10.52711/0974-360X.2022.00315 (https://doi.org/10.52711/0974-360X.2022.00315) (https://scholar.google.co.in/scholar?q=10.52711/0974-360X.2022.00315)

Address: Nilanjana Das1<sup>\*</sup>, Ashwini Prabhakar Shende1, Keerthana G1, Sanjeeb Kumar Mandal2 1Bioremediation Laboratory, School of Bio Sciences and Technology, VIT, Vellore 632014, Tamil Nadu, India. 2Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad - 500075, Telangana, India.

\*Corresponding Author

Published In: Volume - 15, Issue - 4, Year - 2022 (Issues.aspx?VID=15&IID=4)





(HTMLPaper.aspx? Journal=Research Journal of Pharmacy and

### **ABSTRACT:**

The application of bioflocculants has recently become a promising solution for the new methan additional and wastewater as well as removal of pollutants from environment. Water pollutator and wastewater as well as removal of pollutants from environment. Water pollutator additional issue in the developing countries to determine the quality of life. The wastewater from different sources contains suspended solids, organic and inorganic particles, dissolved solids, heavy metals, dyes and other impurities which are harmful to the environment causing major health hazards in human and animals. The use of bioflocculants is advantageous for the control of environmental pollution as they are non- toxic and biodegradable in nature. Moreover, they do not create any secondary pollution. Chemical flocculants being a source of carcinogens can be replaced by bioflocculants which needs to be produced on a large scale. However, commercially viable bioflocculants are yet to be produced and marketed widely. This review intends to present the updated information on microbial bioflocculants and their applications for remediation of pollutants from wastewater. It may bring up the significant issues which can be attempted by future researchers for a better understanding to develop commercially viable, safe, eco-friendly and cost effective bioflocculants using new biotechnological techniques.

 Keywords:
 Bioflocculant ()
 Biodegradable ()
 Eco-Friendly ()
 Flocculation Activity ()

 Wastewater Treatment. ()

## Cite this article:

Nilanjana Das, Ashwini Prabhakar Shende, Keerthana G, Sanjeeb Kumar Mandal. Applications of Microbial bioflocculants for Environmental remediation: An Overview. Research Journal of Pharmacy and Technology. 2022; 15(4):1883-0. doi: 10.52711/0974-360X.2022.00315

## Cite(Electronic):

Nilanjana Das, Ashwini Prabhakar Shende, Keerthana G, Sanjeeb Kumar Mandal. Applications of Microbial bioflocculants for Environmental remediation: An Overview. Research Journal of Pharmacy and Technology. 2022; 15(4):1883-0. doi: 10.52711/0974-360X.2022.00315 Available on: https://rjptonline.org/AbstractView.aspx?PID=2022-15-4-81

#### **REFERENCES:**

1. Sharmila S, Dinesh M, Kowsalya E, Kamalambigeswari R and Rebecca LJ. Biosorption of dye using Lawsonia sp. as adsorbent. Research Journal of Pharmacy and Technology. 2020; 13(4): 1651-1654.

- 2. Mandal SK and Das N. Biodegradation of benzo [a] pyrene by Rhodotorula sp. NS01 strain isolated from contaminated soil sample. Research Journal of Pharmacy and Technology. 2017; 10(6):1751-1757.
- 3. Gupta AK, Ganjewala D, Goel N, Khurana N, Ghosh S and Saxena A. Bioremediation of tannery chromium: A

microbial approach. Research Journal of Pharmacy and Technology. 2014; 7(1):118-122.

4. Verma M and Ekka A. Decolorization and degradation of kraft lignin discharged from pulp and paper mill industry by axenic and co-culture of Bacillus sp. Research Journal of Pharmacy and Technology. 2018; 11(10):4386-4392.

5. Abbas BF, Al-Jubori WM, Abdullah AM, Shaaban H and Mohammed MT. Environmental pollution with the heavy metal compound. Research Journal of Pharmacy and Technology. 2018; 11(9):4035-4041.

6. Ragadevan V, Kanchanabhan TE, Dayakar P, Mani A and Chockalingam MP. Removal of heavy metal ions (Lead) using natural adsorbent. Research Journal of Pharmacy and Technology. 2019; 12(8):3693-3696.

7. Purushothaman V, Madhumathi R and Sakthiselvan P. Removal of Nickel (II) and Zinc (II) present in the electroplating industry wastewater by bioaccumulation method. Research Journal of Pharmacy and Technology. 2019; 12(4):1495-1503.

8. Sajen S, Jose JV, Bukke S, Subbarao SS and Mandla VR. Removal of basic dye from synthetic wastewater using sugarcane bagasse modified with propionic acid. Research Journal of Pharmacy and Technology. 2017; 10(6):1627-1634.

9. Meshram R and Jadhav SK. Treatment of oil refinery wastewater simultaneously with bioelectricity production in mediator-less microbial fuel cell using native gram-positive Bacillus sp. Research Journal of Pharmacy and Technology. 2019; 12(4):1953-1961.

10. Oda AM, Naji HK, Lafta AJ, Salih A, Ahmed L, Jawad H and Falah K. Congo red dye removal from simulated textile wastewaters over a neat and silver doped zinc oxide nanoparticles. A kinetics study. Research Journal of Pharmacy and Technology. 2019; 12(6):2669-2676.

11. Ramya M, Kalaivani RA and Raghu S. Microbial fuel cell: A renewable equipment for bio-power production and simultaneous treatment of industrial wastewaters. Research Journal of Pharmacy and Technology. 2019; 12(7):3551-3554.

12. Abdollahi K, Yazdani F, Panahi R and Mokhtarani B. Biotransformation of phenol in synthetic wastewater using the functionalized magnetic nano-biocatalyst particles carrying tyrosinase. 3 Biotech. 2018; 8(10):419.

13. Ortiz-Oliveros HB and Flores-Espinosa RM. Simultaneous removal of oil, total Co and 60 Co from radioactive liquid waste by dissolved air flotation. International Journal of Environmental Science and Technology. 2019; 16(7):3679-3686.

14. Liu H, Chen G and Wang G. Characteristics for production of hydrogen and bioflocculant by Bacillus sp. XF-56 from marine intertidal sludge. International Journal of Hydrogen Energy. 2015a; 40(3):1414-1419.

15. Liu Z, Huang M, Li A and Yang H. Flocculation and antimicrobial properties of a cationized starch. Water Research. 2017a; 119: 57-66.

16. Liu Z, Wei H, Li A and Yang H. Evaluation of structural effects on the flocculation performance of a co-graft starch-based flocculant. Water Research. 2017b; 118:160-166.

17. Abu Tawila ZM, Ismail S, Dadrasnia A and Usman MM. Production and characterization of a bioflocculant produced by Bacillus salmalaya 139SI-7 and its applications in wastewater treatment. Molecules. 2018; 23(10):2689.

18. Aguilar MI, Sáez J, Lloréns M, Soler A, Ortuño JF, Meseguer V and Fuentes A. Improvement of coagulation-flocculation process using anionic polyacrylamide as coagulant aid. Chemosphere. 2005; 58(1):47-56.

19. Yang R, Li H, Huang M, Yang H and Li A. A review on chitosan-based flocculants and their applications in water treatment. Water Research. 2016; 95:59-89.

20. Ferasat Z, Panahi R and Mokhtarani B. Natural polymer matrix as safe flocculant to remove turbidity from kaolin suspension: Performance and governing mechanism. Journal of Environmental Management. 2020; 255:109939.

21. Lapointe M and Barbeau B. Dual starch-polyacrylamide polymer system for improved flocculation. Water Research. 2017; 124:202-209.

22. Im D, Nakada N, Kato Y, Aoki M and Tanaka H. Pretreatment of ceramic membrane microfiltration in wastewater reuse: A comparison between ozonation and coagulation. Journal of Environmental Management. 2019; 251:109555.

23. Liu Z, Wei H, Li A and Yang H. Enhanced coagulation of low-turbidity micro-polluted surface water: properties and optimization. Journal of Environmental Management. 2019; 233:739-747.

24. Abdollahi K, Yazdani F and Panahi R. Covalent immobilization of tyrosinase onto cyanuric chloride crosslinked amine-functionalized superparamagnetic nanoparticles: synthesis and characterization of the recyclable

nanobiocatalyst. International Journal of Biological Macromolecules. 2017; 94:396-405.

25. Abdollahi K, Yazdani F and Panahi R. Fabrication of the robust and recyclable tyrosinase-harboring biocatalyst using ethylenediamine functionalized superparamagnetic nanoparticles: nanocarrier characterization and immobilized enzyme properties. Journal of Biological Inorganic Chemistry. 2019; 24(7): 943-959.

26. Firooz NS, Panahi R, Mokhtarani B and Yazdani F. Direct introduction of amine groups into cellulosic paper for covalent immobilization of tyrosinase: support characterization and enzyme properties. Cellulose. 2017; 24(3): 1407-1416.

27. Kothari R, Pathak VV, Pandey A, Ahmad S, Srivastava C and Tyagi VV. A novel method to harvest Chlorella sp. via low cost bioflocculant: Influence of temperature with kinetic and thermodynamic functions. Bioresource Technology. 2017; 225: 84-89.

28. Shahadat M, Teng TT, Rafatullah M, Shaikh ZA, Sreekrishnan TR and Ali SW. Bacterial bioflocculants: a review of recent advances and perspectives. Chemical Engineering Journal. 2017; 328: 1139-1152.

29. Dao VH, Cameron NR and Saito K. Synthesis, properties and performance of organic polymers employed in flocculation applications. Polymer Chemistry. 2016; 7(1):11-25.

30. Mu J, Zhou H, Chen Y, Yang G and Cui X. Revealing a novel natural bioflocculant resource from Ruditapes philippinarum: Effective polysaccharides and synergistic flocculation. Carbohydrate Polymers. 2018; 186:17-24.

31. Lee DJ and Chang YR. Bioflocculants from isolated stains: A research update. Journal of the Taiwan Institute of Chemical Engineers. 2018; 87:211-215.

32. Siddeeg SM, Tahoon MA and Rebah FB. Agro-industrial waste materials and wastewater as growth media for microbial bioflocculants production: a review. Materials Research Express. 2020; 7(1):012001.

33. Abd El-Salam AE, Abd-El-Haleem D, Youssef AS, Zaki S, Abu-Elreesh G and El-Assar SA. Isolation, characterization, optimization, immobilization and batch fermentation of bioflocculant produced by Bacillus aryabhattai strain PSK1. Journal of Genetic Engineering and Biotechnology. 2017; 15(2):335-344.

34. Abdullah AM, Hamidah H and Alam MZ. Research progress in bioflocculants from bacteria. International Food Research Journal. 2017; 24:402-409.

35. Agunbiade MO, Pohl CH and Ashafa AO. A Review of the application of biofloccualnts in wastewater treatment. Polish Journal of Environmental Studies. 2016; 25(4):1381-1389.

36. David OM, Oluwole OA, Ayodele OE and Lasisi T. Characterisation of fungal bioflocculants and its application in water treatment. Current Journal of Applied Science and Technology. 2019; 34(6):1-9.

37. Maliehe TS, Basson AK and Dlamini NG. Removal of pollutants in mine wastewater by a non-cytotoxic polymeric bioflocculant from Alcaligenes faecalis HCB2. International Journal of Environmental Research and Public Health. 2019; 16(20):4001.

38. Dlamini NG, Basson AK and Pullabhotla VS. Optimization and application of bioflocculant passivated copper nanoparticles in the wastewater treatment. International Journal of Environmental Research and Public Health. 2019; 16(12):2185.

39. Dlangamandla C, Ntwampe SK and Basitere M. A bioflocculant-supported dissolved air flotation system for the removal of suspended solids, lipids and protein matter from poultry slaughterhouse wastewater. Water Science and Technology. 2018; 78(2):452-458.

40. Agunbiade M, Pohl C and Ashafa O. Bioflocculant production from Streptomyces platensis and its potential for river and waste water treatment. Brazilian Journal of Microbiology. 2018; 49(4):731-741.

41. Didar Z and Ferdosi-Makan A. Bioflocculant production by different microbial species and their potential application in dairy wastewater treatment. Journal of Advances in Environmental Health Research. 2016; 4(1):18-24.

42. Pu SY, Qin LL, Che JP, Zhang BR and Xu M. Preparation and application of a novel bioflocculant by two strains of Rhizopus sp. using potato starch wastewater as nutrilite. Bioresource Technology. 2014; 162:184-191.

43. Zhong C, Xu A, Chen L, Yang X, Yang B, Hong W, Mao K, Wang B and Zhou J. Production of a bioflocculant from chromotropic acid waste water and its application in steroid estrogen removal. Colloids and Surfaces B: Biointerfaces. 2014; 122:729-737.

44. Guo J, Yang C and Zeng G. Treatment of swine wastewater using chemically modified zeolite and bioflocculant from activated sludge. Bioresource Technology. 2013; 143:289-297.

45. Zhang CL, Cui YN, Wang Y. Bioflocculant produced from bacteria for decolorization, Cr removal and swine wastewater application. Sustainable Environment Research. 2012; 22(2):129-134.

46. Gong WX, Wang SG, Sun XF, Liu XW, Yue QY and Gao BY. Bioflocculant production by culture of Serratia ficaria

and its application in wastewater treatment. Bioresource technology. 2008; 99(11):4668-4674.

47. Vimala RT, Escaline JL and Sivaramakrishnan S. Characterization of self-assembled bioflocculant from the microbial consortium and its applications. Journal of Environmental Management. 2020; 258:110000.

48. Biswas JK, Banerjee A, Sarkar B, Sarkar D, Sarkar SK, Rai M and Vithanage M. Exploration of an extracellular polymeric substance from earthworm gut bacterium (Bacillus licheniformis) for bioflocculation and heavy metal removal potential. Applied Sciences. 2020; 10(1):349.

49. Agunbiade MO, Pohl C, Heerden EV, Oyekola O and Ashafa A. Evaluation of fresh water actinomycete bioflocculant and its biotechnological applications in wastewaters treatment and removal of heavy metals. International Journal of Environmental Research and Public Health. 2019; 16(18):3337.

50. Fan HC, Yu J, Chen RP and Yu L. Preparation of a bioflocculant by using acetonitrile as sole nitrogen source and its application in heavy metals removal. Journal of Hazardous Materials. 2019; 363:242-247.

51. Ayangbenro AS, Babalola OO and Aremu OS. Bioflocculant production and heavy metal sorption by metal resistant bacterial isolates from gold mining soil. Chemosphere. 2019; 231: 113-120.

52. Dih CC, Jamaluddin NA and Zulkeflee Z. Removal of heavy metals in lake water using bioflocculant produced by Bacillus subtilis. Pertanika Journal of Tropical Agricultural Science. 2019; 42(1):89-101.

53. Sajayan A, Kiran GS, Priyadharshini S, Poulose N and Selvin J. Revealing the ability of a novel polysaccharide bioflocculant in bioremediation of heavy metals sensed in a Vibrio bioluminescence reporter assay. Environmental Pollution. 2017; 228:118-127.

54. Pathak M, Sarma HK, Bhattacharyya KG, Subudhi S, Bisht V, Lal B and Devi A. Characterization of a novel polymeric bioflocculant produced from bacterial utilization of n-hexadecane and its application in removal of heavy metals. Frontiers in Microbiology. 2017; 8:170.

55. Zhao H, Zhong C, Chen H, Yao J, Tan L, Zhang Y and Zhou J. Production of bioflocculants prepared from formaldehyde wastewater for the potential removal of arsenic. Journal of Environmental Management. 2016; 172:71-76.

56. Subudhi S, Bisht V, Batta N, Pathak M, Devi A and Lal B. Purification and characterization of exopolysaccharide bioflocculant produced by heavy metal resistant Achromobacter xylosoxidans. Carbohydrate Polymers. 2016; 137:441-451.

57. Devi KK and Natarajan KA. Production and characterization of bioflocculants for mineral processing applications. International Journal of Mineral Processing. 2015; 137:15-25.

58. Bisht V and Lal B. Exploration of performance kinetics and mechanism of action of a potential novel bioflocculant BF-VB2 on clay and dye wastewater flocculation. Frontiers in Microbiology. 2019; 10:1288.

59. Chouchane H, Mahjoubi M, Ettoumi B, Neifar M and Cherif A. A novel thermally stable heteropolysaccharidebased bioflocculant from hydrocarbonoclastic strain Kocuria rosea BU22S and its application in dye removal. Environmental Technology. 2018; 39(7):859-872.

60. Buthelezi SP, Olaniran AO and Pillay B. Textile dye removal from wastewater effluents using bioflocculants produced by indigenous bacterial isolates. Molecules. 2012; 17(12):14260-14274.

61. Deng S, Yu G and Ting YP. Production of a bioflocculant by Aspergillus parasiticus and its application in dye removal. Colloids and Surfaces B: Biointerfaces. 2005; 44(4):179-186.

62. Zhao H, Liu H and Zhou J. Characterization of a bioflocculant MBF-5 by Klebsiella pneumoniae and its application in Acanthamoeba cysts removal. Bioresource Technology. 2013; 137:226-232.

63. Cao G, Zhang Y, Chen L, Liu J, Mao K, Li K and Zhou J. Production of a bioflocculant from methanol wastewater and its application in arsenite removal. Chemosphere. 2015; 141:274–281.

64. Li Z, Zhong S, Lei HY, Chen RW, Yu Q and Li HL. Production of a novel bioflocculant by Bacillus licheniformis X14 and its application to low temperature drinking water treatment. Bioresource Technology. 2009; 100:3650–3656.

65. Liu W, Hao Y, Jiang J, Zhu A, Zhu J and Dong Z. Production of a bioflocculant from Pseudomonas veronii L918 using the hydrolyzate of peanut hull and its application in the treatment of ash-flushing wastewater generated from coal fired power plant. Bioresource Technology. 2016; 218:318–325.

66. Yang Z, Liu S, Zhang W, Wen Q and Guo Y. Enhancement of coal waste slurry flocculation by CTAB combined with bioflocculant produced by Azotobacter chroococcum. Separation and Purification Technology. 2019; 211:587–593.

# **RECOMONDED ARTICLES:**



Research Journal of Pharmacy and Technology (RJPT) is an international, peer-reviewed, multidisciplinary journal....

Read more >>> (AboutJournal.aspx)

RNI: CHHENG00387/33/1/2008-TC DOI: 10.5958/0974-360X

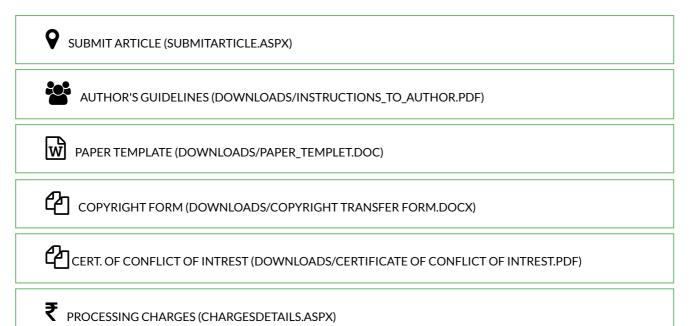


(https://www.scopus.com/sourceid/21100197160?dgcid=sc\_widget\_citescore)



(https://www.scimagojr.com/journalsearch.php?q=21100197160&tip=sid&exact=no)

# QUICK LINKS





INDEXING INFORMATION (INDEXED\_IN.ASPX)

# LATEST ISSUES

NOVEMBER 2022 (91) (ISSUES.ASPX?VID=15&IID=11)

OCTOBER 2022 (88) (ISSUES.ASPX?VID=15&IID=10)

SEPTEMBER 2022 (87) (ISSUES.ASPX?VID=15&IID=9)

AUGUST 2022 (82) (ISSUES.ASPX?VID=15&IID=8)

JULY 2022 (80) (ISSUES.ASPX?VID=15&IID=7)

JUNE 2022 (82) (ISSUES.ASPX?VID=15&IID=6)

MAY 2022 (78) (ISSUES.ASPX?VID=15&IID=5)

APRIL 2022 (83) (ISSUES.ASPX?VID=15&IID=4)

# **POPULAR ARTICLES**

(AbstractView.aspx?PID=2017-10-9-42) Detection of Food Adulterants in Chilli, Turmeric and Coriander Powders by Physical and **Chemical Methods** 

(AbstractView.aspx?PID=2017-10-9-42)

(AbstractView.aspx?PID=2020-13-1-43) Formulation and Evaluation of Herbal Face Cream

(AbstractView.aspx?PID=2020-13-1-43)

(AbstractView.aspx?PID=2013-6-2-15) **Medicinal Plants from Solanaceae Family** 

(AbstractView.aspx?PID=2013-6-2-15)

(AbstractView.aspx?PID=2019-12-1-69) Recent Advances in Preventive Resin Restoration (PRR)

(AbstractView.aspx?PID=2019-12-1-69)

(AbstractView.aspx?PID=2020-13-4-16) Formulation and Evaluation of Herbal Lipsticks

(AbstractView.aspx?PID=2020-13-4-16)

(AbstractView.aspx?PID=2017-10-12-61) Mathematical Models in Drug Discovery, Development and Treatment of Various Diseases – A Case Study

(AbstractView.aspx?PID=2017-10-12-61)

(AbstractView.aspx?PID=2018-11-2-70) Recent Advancements in Laminates and Veneers in Dentistry

(AbstractView.aspx?PID=2018-11-2-70)

(AbstractView.aspx?PID=2020-13-7-74)

Pharmaceutical Incompatibilities: Causes, Types and Major ways of Overcoming in Extemporaneous Medicinal forms

(AbstractView.aspx?PID=2020-13-7-74)

(AbstractView.aspx?PID=2014-7-9-14)

The Use of Neem in Oral Health

(AbstractView.aspx?PID=2014-7-9-14)

(AbstractView.aspx?PID=2019-12-11-80) Dental Waxes-A Review

(AbstractView.aspx?PID=2019-12-11-80)

(AbstractView.aspx?PID=2010-3-3-60) Evaluation of Ayurvedic Marketed Formulations Asava's and Arista's.

(AbstractView.aspx?PID=2010-3-3-60)

(AbstractView.aspx?PID=2014-7-9-16)

Project Writing for Retail Pharmacy Practical Training: A Proforma

(AbstractView.aspx?PID=2014-7-9-16)

(AbstractView.aspx?PID=2012-5-5-5)

A comparative, Bioequivalence study to evaluate the safety and pharmacokinetic profile of single dose lvabradine 7.5mg Tablets in healthy, adult, human subjects under fasting condition.

(AbstractView.aspx?PID=2012-5-5-5)

(AbstractView.aspx?PID=2017-10-9-19)

Formulation and Evaluation of Aspirin Tablets by Using Different Lubricants in Combination for better Kinetic Drug Release Study by PCP

(AbstractView.aspx?PID=2017-10-9-19)

(AbstractView.aspx?PID=2015-8-12-24) Screening Methods for Hepatoprotective Agents in Experimental Animals

(AbstractView.aspx?PID=2015-8-12-24)

# **Recent Articles**

# Tags

Not Available

# **ABOUT JOURNAL**

Research Journal of Pharmacy and Technology (RJPT) is an international, peer-reviewed, multidisciplinary journal, devoted to pharmaceutical sciences. The aim of RJPT is to increase the impact of pharmaceutical research both in academia and industry, with strong emphasis on quality and originality. RJPT publishes Original Research Articles, Short Communications, Review Articles in all areas of pharmaceutical sciences from the discovery of a drug up to clinical evaluation. Topics covered are: Pharmaceutics and Pharmacokinetics; Pharmaceutical chemistry including medicinal and analytical chemistry; Pharmacognosy including herbal products standardization and Phytochemistry; Pharmacology: Allied sciences including drug regulatory affairs, Pharmaceutical Marketing, Pharmaceutical Microbiology, Pharmaceutical biochemistry, Pharmaceutical Education and Hospital Pharmacy. Read More >>> (AboutJournal.aspx)

## VISITORS



Yesterday: 31736

HOME (HOME.ASPX) I ABOUT JOURNAL (ABOUT JOURNAL.ASPX) I

EDITORIAL BOARD (EDITORIALBOARD.ASPX) I SITEMAP (SITEMAP.XML)

Designed and Developed by: (https://tlabssolutions.com/) T-Labs Solutions (https://tlabssolutions.com/)



#### Chemosphere

Volume 287, Part 4, January 2022, 132299

# Application of bioelectrochemical systems to regulate and accelerate the anaerobic digestion processes

C. Nagendranatha Reddy <sup>a, b</sup>, Sanath Kondaveeti <sup>c</sup>, Gunda Mohanakrishna <sup>d</sup>, Booki Min <sup>a</sup> 📯 🖾

Show more  $\checkmark$ 

😪 Share 🌖 Cite

https://doi.org/10.1016/j.chemosphere.2021.132299

Get rights and content

#### Abstract

<u>Anaerobic digestion</u> (AD) serves as a potential <u>bioconversion</u> process to treat various organic wastes/wastewaters, including <u>sewage</u> <u>sludge</u>, and generate renewable green energy. Despite its efficiency, AD has several limitations that need to be overcome to achieve maximum energy recovery from organic materials while regulating inhibitory substances. Hence, bioelectrochemical systems (BESs) have been widely investigated to treat inhibitory compounds including ammonia in AD processes and improve the AD operational efficiency, stability, and <u>economic viability</u> with various integrations. The BES operations as a <u>pretreatment</u> process, inside AD or after the AD process aids in the upgradation of <u>biogas</u> (CO<sub>2</sub> to methane) and residual volatile fatty acids (VFAs) to valuable chemicals and fuels (alcohols) and even directly to electricity generation. This review presents a comprehensive summary of BES technologies and operations for overcoming the limitations of AD in lab-scale applications and suggests upscaling and future opportunities for BES-AD systems.

#### **Graphical abstract**



#### Introduction

Anaerobic digestion (AD) is a conventional process for the bioconversion of organic matter/CO<sub>2</sub> to biogas that has great potential to recover a spectrum of biobased products (Appels et al., 2008; Zhou et al., 2017). It is generally known as a controllable and sustainable way to treat sewage sludge compared with other disposal routes such as landfill and composting. However, the rate and efficiency of AD are low, especially when no inoculators are added and require longer operation time to achieve effective substrate removal and value-addition yields (Chen et al., 2008; Lamastra et al., 2018; Oladejo et al., 2019; Przydatek and Wota, 2020). Some other limitations of AD process includes extended startup time (Goux et al., 2016), accumulation of VFA thereby leading to collapsing the anaerobic process (Moreno et al., 2018), lower contents of methane (40–60%) and H<sub>2</sub> (14–27%) (Börjesson and Mattiasson, 2008; Venkata Mohan et al., 2008; Gude, 2018), inhibition of microbial activity due to nutrient overload (Cerrillo et al., 2016), specific operational conditions (Khan et al., 2020), incomplete removal of recalcitrant pollutants (Sreelatha et al., 2015), failure to maintain a correct balance among

the kinetics of different reactions thereby leading to process instability, hampering treatment efficiencies (Cheng and Kaksonen, 2017), large amount of investment with lower yields (Beegle and Borole et al., 2018), etc. The search for alternate, integrated strategies for producing value-added products and to recover maximum energy content from the substrate have shown bioelectrochemical systems (BES) as an emerging and complementary technology to conventional anaerobic and fermentative processes (Pham et al., 2006). BES is a biocatalyzed electrochemical process that uses biological organisms as a biocatalyst to generate diverse value added products viz., electricity, biofuels, alcohols, Volatile fatty acids (VFAs), etc. by organic substrate degradation. This BES technology, a multidisciplinary approach, has been extensively investigated during the past decade and emerged as a new generation of biobased technologies with great potential to treat wastewater with simultaneous energy generation and resource recovery (Li et al., 2015; Pant et al., 2012; Bajracharya et al., 2016; Cheng and Kaksonen, 2017; Modestra et al., 2020). The BES is an electrochemical cell, catalyzed by microbes in which one or more reaction takes place. At the anode of BES, the anaerobic active bioelectrogenic microbes form a biofilm and oxidize the degradable organic matter to carbon dioxide (CO<sub>2</sub>) by generating electrons and protons. This is often represented by the oxidation of simple organics such as acetate (Eq. (1)).CH<sub>3</sub>COO<sup>-</sup> + 4H<sub>2</sub>O  $\rightarrow$  2HCO<sub>3</sub><sup>-</sup> + 9H<sup>+</sup> +8e<sup>-</sup>

The generated electrons by bioelectrogenic microbes are transferred to the cathode by an external circuit where the reduction reaction occurs. The potential difference created during the oxidation and reduction processes at anode and cathode, respectively, drives the electron flow in BES.

BES is proven to be energy and effective for ammonium recovery from wastewater. In contrast to organic substrate oxidation in anode, the ammonium present in wastewater is diffused/migrated to the cathode chamber via the separator (ex: cation exchange membrane, CEM) (Zhao et al., 2016, Zheng et al., 2020). The high catholyte pH assists in nitrogen recovery in the form of ammonia, thereby limiting the usage of caustics that are majorly required for ammonia recovery technologies. In the removal process, along with the electrochemical activity of the bacterial cells present on the electrode surface, the external electrical potential also participates. However, the removal due to the induced electric field is depends on the electrochemical activity biofilm. The study was performed along with control to evaluate the effect of induced electric field on the removal process (Kondaveeti et al., 2014, 2019). Electrochemical ammonium recovery using an abiotic electrochemical cell was initially investigated by Desloover et al. using the effluent from anaerobic digestion (Desloover et al., 2012). In their system, the ammonium transported to the cathode chamber through a separator was stripped from the catholyte by generated H<sub>2</sub>. Thus, the current and rate of ammonium transport in these abiotic systems are not constrained by biotic reactions at anode such as organic oxidation. In addition, common restraints such as internal resistance, temperature, pH, and O<sub>2</sub> concentration are not found in an electrochemical cell. Therefore, the calculated ammonia transport rates (120 gN/m<sup>2</sup>/d) in an electrochemical cell are found to be much higher than those reported in MFC. Also, the overall ammonium transport accounted for the 40% charge transport over the membrane, and similar results were found in BES (Kuntke et al., 2012).

Based on the requirement, BES can be broadly classified into microbial fuel cells (MFC) that generate bioelectricity and treat complex, recalcitrant, and high strength wastewaters (Venkata Mohan et al., 2014; Sreelatha et al., 2015), microbial electrolysis cells (MEC) produces  $H_2$  at cathode by utilizing the electron equivalents generated at the anode, and microbial electrosynthesis (MES) to generate  $CH_4$  and platform chemicals (Modestra et al., 2015), and microbial desalination cells (MDC) to separate ions (Cao et al., 2009) (Fig. 1).

MFCs can be compared with the widely developed fuel cell technologies. Fuel cells are energy conversion systems producing electrical energy from the reactant fuels using an abiotic catalyst. MFC can generate electrical energy through bacterial catalytic reactions at the electrode (Logan et al., 2006; Rabaey et al., 2011). This MFC technology has been extensively investigated during the past two decades and emerged as a new generation of biobased technologies with great potential to treat wastewater with simultaneous electricity generation (Li et al., 2015; Mohan et al., 2008; Kadier et al., 2020; Marassi et al., 2019; Sevda et al., 2013). In the anode chamber of the MFC process, the oxidation process occurring in the anode chamber generates CO<sub>2</sub>, protons, and electrons. The protons pass through the membrane while the electrons were carried to the cathode chamber when the connection is made. In the presence of a terminal electron acceptor (TEA), water is formed in the case of general MFC operation. Several TEAs viz., oxygen, nitrate, ferricyanide, persulfate, permanganate, manganese dioxide, iron, chromium, hydrogen peroxide, etc. have been studied in the cathode chamber of MFC, and their impact on the overall efficiency of MFC was elucidated (Ucar et al., 2017; Oon et al., 2017; Song et al., 2019; Nagendranatha Reddy et al., 2019). According to the placement of electrodes, biocatalyst, and design of MFCs, they can still be classified as benthic, stacked, multielectrode, hybrid, enzymatic fuel cells, plant MFCs, submersible MFC, etc. (Min and Angelidaki, 2008; Butti et al., 2016).

Secondly, in MEC, the exoelectrogens catalyze the production of hydrogen when an external voltage is applied. The MEC produces higher hydrogen yield with varied substrate diversity. Several studies reported hydrogen production at various optimal conditions, which has led to the development of MES that drives the bioelectrochemical production of other multicarbon compounds under controlled conditions apart from methane. The cathodic biocatalyst and electron acceptor present in the cathode determines the specific product formation (Pant et al., 2012; Bajracharya et al., 2016). Recent research interests in MES have been emerging on diverse applications, suggesting the broad application of renewable energy and synthesis of value-added chemicals (Bajracharya et al., 2017; Rabaey et al., 2011; Kondaveeti et al., 2020). Along with various products formation, BES also focuses on desalinating the sea water. The desalination process utilizing the electroactive bacteria to drive ion migration to respective anode and cathode chambers

is called MDC. MDC can treat wastewater, generate electricity, and desalinate the saline water with simultaneous generation of value added products (Al-Mamun et al., 2018). Valorization of wastewaters and concomitant treatment makes BES a sustainable waste-to-energy/chemical conversion platform (Pant et al., 2010). In the case of dual-chambered MEC/MES, the electrons are generated in the anode chamber either by the electrolysis reaction or substrate oxidation process, and they reach the cathode chamber to form a specific product at optimum conditions. The main difference, when compared to conventional MES, is that the external potential is applied to the MES system to catalyze the reaction towards particular product formation. Various products have been formed by utilizing simple, complex, and inorganic substrates. The configurations and opeations of all the BES components are given in Fig. 2.

The MFCs belong to the galvanic cell category, and they recover the chemical energy present in the organic substrate as bioelectricity. Whereas, in the electrolytic cells, the reactions are controlled by maintaining optimum conditions, and the products are recovered in the form of value added compounds like gases ( $H_2$  and  $CH_4$ ), volatile fatty acids (VFAs), and alcohols (Electrolytic cells). In the electrolytic cell, additional energy in the form of voltage/current is provided to overcome thermodynamic barriers and to pursue a desired cathodic reaction to generate a specific product of interest (Cheng and Kaksonen, 2017).

Integration of BES to AD is one such kind that helps in increasing the efficiency related to waste remediation and biobased product synthesis. To optimize energy conversion efficiency (substrate to product) and operational stability in the traditional AD, coupling of AD with BES is an efficient electro-fermentation (EF) strategy (Schievano et al., 2016a, 2016b; Rabaey and Rozendal, 2010). The rate kinetics and process performance of AD could be improved by introducing electrodes in the microenvironment. Microbial community functioning for electrochemical reactions is also found to depend on the type of material used for the electrode and structure of the electrode. The mechanism for the enhancement of exoelectrogenic microorganisms in the microbial communities with electrode placement needs to be specifically focused on improving the process efficiencies, which can directly improve productivity at an industrial scale (Reguera et al., 2006; Gorby et al., 2006). Further, if the electrodes are connected externally while applying voltage/potential across them, the process may be further enhanced (Villano et al., 2017; Stamenkovic et al., 2016; Nikhil et al., 2015). Understanding the microbial mechanism and microbial community diversity that prevailed on the electrode surface helps to enhance the specific product output during AD integration with BES. The application of voltage/potential to the microbial community during the EF process creates mutual interactions between the electrode and biocatalysts, thereby increasing the yields of the biobased products. If the potential is poised to develop electroactive biofilm, electrochemically active microorganisms, and electrochemically inactive microorganisms may proliferate to function in a syntrophic manner (Hirose et al., 2009; Babauta et al., 2012). The former biocatalyst aids in efficient electron transfer while the latter involves processes such as the breakdown of complex organics (Borole et al., 2011). Electrochemically-driven microbial interactions are effectively involved during the AD-BES integration and could improve the electrocatalytic efficiency of the reactions. The voltage/potential provided to the BES system towards microbial synthesis helps drive the reactions faster rather than directly involved in the reaction as an electron donor. Microbial electrochemical metabolisms need to be determined to understand the covalent and non-covalent interactions occurring during the microbial synthesis process. The electrometabolic reactions decrease the electrochemical losses by increasing the oxygen-reduction reaction (ORR) related to substrate-hydroxide-oxide binding increasing waste utilization capabilities. Bacteria are usually negatively charged, and thereby a positive potential on the anode could accelerate the biofilm formation due to electrostatic interactions (Srikanth et al., 2011). Electrochemical interactions are crucial in affecting the AD process, playing a specific role in biogas production while determining the metabolic conditions of microbial growth (Moscoviz et al., 2016; Kumar et al., 2017).

The application of poised potential (voltage) to the microbial community and microbe-electrode interactions is another scientific factor that needs to be focused on specifically deriving a biobased product from the organic substrate. The regulatory role of these bioelectrochemical strategies aids in optimizing the process thermodynamics, which in turn enhances the EF efficiency for product synthesis (Bhagchandanii et al., 2020). Microbe-electrode interactions help derive a specific product production while optimizing the thermodynamic energy needed to synthesize the product. Electrochemical reduction of an organic substrate, such as acetate, ethanol, formate, etc., to various biobased and high-value products can become an economical and commercially viable process (Choi and Sang, 2016; Rabaey et al., 2011; Mohanakrishna et al., 2018; De Vrieze et al., 2018). The microbial production of multiple biobased products from organic substrates with electrical energy as an influencing factor is economically feasible (Venkata Mohan et al., 2016a, Venkata Mohan et al., 2016; (Zhang et al., 2020). Integration of electro-strategies to the fermentative environment can influence catalytic capabilities of microorganisms, which positively affects organic substrates, redox conditions (pH, buffering), reducing equivalents (electrons (e<sup>-</sup>) and protons (H<sup>+</sup>)), developing a controlled process performance (Villano et al., 2017). The electrochemical control on the microenvironment can also improve the microbial electrochemical metabolism, which is beneficial for process upscaling.

EF integration can be considered as an alternative energy-efficient process that can overcome the limitations of AD. The microbial metabolism during EF helps in controlled utilization of reducing equivalents at the cathode, resulting in higher production of biogas, fatty acids, biofuels, and platform chemicals (Kumar et al., 2017; Redwood et al., 2012; Rabaey et al., 2011). The processes are futuristic in terms of having efficient utilization of renewable forms of substrates for bioenergy production and can significantly contribute to the transition towards bioeconomy and sustainability. The mutual and inter-dependent interactions involved during the BES process affect the rapid and enhanced conversion of organic substrates into commercial biobased products. Additional benefits of AD-BES integrations include delay in VFA accumulation due to integration of electrodes which inturn accelerates the stratup time and allows the growth of various microbial communities in the system rapidly (Moreno et al., 2018; Xie et al., 2021), low

sludge production of the BES configuration having 25% of that of the conventional waste activated sludge system, thereby yielding a sludge production of only 80 mg TSS per g/COD (Brown et al., 2015), increase of H<sub>2</sub> gas yields to >85% when fermentation and MEC are combined (Gude, 2018), and *In-situ* H<sub>2</sub> mediated bioelectrochemical CH<sub>4</sub> enrichment to provide quality of biogas, thereby aiding in efficient energy conversion (Aryal et al., 2018; Beegle and Borole et al., 2018). The capital expenditure (CAPEX) and Operation and Maintenance (O&M) of integrated AD-BES may be slightly higher but the energy recovery is several folds higher, which makes the integration more sustainable (Beegle and Borole et al., 2018). Coupling AD with MEC recovered 40% of N and increased treatment efficiency (46%) (Cerrillo et al., 2016). Bioelectrochemical reactions facilitated degradation of recalcitrant and complex pollutants. For example, phenanthrene degradation was increased by 30.5% than traditional AD (Lin et al., 2019; Cui et al., 2016; Mohanakrishna et al., 2010), and average BOD<sub>5</sub>/COD effluent ratio in the BES-AD was increased by 16.3% when compared to stand alone AD process thereby increasing the digestibility of substrate which helps to integrate in biorefinery approach. Bioelectrochemical reactions offers BES a unique ability to monitor, control and stabilize the AD process as a biosensor, eliminate toxicity and recover nutrients, etc. (Cheng and Kaksonen, 2017; De Vrieze et al., 2018). The synergistic approach of integrating microbial environment with electrochemistry is a promising technology that establishes it as a futuristic, green, and sustainable route in its approach.

#### Section snippets

#### Bioelectrochemical systems in removal and recovery of ammonium

BES offers a new advantage compared to conventional nitrogen removal processes in low sludge generation and offers a nitrogenbased reaction at cathode and anode. One prominent mechanism in the ammonium recovery/removal in BES is the active/passive transport through the separator based on acid/base equilibrium. For instance, the ammonium in high-strength wastewater is ion transported to the cathode chamber either in non-charged NH<sub>3</sub> form or charged NH<sub>4</sub><sup>+</sup>. At the cathode, it can depart from BES in ...

#### Electricity generation from AD effluents

The anaerobic wastewater treatment process is the conventional biological process for reducing organics and the generation of energy in the form of biogas. They have been well operated in many of the developing countries and being researched for increasing efficiency. However, they exhibit several limitations, such as the generation of H<sub>2</sub>S from sulphur and the need for larger volumes to generate higher gas production to integrate with the natural gas grid. However, this also depends on the...

#### Conclusions and future perspectives

The review documents the feasibility of integrating AD and bioelectrochemical processes for harnessing various biobased products. The mechanism-oriented aspects and limitations during AD were presented. Integration of electrochemical processes involving the microbe-electrode interactions was explained as the process having scope for improving the product output by overcoming the major bottlenecks in AD. Upscaling of the process for commercial viability and marketability needs to focus on...

#### Credit author statement

C. Nagendranatha Reddy: Conceptualization, Writing – original draft, Writing – review & editing. Sanath Kondaveeti: Writing – original draft, Writing – review & editing. Gunda Mohanakrishna: Writing – original draft, Writing – review & editing. Booki Min: Conceptualization, Writing – review & editing, Supervision...

#### **Declaration of competing interest**

All the authors in the manuscript declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper....

#### Acknowledgments

The study was carried out with a research grant from the National Research Foundation of Korea (2018R1A2B6001507). CNR thank the management of CBIT for their constant support...

C. Lin et al.

Enhanced biogas production and biodegradation of phenanthrene in wastewater sludge treated anaerobic digestion reactors fitted with a bioelectrode system

Chem. Eng. J. (2019)

#### J.J. Li et al.

**Perchlorate reduction in microbial electrolysis cell with polyaniline modified cathode** Bioresour. Technol. (2015)

#### S.-H. Lee et al.

**Enrichment of Clostridia during the operation of an external-powered bio-electrochemical denitrification system** Process Biochem. (2013)

#### M. Lee et al.

In situ integration of microbial electrochemical systems into anaerobic digestion to improve methane fermentation at different substrate concentrations Int. J. Hydrogen Energy (2019)

III. J. Hydrogen Energy (201

#### T.A. Larsen et al.

Separate management of anthropogenic nutrient solutions (human urine) Water Sci. Technol. (1996)

#### P. Kuntke et al.

Ammonium recovery and energy production from urine by a microbial fuel cell Water Res. (2012)

#### P. Kuntke et al.

**Hydrogen production and ammonium recovery from urine by a Microbial Electrolysis Cell** Int. J. Hydrogen Energy (2014)

#### P. Kuntke et al.

Effects of ammonium concentration and charge exchange on ammonium recovery from high strength wastewater using a microbial fuel cell

Bioresour. Technol. (2011)

#### S. Kumar et al.

**Microbial fuel cells (MFCs) for bioelectrochemical treatment of different wastewater streams** Fuel (2019)

#### G. Kumar et al.

A comprehensive overview on light independent fermentative hydrogen production from wastewater feedstock and possible integrative options Energy Convers. Manag. (2017)

View more references

#### Cited by (7)

Application of a membrane-less air cathode microbial fuel cell to treat municipal waste composting leachate 2023, Journal of Environmental Management

Show abstract  $\checkmark$ 

Sustainable bioelectrochemical systems for bioenergy generation via waste treatment from petroleum industries 2023, Fuel

#### Show abstract $\checkmark$

Scale-up of the bioelectrochemical system: Strategic perspectives and normalization of performance indices 2022, Bioresource Technology

Show abstract  $\checkmark$ 

Mechanism of microbial involvement in nitrogen conversion affecting methane production in dry anaerobic digestion

2022, Journal of Cleaner Production

#### Show abstract $\checkmark$

A critical review on microbe-electrode interactions towards heavy metal ion detection using microbial fuel cell technology

2022, Bioresource Technology

#### Show abstract $\checkmark$

Regulation and augmentation of anaerobic digestion processes via the use of bioelectrochemical systems

2022, Bioresource Technology

Show abstract  $\checkmark$ 

View all citing articles on Scopus

#### **Recommended articles (6)**

#### Research article

Combining metal-microbe and microbe-microbe dual direct electron transfer on Fe(0)-cathode of bio-electrochemical system to enhance anaerobic digestion of cellulose wastewater

Chinese Chemical Letters, Volume 33, Issue 6, 2022, pp. 3106-3112

#### Show abstract $\checkmark$

Research article

Bioelectrochemical enhancement of anaerobic digestion: Comparing single- and two-chamber reactor configurations at thermophilic conditions

Bioresource Technology, Volume 245, Part A, 2017, pp. 1168-1175

Show abstract  $\checkmark$ 

Research article

Impact of electric potential and magnetic fields on power generation in microbial fuel cells treating food waste leachate

Journal of Water Process Engineering, Volume 40, 2021, Article 101841

Show abstract  $\checkmark$ 

Research article

Influence of Trace Metals concentration on Methane generation using Microbial Electrochemical Systems

Process Biochemistry, Volume 102, 2021, pp. 213-219

Show abstract  $\checkmark$ 

#### Research article

Methane production improvement and associated methanogenic assemblages in bioelectrochemically assisted anaerobic digestion

Biochemical Engineering Journal, Volume 117, Part B, 2017, pp. 105-112

Show abstract  $\checkmark$ 

Research article

Bioelectrochemical system for the enhancement of methane production by anaerobic digestion of alkaline pretreated sludge

#### Show abstract $\checkmark$

View full text

© 2021 Elsevier Ltd. All rights reserved.



Copyright © 2022 Elsevier B.V. or its licensors or contributors. ScienceDirect® is a registered trademark of Elsevier B.V. *RELX*<sup>™</sup>

Download PDF

Review Article Published: 23 June 2022

# A critical review on valorization of food processing wastes and byproducts for pullulan production

Bishwambhar Mishra, Yugal Kishore Mohanta, Sunita Varjani <sup>[]</sup>, Sanjeeb Kumar Mandal, N. S. V. Lakshmayya, Preeti Chaturvedi, Mukesh Kumar Awasthi, Zengqiang Zhang, Raveendran Sindhu, Parameswaran Binod, Reeta Rani Singhania & Vinod Kumar

*Journal of Food Science and Technology* (2022) **374** Accesses | **1** Citations | <u>Metrics</u>

# Abstract

Pullulan is a commercially available exopolymer biosynthesized by *Aureobasidium pullulans* supplemented with nitrogen, carbon and other vital components through submerged and solid-state fermentation. These nutrients are very expensive and it raises the cost for the production of pullulan. Hence, the need of alternative cost-effective raw materials for its production is a prerequisite. Owing to its unique physicochemical features, pullulan has various applications in the food, pharmacological, and biomedical domains. Food industrial wastes generate a considerable number of by-products which accumulates and has a negative influence on the environment. These by-products are made up of proteins, carbohydrates, and other components, can be employed as substrates for the production of pullulan. The present review briefs on the pullulan production using food processing waste and byproducts and the elements that impact it. It provides an insight into versatile applications of pullulan in food industries. Various challenges and future prospects in the field of research on pullulan production have been uncovered.

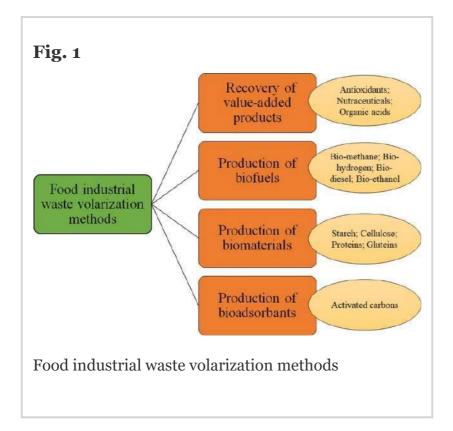
Access provided by CBIT-Library & Information Centre Hyderabad

# Introduction

Pullulan is an inert, linear polysaccharide generated aerobically over sugar and starch conditions by Aureobasidium pullulans, a yeast-like microorganism with gene mutations. The molecule is structured of repeated units of maltotriose coupled by 1,6-glycosidic interconnections to three 1,4-linked glucose molecules (Singh et al. 2017, 2021; Mishra and Varjani 2019). A stair-step structure is formed by this repeating pattern. Chain flexibility and solubility are enhanced by the regular modification of -1,4 and -1,6 bonds (Hamidi et al. 2019; Vivek et al. 2020). Nitrogen source, carbon source, and other functional ingredients for A. pullulans are required for fermentative biosynthesis of pullulan. It is a 'generally considered as safe' (GRAS) excipient since it is innocuous, non-immunogenic, noncarcinogenic,

and non-mutagenic (Mishra and Suneetha 2014; Mishra et al. 2018; Liu et al. 2020). It serves as a low-calorie dietary fibre alternative for starch in food preparations. Molding a wet pullulan solution on a flat surface produces good films with minimal oxygen permeability (Raychaudhuri et al. 2020; Priyadarshi et al. 2021). Pullulan granules are crystalline, non-hygroscopic, whitish, and breakdown promptly in both hot and cold water. In opposed to dextran, pullulan degrades much more quickly in blood serum (Tabasum et al. 2018). For its non-animal origin, pullulan is appropriate for all consumer groups. Chewing gum and bubble gum contain this as an exfoliant and glazing agent. It's also utilised in milk-based sweets as a foaming ingredient (Singh et al. 2017; Mishra and Varjani <u>2019</u>).

The nutrients needed in the synthesis of pullulan are costly. It adds to the expense of production (Mishra and Varjani 2019). However, many food processing industries generate waste enriched with inorganic and organic compounds essential for *A*. *pullulans* to flourish. Food processing and agribusiness dwellers engender a significant amount of waste, which, if disposed of untreated, can result in serious ecological concerns (Mishra et al. 2018; Varjani et al. 2020, 2021; Vyas et al. 2022; Yaashikaa et al. 2022). On a global scale, it is statistically found that nearly one-third of all food residues is wasted, equivalent to 1.3 billion tonnes of food every year. Furthermore, lost or wasted food generates roughly 3.49 billion tonnes of greenhouse emissions across the supply chain (FAO <u>2019</u>). Landfilling, composting, thermal treatment is among the most common waste management technique now in use. A multitude of food industrial by-products has been documented to produce pullulan (Mishra et al. <u>2018</u>; Vivek et al. <u>2020</u>; Abdeshahian et al. <u>2021</u>; Wani et al. <u>2021</u>). The volarization methods for food industrial wastes have been illustrated in Fig. <u>1</u>.



Due to its higher cost (Approximately, Rs 3000– 6000 per kg in India), pullulan is underutilised in comparison to other exopolysaccharides. This biopolymer is imported into India from China, Japan, and the United States. To meet market demand, it is necessary to boost pullulan production on a pilot scale using low-cost and environmentally friendly methods. The present review describes the utilization of various food processing waste and its by-products for efficient production of pullulan and its applications. These residues can be utilized as an alternate substrate to produce pullulan through solid-state fermentation or submerged fermentation.

# Biosynthesis of pullulan

Despite the fact that pullulan's chemical composition was discovered in the 1960s and it has been involved in the production and exploited in the medicaments, cosmetics, and food sectors for over 40 years, its biosynthetic mechanism had remained a mystery for decades (Mishra et al. <u>2011</u>). Despite this, many efforts have been made to decipher its synthesis route, as well as the necessary enzymes and genes that encode it.

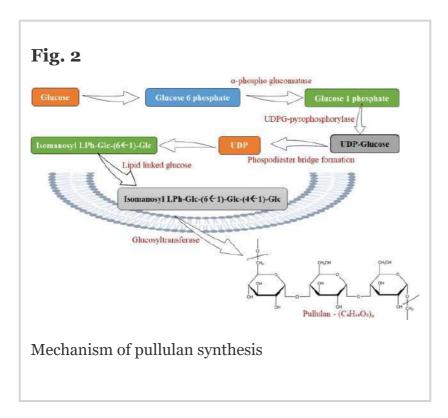
# Microbial sources

Because of its high yield and excellent pullulan characteristics, *Aureobasidium pullulans* is one of the most extensively utilised strains in commercial pullulan production. *Aureobasidium pullulans* is a genetically distinct yeast-like fungus that can often be encountered in freshwater, wood, soils, rock, and animals and plants tissues, besides other places. It is harmful to plants but non-pathogenic to people, but only a few strains of *A. pullulans* are pathogenic and can cause health problems (Singh et al. 2019). Amylases, esterases, hemicellulases, pectinases, proteases, and other enzymes are produced by A. pullulans isolates (Singh and Saini 2012). The synthesis of pullulan via, blastospores and hyphal cells in submerged fermentation, and other aspects of A. pullulans' development cycle were examined. A few investigations have also shown that different A. pullulans strains produce dissimilar pullulans (composition and structure). Apart from the polysaccharide pullulan, A. *pullulans* generate a dark pigment known as melanin, which gives antimicrobial properties to phagocytosis in the recipient and also causes polysaccharide chlorosis (Mishra et al. 2018; Singh et al. 2019; Wani et al. 2021). Various parameters, such as the ATP/ADP ratio, knocking out the PKSIII (Polyketide Synthase III) gene, incorporating desired genes into genomic DNA, and others, have been found to boost pullulan productivity and diminish melanin synthesis in metabolic engineering (Li et al. 2016).

There are several physicochemical ways for removing melanin from fermented media (adsorption with solvents, activated charcoal, and salts), however, the cost must be considered. To reduce capital investment, strains must be altered, metabolisms must be engineered. However, care must be taken to preserve the strain's potential for producing pullulan with good viscosity, molecular weight distribution, and other physical features (Seviour et al. 2011; Castillo et al. 2015; Reddy et al. 2021). *Rhodotorula bacarum, Rhodosporidium paludigenum, Cyttaria darwinii, Cyttaria harioti,*  Cryphonectria parasitica, Aspergillus japonicus, Teloschistes flavicans, Tremella mesenterica, Micrococcus leuteus are among the strains capable of producing pullulan (Mishra et al. 2018). In an attempt to optimise *A. pullulans'* pullulan productivity, the strain must be investigated through mutation and metabolic engineering. Some of the strains, like *Aureobasidium mousonni* (NCIM 1226), *Aspergillus japonicus*-VITSB1, were modified utilising Ethyl methane sulfonate (EMS) and UV rays' mutagenesis for good yields and enhanced level of pullulan (Mishra and Suneetha 2014).

Mechanism of pullulan synthesis Within the cell, pullulan is produced and extravasated into the medium as a slimy, loose, and amorphous layer through the -glucan layer. The microbe's creation of the precursor will speed up the formation of pullulan. Pullulan is made up of units of maltitriose joined together by a -1,4 glycosidic connection, whereas -1,6 glycosidic bonds connect the succeeding maltotriose units. The connection offers great structural flexibility as well as increased pullulan solubility (Dailin et al. 2019; Liu et al. 2021). Pullulan biosynthesis is a multistep biological reaction in A. pullulans. Pullulan is synthesised through the adjudication of sugar-nucleotide-lipid transport medians in the membrane of the cell section. Because of the complex properties of the microorganism that generates pullulan, the specific method of the

pullulan biosynthetic pathway has not been fully elucidated. Pullulan synthesis is aided by the accumulation of glucose in the cell during the early stages of fermentation. Phosphoglucomutase, glucosyltransferase, and Uridine diphosphate glucose pyrophosphorylase (UDPGpyrophosphorylase) are the major enzymes engaged in the synthesis of pullulan. The enzymes phosphoglucomutase and UDPGpyrophosphorylase convert subtle carbon (glucose) to Uridine Diphosphate glucose, which is a necessary prerequisite of pullulan synthesis. Hexokinase helps to combine glucose-6-phosphate with glucose, further converted to glucose-1phosphate by the enzyme -phosphoglucomutase. The D-glucose in Uridine Diphosphate-glucose generates an isomaltosyl residue when it mixes with additional glucose units. The isopanosyl moiety is produced by the metabolic interaction between isomaltosyl and lipid-linked glucose, which is subsequently polymerized by the glucosyltransferase enzyme to make pullulan polysaccharide (Duan et al. 2008; Sugumaran and Ponnusami 2017; Mishra et al. 2018; Singh et al. 2019). The generation of phosphodiester links from UDP-glucose, the development of isomaltose monomers, and the manufacture of iso-panosyl molecules are the different phases of pullulan chain biosynthesis. Figure <u>2</u> depicts the biosynthetic routes for the formation of pullulan.



# Utilization of food processing waste for pullulan production

# Sugarcane bagasse and molasses

Sugarcane is among the most widely grown in cultivation in India and other parts of the world. Sugarcane bagasse is produced when cane pulp is harvested for the production of refined sugar and its by-products. Bagasse is produced in the amount of 280 kg each tonne of sugar churns out amounting to about 10 crore tonnes annually. Cane biomass is a lignocellulosic substance made up of, hemicellulose (27.89  $\pm$  2.68%), cellulose (38.59  $\pm$  3.45%), organic matter (1.61  $\pm$  0.16%), lignin (17.79  $\pm$  0.62%), and ashes (8.80  $\pm$  0.02%) (Cheng and Zhu 2013). Hydrolysis of cellulose from cane biomass transforms plant-derived dry sugars into basic sugars that can be used by a wide range of microorganisms. Sulfuric acid was used to hydrolyse the vaporised cane biomass at 100 °C for 30 min, and at 28 °C, activated charcoal was used to detoxify the digestate, with continuous vertexing (50 rpm) for 4 h. The hydrolysate was 12% glucose, 7% arabinose, 70% xylose, and 11% other chemicals, and it was utilised by A. pullulans to produce pullulan. The addition of DL-dithiothreitol (1.0 mM) to a sugarcane bagasse hydrolysate-based medium and pH control improved pullulan generation in shake-flask fermentation processes (Chen et al. <u>2014</u>). Pullulan generation by Aureobasidium pullulans is coupled with the creation of melanin, which drives up the cost of downstream treatments. Deploying a blue LED entirely prevents melanin formation throughout the fermentation procedure, while a red LED promotes A. pullulans development. In shake-flask fermentation processes and column bubble photobioreactors, sugarcane bagasse hydrolysate was employed to produce pullulan by A. pullulans. Pullulan yield in column bubble photobioreactors (25.19 g/L) was comparable to shake-flask fermentations (Hilares et al. 2019).

Molasses is a dusky viscous fluid that forms as an offshoot of the sugarcane juice refining process. The sugar factory releases a large quantity of molasses into the local water source, causing significant contamination. Molasses is made up of fermentable sugars like total solids (70–85%), glucose and fructose (48–60%), organic content (9–12%) (Singh et al. <u>2019</u>). Molasses may be

readily absorbed as a substrate of carbon for the formation of pullulan by A. pullulans because of these sugars. Molasses, on the other hand, contains heavy metals (iron, manganese, copper, zinc, magnesium, calcium, and so on), which inhibit the development of microbes, suppress beneficial enzymes, and reduce the end yield of the product (Mishra et al. 2018). As a result, molasses pretreatment is an important step in achieving a high-quality and high-quantity product output. The best approach for removing heavy metals is to treat molasses with sulphuric acid. Sulphuric acid (1 N) was appended to molasses as a pretreatment, after which the mixture has been left to exist for 24 h before centrifugation was used to extract the supernatant (Singh et al. 2019). The use of activated carbon in conjunction with sulfuric acid aids in the expelling of excess colouring compounds, amino acids, and heavy metals, improving pullulan synthesis at the shake-flask level. Pullulan manufacture is cost-effective when pretreated molasses is used as the production medium (Srikanth et al. 2014).

Potatoes and sweet potatoes residues The starch grain is found in the cells of the potato root tuber. The potato starch business has released a significant quantity of waste residue, which comprises leachates and potato residues. This has big repercussions for the ecosystem. Carbohydrates are the primary elements of potato starch waste. These effluents have a chemical oxygen demand

(COD) that was found to be greater than 30 g/L, indicating that they are high in eco-friendly elements (cellulose, starch, and proteins) that microorganisms may use. The utilization of potato starch waste for the synthesis of pullulan by using the strain of A. pullulan P56 was investigated by some researchers (Mishra et al. 2018). Amyloglucosidase and Pullulanase enzymes (Caalginate immobilised form) were used to liquefy potato starch in a packed bed reactor. The threshold pullulan generation was discovered to be 19.2 g/L, and after optimising several course criteria, the output was enhanced by 20% over the preliminary level (Mishra et al. 2018). It was observed by combining potato starch hydrolysate with sucrose improved pullulan synthesis, and that a minuscule portion of sucrose could trigger the enzymes required for pullulan fabrication, allowing for more effective potato starch hydrolysate conversion. It was also looked at using crude potato starch hydrolysates for pullulan synthesis. After 96 h of fermentation, the highest pullulan manufacture was reported to be 36.17 g/L. Pullulan production was compared using glucose and sucrose as carbon sources, yielding 22.07 g/L and 31.42 g/L of pullulan, respectively (Wu et al. <u>2016</u>). These observations highlight the possibility of using fresh potato starch hydrolysates as an affordable provenance of carbon for producing pullulan.

Sweet potato is a carbohydrate-rich, beta-carotenerich, vitamin-rich, and fibre-rich tuberous root vegetable. Proteins account for 87% of the sweet potato hydrolysate, followed by sugar (1.56%), blubber (0.6%), coarse fibre (0.16%), and cinders (2.19%). Sweet potato is mostly made up of starch, which is well suited to industrial fermentation despite the fact that many industrially significant microbes cannot use it in its natural state. The same procedure is used to hydrolyse sweet potato starch as it is for potato starch. Small bits of sweet potato are treated with separate enzymes (amylase, pullulanase, and  $\beta$ -amylase) during the saccharification process. Because sweet potatoes contain a significant quantity of  $\beta$ -amylase, it is not necessary for accentuating another resource. The sweet potatoes are treated with  $\beta$ -amylase and pullulanase in the first phase of hydrolysis.  $\beta$ amylase, which is found in sweet potatoes, might further saccharify the hydrolysate. In fermentation processes, saccharine potato hydrolysate can be employed as an economical base for carbon. A. pullulans used sweet potato hydrolysate in shakeflask fermentation to produce pullulans (Wu et al. 2009; Mishra et al. 2018). Pullulan derived using sweet potato hydrolysate (3.4 105 Da) had a mol. wt. larger than that obtained from glucose (1.3 105 Da) and sucrose (1.7 105 Da) media. Marine cold-adapted -amylase can successfully hydrolyze sweet potato starch (Wu et al. 2009). Various sugars like isomaltose, maltose, maltotriose, glucose, and other maltooligosaccharides make up the sweet potato hydrolysate. These hydrolysate components have a high interfacial adhesion. In a

study, *A. pullulans* produced more pullulans (36.17 g/L) from sweet potato hydrolysate than it did from glucose (22.07 g/L) or sucrose (31.42 g/L). As a result, sweet potato hydrolysate would be used to produce pullulan at a low cost (Wu et al. <u>2016</u>).

## Grape residues

Grapes are a vital component of the wine and juice industries. Grapes are processed by removing the exocarp and extracting the taille from the mash. Grape extract is generally employed in the creation of bottled goods; however, grape peel and the slash are discarded as grape pomace after processing. Total sugars (85.20%), reducing sugars (3.40%), protein (7.80%), and glucose (1.280%) are all present in grape pomace (Mishra et al. 2018). Acids, colours, and specific salts are also abundant, all of which are employed in the food sector. In its solid form, a grape poultice is difficult to use; however, grape peel and slop extricate is much easier to ply. The grape poultice harvest can be made by pouring boiling water into the grape pomace, blending for 30 min, and then filtering (Singh et al. 2019). Pullulan production by Aureobasidium pullulans using shake-flask fermentation processes was achieved using grape poultice extricate, with a pullulan yield of 22.3 g/L(Israilides et al. <u>1998</u>). Pullulan made from grape pomace extract is uniformly composed, has a high molecular weight, and has a higher yield.

# Other food industrial residues

Sugumaran et al. (2014) conducted research in which four food waste by-products, namely rice and wheat bran, coconut and palm kernels, were identified as nadir carbon sources for *A. pullulans* pullulan synthesis in the solid state for fermentation (50% moisture content). The ideal carbon source amongst four food waste by-products was palm kernel, which yielded 16 g/L pullulan. Later, using Response Surface Methodology (RSM) with Asian Palm Kernel as a carbon source, they have improved the process variables for pullulan production. The output of pullulan was raised to 30.4 g/L. In conclusion, palm kernel proves to be a minimal substrate for pullulan biosynthesis.

The soy sauce industry produces a lot of soybean pomace, which is a key food waste by-product. Carbohydrates and proteins are the two main components. Despite the fact that soybean pomace is quite useful, it is dumped as dissipate due to the extreme sodium chlorite level (NaCl). This has major consequences for the ecosystem. Furthermore, discarding soybean pomace, which is an abundant wellspring of carbs and proteins, is a major waste of natural deposits. So many studies had been performed with soybean pomace as a source of nitrogen pullulan production by *A. pullulan* HP-2001 (Mishra et al. 2018; Singh et al. 2019).

Coconut water is indeed a transparent beverage found in the centre of the coconut. It is made up of simple sugars and electrolytes, which are easily absorbed carbohydrates. Coconut milk is made by grating the meat of a ripe coconut into a liquid. Various industries that produce desiccated coconut, copra, as well as items made from coconut meat (Coconut honey, Coco sauce, roasted young coconut, coconut chips, cream, candy, and flour, for example) coconut water and coconut milk are produced as waste. Coconut offshoot is classified as a vital contaminant in nature due to its greater Biological Oxygen Demand (BOD). This environmental issue has piqued current academics' interest in coconut by-products and prompted their use in the manufacturing of such a pivotal industrial product. Thirumavalavan et al. (2009) investigated utilised coconut milk and water to develop pullulan. Since coconut milk has a greater C/N ratio than coconut water, it has been demonstrated to be somewhat more beneficial for pullulan synthesis.

Jaggery was employed as a carbon source for the manufacture of pullulan by various researchers with *A. pullulans* CFR-77 and *A. pullulans* MTCC 2195 (Mishra et al. 2018). A concise delineation regarding the utilization of food processing waste for pullulan production has been highlighted in Table <u>1</u>.

Table 1 Comprehensive report on the utilization of food processing waste for pullulan production

## Fermentative production of pullulan

Different media as well as other process variables influence the pullulan fermentation process. Fermentation media structure, fermentation pattern and duration, arrangement, bioreactor construction, microbial entities, moisture levels, physical properties, morphogenesis, deployable temperature, pH, illuminance, oxygen profile, and other factors might very well impact the efficient implementation of the fermentation process for increased pullulan productivity.

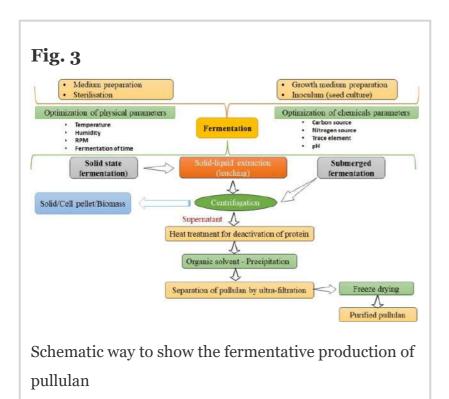
### Microbial culture

The form of microbial culture is another crucial aspect that influences pullulan productivity. According to prior publications, A. pullulans seems to be the highest pullulan-producing wild strain ever discovered. The mutant strains facilitated the large-scale execution of reactions under ideal conditions. Other mutant strains aided with the manufacturing of high-molecular-weight pullulan, which increased cell proliferation while reducing melanin pigmentation (Liu et al. 2020). Pullulan was synthesized through coculturing of a strain that produces pullulans, A. Kluyveromyces fragile ATCC 52,466, an insulin degradation strain, and A. pullulans SH 8646. The efficacy of fermentation suggests that the polymer synthesising activity of the currently employed genetically mutated isolates

of *A. pullulans* is practically indistinguishable (Mishra et al. <u>2018</u>).

#### Type of fermentation

Multiple investigations examined the repercussions of fermentation formats, such as batch, fed-batch, and continuous, on competence of pullulan production. The problem of suppressing the effect of increased concentration of substrate could be avoided by supplying restricting substrates to the medium on an irregular basis. The fed-batch mode, on the other hand, boosted productivity until a certain point but did not exhibit a significant improvement in yield after adding sucrose (Singh et al. <u>2019</u>; Reddy et al. <u>2021</u>). Furthermore, within a week of cultivation, the fed-batch technique showed a negligible decline in pullulan concentration. Several investigations have shown that continuous mode is used to produce pullulan Exopolysaccharide production was said to have increased for a long period without causing any difficulties, according to reports. However, in the continual modus operandi, the dilution rates were exceptionally low. In a chemostat, the rates of dilution are indeed a significant parameter that determines biopolymer production. According to the literature, using a chemostat system increased pullulan output albeit at lower dilution rates. Longterm production is possible with continuous fermentation procedures combined with increased cell biomass (Reddy et al. 2021). The process of production of pullulan has been illustrated in Fig. 3.



Bioreactor operation and configuration The broth makeup and behaviour at various agitation speeds, firm airflow access, and low shear rate, among other aspects, all have a significant impact on the synthesis process in submerged fermentation, resulting in ideal conditions for microbe development. All of the parameters listed above could be manipulated in the bioreactor. As a result, bioreactor configuration plays a critical role in improving pullulan production efficiency. High productivity will be aided by the development of novel and revolutionary fermentation reactors. Different bioreactors, such as the reciprocating plate bioreactor, have been created to accommodate the fermentation process and produce high pullulan productivity. The configuration of the reactor, such as biofilm and suspended culture, has an impact on the biological

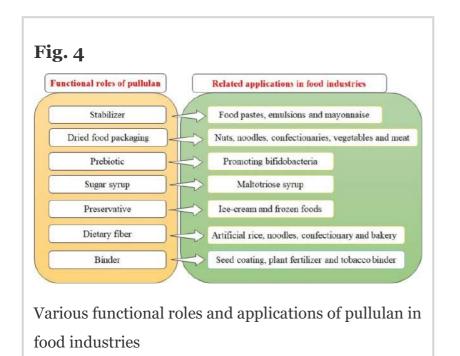
system's function and regulates the process (Reddy et al. 2021). To immobilise the strain, transporters for biofilm configuration has been widely used. Despite the multiple benefits of biofilm structure, substrate clumping and other parameters such as inadequate free volume, aeration rate, and so on had an impact on metabolite production (Seviour et al. 2011; Wani et al. 2021).

With the passage of time, the quantity of pullulan generated and its yield change. According to reports, the fermentation period required to achieve optimum pullulan output varies depending on operational circumstances and microbial cultures. As a result, depending on the microbial populations and operating conditions, the best period for producing high pullulan yields ranges from 48 h to 5.36 days (Sugumaran et al. <u>2014</u>).

### Pullulan supplication in food industries

Pullulan is also useful for making edible coatings because it is simultaneously a food ingredient and has the potential to form films due to its properties. In the food industry, Pullulan can be used as a starch substitute in low-calorie food recipes, as well as a food deposition and bottling material. It can also be utilised as a spice and flavouring in microencapsulated seasoning agents (Priyadarshi et al. 2021). Because of its intensifier qualities, it is commonly used in sauces, soups, and beverages. It is often used to keep mayonnaise's grade and appearance stable (Singh et al. <u>2019</u>). Pullulan is sometimes used to stick nuts to cookies, as a dental implant adhesive, as a binding material and stabilizing agent in food pastes.

Pullulan can be used as a tobacco binder, seed coat, and plant nutrients (Priyadarshi et al. 2021). Because of its inclusion in the GRAS list and its slow digestion, pullulan can be employed effectively in the development of light (diet) meals. Distributable films dissolve easily in water, giving them the ability to soften as orally potable food toppings. Pullulan films are suitable for protecting rapidly oxidised lipids and vitamins in food because of their oxygen resistance (Abdeshahian et al. 2021). The involvement of pullulan in various foods along with functional roles and related applications have been illustrated in Fig. <u>4</u>.



Pullulan films can be used to coat or package dried items such as noodles, confections, nuts, meats, and vegetables. As a protective coating, pullulan can be applied directly to food. To stabilise fatty emulsions, pullulan can be replaced by cholesterol or fatty acids (Priyadarshi et al. 2021). Maltotriose syrup can be made utilising the debranching enzyme pullulanase and enzymatic hydrolysis of a polysaccharide pullulan. The following characteristics were used to make maltotriose syrup using pullulanase from pullulan: a. extremely low freezing point recession; b. gentle sweetness; c. moisture retention; d. mitigation of starch retrogradation in foodstuffs; e. less palette formation when collated to maltose or glucose syrups, or sucrose; f. good heat stability. These characteristics are advantageous in the food industry for utilizing pullulan as a substrate as compared to other polysaccharides (Priyadarshi et al. 2021).

#### Future prospects

Despite its many useful applications, pullulan's cost, which is 3 times that of other polysaccharides like Xanthan and Dextran, is a major barrier to its utilisation. Previous research has looked into the melanin derivate in generating pullulan, but the cost (25–30 USD/Kg) is a bigger issue. Engineering breakthroughs or effective production lines, particularly with lower melanin production, could help to enhance production economics, hence offering new paths for pullulan use. To improve product quality and to research pullulan biosynthesis in Metabolic Engineering and Molecular Editing, a thorough understanding of the mechanism is essential. Pullulan's biology holds the key to solving critical downstream and manufacturing issues. Pullulan production in connection to molecular characteristics, upstream genetic regulators, and downstream processes, encompassing innovative bioreactor design, cultivation settings, and uses, has yet to be thoroughly investigated. Pullulan could be a potential source of novel bioactive derivatives in a variety of sectors with further chemical changes. Modified pullulan analogues with various material qualities and pullulan with a specific size distribution can be developed using cutting-edge modification and cultivation technologies. Pullulan is becoming more popular in cancer therapy as a result of new research. The modified pullulan has strong bioactivity with several cytotoxic chemicals and is known to form complexes with those compounds. The build-up of these inclusion complexes at target areas aids the slow release of cytotoxic chemicals. Pullulan is used to replace other synthetic materials that produce  $CO_2$  in the medical cosmetics industry because it has no negative side effects. It's important to see if they can be used in additional personal maintenance and aesthetic purposes with the same polymer, not only as a groundbreaking active component but more as a harmless component for environmentally

friendly materials and packaging. Anti-ageing cosmetics appear to have a strong demand. Personal hygiene and aesthetic items should be packaged in environment friendly containers to minimise environmental impact. The biomedical engineering market is another rising sector, as pullulan has a high absorption capacity. For the biosynthesis of pullulan, safer and more novel approaches are being developed. Pullulan has been used in drug delivery in a variety of ways, including subcellular attacking, stimulus-responsive drug delivery devices, and nanoplatforms. Pullulan derived nanostructures or gels have a broad spectrum of supplications in the pharmaceutical and food sectors for medication delivery and gene transfer. Pullulan is being used in regenerative medicine, visualization, cancer cell targeting, and other applications. In light of these considerations, pullulan has a promising future in the healthcare industry for the benefit of humanity. Pullulan can have its surface modified to broaden its applicability. Future studies could focus on providing surface adhesion for cell attachment in bone tissue culture applications via osteogenesis.

Despite the fact that pullulan has numerous uses in biotechnology, its production and control have remained a mystery. Pullulan biosynthesis and its regulation have recently been described biochemically, along with their genes and encoding proteins. Presently, major research is going on regulating such a metabolic process through the important enzymes and genes manipulation. Any other transcriptional factors or signalling mechanisms that regulate pullulan production are likewise yet to be discovered.

### Conclusion

Every day, a large pile of waste products is produced in the food processing industries and its improper management results in serious issues impacting the environment. These wastes should be investigated for use in the manufacturing of pullulan on a large scale. For the selection of the appropriate biotransformation, it's critical to understand the biochemical makeup and microbial growth requirements. The key constituents in food processing wastes are unavailable, and these wastes must be pre-treated in order to provide a fermentable sugar and nitrogen source. Pullulan production costs have been reduced in half owing to the use of food-industrial waste. Pullulan's practical application in food have mostly been discovered and accepted, but they have yet to be tested on a large scale. The eventual goal will be to define pullulan usage at the industrial level and to determine whether or not pullulan will be effective in the food industry.

### Data availability

All data, models, and code generated are used during the study appear in the submitted article.

## Code availability

None.

### Abbreviations

| <b>GRAS:</b> | Generally considered as safe |
|--------------|------------------------------|
| GRAS:        | Generally considered as safe |

- **EMS:** Ethyl methane sulfonate
- **UV:** Ultra violate
- **ATP:** Adenosine triphosphate
- **ADP:** Adenosine diphosphate
- **PKSIII:** Polyketide synthase III
- **DNA:** Deoxyribonucleic acid
- **UDPG:** Uridine diphosphate glucose
- **UDP:** Uridine diphosphate
- **LED:** Light emitting diode
- **COD:** Chemical oxygen demand
- **RSM:** Response surface methodology
- **BOD:** Biological oxygen demand
- **DO:** Dissolved oxygen

### References

Abdeshahian P, Ascencio JJ, Philippini RR, Antunes FA, de Carvalho AS, Abdeshahian M, dos Santos JC, da Silva SS (2021) Valorization of lignocellulosic biomass and agri-food processing wastes for production of glucan polymer. Waste Biomass Valorization 12:2915–2931. https://doi.org/10.1007/s12649-020-01267-z

An C, Ma SJ, Chang F, Xue WJ (2017) Efficient production of pullulan by *Aureobasidium pullulans* grown on mixtures of potato starch hydrolysate and sucrose. Braz J Microbiol 48:180– 185. <u>https://doi.org/10.1016/j.bjm.2016.11.001</u>

Castillo NA, Valdez AL, Fariña JI (2015) Microbial production of scleroglucan and downstream processing. Front Microbiol 6:1106. <u>https://doi.org/10.3389/fmicb.2015.01106</u>

Chen Y, Guo J, Li F, Liu M, Zhang X, Guo X, Xiao D (2014) Production of pullulan from xylose and hemicellulose hydrolysate by *Aureobasidium pullulans* AY82 with pH control and DL-dithiothreitol addition. Biotechnol Bioproc E 288:282–288. <u>https://doi.org/10.1007/s12257-013-0715-4</u>

Cheng J, Zhu M (2013) A novel anaerobic coculture system for bio-hydrogen production from sugarcane bagasse. Bioresour Technol 144:623– Choudhury AR, Sharma N, Prasad G (2012) Deoiledjatropha seed cake is a useful nutrient for pullulan production. Microb Cell Fact 11:39. <u>https://doi.org/10.1186/1475-2859-11-39</u>

Dailin DJ, Low LZ, Kumar K, Abd Malek R, Natasya KH, Keat HC (2019) Agro-Industrial waste: a potential feedstock for pullulan production. Biosci Biotech Res Asia 16:229–250. https://doi.org/10.13005/bbra/2740

Duan X, Chi Z, Wang L, Wang X (2008) Influence of different sugars on pullulan production and activities of α-phosphoglucose mutase, UDPGpyrophosphorylase and glucosyltransferase involved in pullulan synthesis in *Aureobasidium pullulans* Y68. Carbohyd Polym 73:587–593. https://doi.org/10.1016/j.carbpol.2007.12.028

FAO (2019) The state of food and agriculture 2019. moving forward on food loss and waste reduction. Rome. Licence: CC BY-NC-SA 3.0 IGO. Available online:

http://www.fao.org/3/ca6030en/ca6030en.pdf. Accessed 22 Mar 2022

Göksungur Y, Uçan A, Güvenç U (2004) Production of pullulan from beet molasses and synthetic medium by *Aureobasidium pullulans*. Turk J Biol 28(1):23–30

Göksungur Y, Uzunoğulları P, Dağbağlı S (2011) Optimization of pullulan production from hydrolysed potato starch waste by response surface methodology. Carbohyd Polym 83:1330– 1337.

https://doi.org/10.1016/j.carbpol.2010.09.047

Hafez AA, Abdelhady HM, Sharaf MS, El-Tayeb TS, El-Kheima S (2007) Bioconversion of various industrial by-products and agricultural wastes into pullulan. J Appl Sci Res 3:1416–1425

Hamidi M, Kennedy JF, Khodaiyan F, Mousavi Z, Hosseini SS (2019) Production optimization, characterization and gene expression of pullulan from a new strain of *Aureobasidium pullulans*. Int J Biol Macromol 138:725–735. https://doi.org/10.1016/j.ijbiomac.2019.07.123

Hilares RT, Orsi CA, Ahmed MA, Marcelino PF, Menegatti CR, da Silva SS, Dos Santos JC (2017) Low-melanin containing pullulan production from sugarcane bagasse hydrolysate by *Aureobasidium pullulans* in fermentations assisted by lightemitting diode. Bioresour Technol 230:76–81. <u>https://doi.org/10.1016/j.biortech.2017.01.052</u> Hilares RT, Resende J, Orsi CA, Ahmed MA, Lacerda TM, da Silva SS, Santos JC (2019) Exopolysaccharide (pullulan) production from sugarcane bagasse hydrolysate aiming to favor the development of biorefineries. Int J Biol Macromol 127:169–177.

https://doi.org/10.1016/j.ijbiomac.2019.01.038

Israilides CJ, Smith A, Harthill JE, Barnett C, Bambalov G, Scanlon B (1998) Pullulan content of the ethanol precipitate from fermented agroindustrial wastes. Appl Microbiol Biotechnol 49(5):613–617.

https://doi.org/10.1007/s002530051222

Israilides C, Smith A, Scanlon B, Barnett C (1999) Pullulan from agro-industrial wastes. Biotechnol Genet Eng Rev 16:309–324. https://doi.org/10.1080/02648725.1999.1064798

1

Lazaridou A, Biliaderis CG, Roukas T, Izydorczyk M (2002) Production and characterization of pullulan from beet molasses using a nonpigmented strain of *Aureobasidium pullulans* in batch culture. Appl Biochem Biotechnol 97:1– 22. <u>https://doi.org/10.1385/ABAB:97:1:01</u>

Li H, Zhang Y, Gao Y, Lan Y, Yin X, Huang L (2016) Characterization of UGPase from *Aureobasidium pullulans* NRRL Y-12974 and application in enhanced pullulan production. Appl Biochem Biotech 178:1141–1153. https://doi.org/10.1007/s12010-015-1934-2

Liu G, Zhao X, Chen C, Chi Z, Zhang Y, Cui Q, Chi Z, Liu YJ (2020) Robust production of pigmentfree pullulan from lignocellulosic hydrolysate by a new fungus co-utilizing glucose and xylose. Carbohyd Polym 241:116400. https://doi.org/10.1016/j.carbpol.2020.116400

Liu F, Zhang J, Zhang L, Diao M, Ling P, Wang F (2021) Correlation between the synthesis of pullulan and melanin in *Aureobasidium pullulans*. Int J Biol Macromol 177:252–260. <u>https://doi.org/10.1016/j.ijbiomac.2021.02.108</u>

Mirzaee H, Khodaiyan F, Kennedy JF, Hosseini SS (2020) Production, optimization and characterization of pullulan from sesame seed oil cake as a new substrate by *Aureobasidium pullulans*. Carbohyd Polym Technol Appl 1:100004.

https://doi.org/10.1016/j.carpta.2020.100004

Mishra B, Suneetha V (2014a) Biosynthesis and hyper production of pullulan by a newly isolated strain of *Aspergillus japonicus*-VIT-SB1. World J Microb Biot 30:2045–2052.

https://doi.org/10.1007/s11274-014-1629-9

Mishra B, Suneetha V (2014b) Strain improvement and statistical analysis of pullulan producing strain of *Aspergillus japonicus*-VIT-SB1 for maximum yield. J Pure Appl Microbiol 8:1535– 1545. <u>https://doi.org/10.1007/s11274-014-1629-9</u>

Mishra B, Vuppu S, Rath K (2011) The role of microbial pullulan, a biopolymer in pharmaceutical approaches: a review. J Appl Pharm Sci 1:45–50

Mishra B, Varjani S (2019) Evaluation of pullulan production by a newly isolated *Micrococcus luteus*. Indian J Exp Biol 57:813–820

Mishra B, Zamare D, Manikanta A (2018) Selection and utilization of agro-industrial waste for biosynthesis and hyper-production of pullulan: a review. Biosynthetic technology and environmental challenges. Springer, Singapore, pp 89–103. <u>https://doi.org/10.1007/978-981-10-</u> 7434-9\_6

Priyadarshi R, Kim SM, Rhim JW (2021) Pectin/pullulan blend films for food packaging: effect of blending ratio. Food Chem 347:129022. https://doi.org/10.1016/j.foodchem.2021.129022

Ray RC, Moorthy SN (2007) Exopolysaccharide (pullulan) production from cassava starch residue by *Aureobasidium pullulans* strain MTTC 1991. J Sci Ind Res 252–255.

http://hdl.handle.net/123456789/1237

Raychaudhuri R, Naik S, Shreya AB, Kandpal N, Pandey A, Kalthur G, Mutalik S (2020) Pullulan based stimuli responsive and sub cellular targeted nanoplatforms for biomedical application: synthesis, nanoformulations and toxicological perspective. Int J Biol Macromol 161:1189–1205. https://doi.org/10.1016/j.ijbiomac.2020.05.262

Reddy CN, Mishra B, Mandal SK, Agrawal DC, Kruthiventi C (2021) An Insight into pullulan and its potential applications. Polysaccharides of microbial origin: biomedical applications. Springer, Cham, pp 1–32. https://doi.org/10.1007/978-3-030-35734-4\_15-1

Seviour RJ, McNeil B, Fazenda ML, Harvey LM (2011) Operating bioreactors for microbial exopolysaccharide production. Crit Rev Biotechn 31:170–185.

https://doi.org/10.3109/07388551.2010.505909

Sharma N, Prasad GS, Choudhury AR (2013) Utilization of corn steep liquor for biosynthesis of pullulan, an important exopolysaccharide. Carbohyd Polym 93:95–101.

https://doi.org/10.1016/j.carbpol.2012.06.059

Sharmila G, Muthukumaran C, Nayan G, Nidhi B (2013) Extracellular biopolymer production by *Aureobasidium pullulans* MTCC 2195 using jackfruit seed powder. J Polym Environ 21:487– 494. <u>https://doi.org/10.1007/s10924-012-0459-9</u>

Sheoran SK, Dubey KK, Tiwari DP, Singh BP (2012) Directive production of pullulan by altering cheap source of carbons and nitrogen at 5 l bioreactor level. Int Sch Res Notice 2012:867198. <u>https://doi.org/10.5402/2012/867198</u>

Singh RS, Kaur N (2019) Understanding response surface optimization of medium composition for pullulan production from de-oiled rice bran by *Aureobasidium pullulans*. Food Sci Biotechnol 28:1507–1520. <u>https://doi.org/10.1007/s10068-</u> 019-00585-w

Singh RS, Kaur N, Rana V, Kennedy JF (2017) Pullulan: a novel molecule for biomedical applications. Carbohyd Polym 171:102–121. https://doi.org/10.1016/j.carbpol.2017.04.089

Singh RS, Saini GK, Kennedy JF (2021) Pullulan production in stirred tank reactor by a colourvariant strain of *Aureobasidium pullulans* FB-1. Carbohydr Polym Tech Appl 2:100086. <u>https://doi.org/10.1016/j.carpta.2021.100086</u> Singh RS, Saini GK (2012) Biosynthesis of pullulan and its applications in food and pharmaceutical industry. Microorganisms in sustainable agriculture and biotechnology. Springer, Dordrecht, pp 509–553. https://doi.org/10.1007/978-94-007-2214-9\_24

Srikanth S, Swathi M, Tejaswini M, Sharmila G, Muthukumaran C, Jaganathan MK, Tamilarasan K (2014) Statistical optimization of molasses based exopolysaccharide and biomass production by *Aureobasidium pullulans* MTCC 2195. Biocatal Agr Biotechnol 3:7–12.

https://doi.org/10.1016/j.bcab.2013.11.011

Sugumaran KR, Ponnusami V (2017) Review on production, downstream processing and characterization of microbial pullulan. Carbohyd Polym 173:573–591.

https://doi.org/10.1016/j.carbpol.2017.06.022

Sugumaran KR, Gowthami E, Swathi B, Elakkiya S, Srivastava SN, Ravikumar R, Gowdhaman D, Ponnusami V (2013) Production of pullulan by *Aureobasidium pullulans* from Asian palm kernel: a novel substrate. Carbohyd Polym 92:697–703. <u>https://doi.org/10.1016/j.carbpol.2012.09.062</u>

Sugumaran KR, Jothi P, Ponnusami V (2014) Bioconversion of industrial solid waste-cassava bagasse for pullulan production in solid state fermentation. Carbohyd Polym 99:22–30. https://doi.org/10.1016/j.carbpol.2013.08.039

Tabasum S, Noreen A, Maqsood MF, Umar H, Akram N, Chatha SA, Zia KM (2018) A review on versatile applications of blends and composites of pullulan with natural and synthetic polymers. Int J Biol Macromol 120:603–632.

https://doi.org/10.1016/j.ijbiomac.2018.07.154

Thirumavalavan K, Manikkadan TR, Dhanasekar R (2009) Pullulan production from coconut byproducts by *Aureobasidium pullulans*. Afr J Biotechnol 8(2):254–258

Varjani S, Lee DJ, Zhang ZQ (2020) Valorizing agricultural biomass for sustainable development: biological engineering aspects. Bioengineered 11:522–523.

https://doi.org/10.1080/21655979.2020.1759185

Varjani S, Shah AV, Vyas S, Srivastava VK (2021) Processes and prospects on valorizing solid waste for the production of valuable products employing bio-routes: a systematic review. Chemosphere 282:130954.

https://doi.org/10.1016/j.chemosphere.2021.1309 54

Viveka R, Varjani S, Ekambaram N (2020)

Valorization of cassava waste for pullulan production by *Aureobasidium pullulans* MTCC 1991. Energy Environ 32:1086–1102. https://doi.org/10.1177/0958305X20908065

Vyas S, Prajapati P, Shah AV, Srivastava VK, Varjani S (2022) Opportunities and knowledge gaps in biochemical interventions for mining of resources from solid waste: a special focus on anaerobic digestion. Fuel 311:122625. <u>https://doi.org/10.1016/j.fuel.2021.122625</u>

Wang D, Ju X, Zhou D, Wei G (2014) Efficient production of pullulan using rice hull hydrolysate by adaptive laboratory evolution of *Aureobasidium pullulans*. Bioresource Technol 164:12–19. https://doi.org/10.1016/j.biortech.2014.04.036

Wani SM, Mir SA, Khanday FA, Masoodi FA (2021) Advances in pullulan production from agro-based wastes by *Aureobasidium pullulans* and its applications. Innov Food Sci Emerg 74:102846.

https://doi.org/10.1016/j.ifset.2021.102846

Wu S, Jin Z, Tong Q, Chen H (2009) Sweet potato: a novel substrate for pullulan production by *Aureobasidium pullulans*. Carbohyd Polym 76:645–649. https://doi.org/10.1016/j.carbpol.2008.11.034 Wu S, Lu M, Chen J, Fang Y, Wu L, Xu Y, Wang S (2016) Production of pullulan from raw potato starch hydrolysates by a new strain of *Auerobasidium pullulans*. Int J Biol Macromol 82:740–743.

https://doi.org/10.1016/j.ijbiomac.2015.09.075

Yaashikaa PR, Kumar PS, Varjani S (2022) Valorization of agro-industrial wastes for biorefinery process and circular bioeconomy: a critical review. Bioresour Technol 343:126126. https://doi.org/10.1016/j.biortech.2021.126126

### Acknowledgements

Bishwambhar Mishra wants to acknowledge Chaitanya Bharathi Institute of Technology, Hyderabad, India for providing infrastructure and facility to carry out this work.

Funding

None.

# Author information

Bishwambhar Mishra and Yugal Kishore Mohanta have been contributed equally to this work.

Authors and Affiliations

Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad, 500075, India Bishwambhar Mishra, Sanjeeb Kumar Mandal & N. S. V. Lakshmayya

Department of Applied Biology, University of Science and Technology Meghalaya (USTM), Ri-Bhoi, Meghalaya, 793101, India Yugal Kishore Mohanta

**Gujarat Pollution Control Board**, **Gandhinagar, Gujarat, 382010, India** Sunita Varjani

Aquatic Toxicology Laboratory, Environmental Toxicology Group, Council of Scientific and Industrial Research-Indian Institute of Toxicology Research (CSIR-IITR), Vishvigyan Bhawan, 31, M.G. Marg, Lucknow, Uttar Pradesh, 226001, India Preeti Chaturvedi

College of Natural Resources and Environment, Northwest A&F University, Yangling, 712100, Shaanxi Province, People's Republic of China Mukesh Kumar Awasthi & Zengqiang Zhang

Department of Food Technology, T K M Institute of Technology, Kollam, Kerala, 691505, India Raveendran Sindhu **CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Trivandrum, Kerala, 695019, India** Parameswaran Binod

Department of Marine Environmental Engineering, National Kaohsiung University of Science and Technology, Kaohsiung City, 81157, Taiwan Reeta Rani Singhania

# CSIR-Indian Institute of Integrative Medicine, Jammu, 180001, India

Vinod Kumar

### Contributions

BM: Conceptualization, literature review, experimentation, writing—original draft; YKM: Literature review, writing original draft, data curation, data analysis; SV: Conceptualization, Supervision, data curation, review and editing, Resources; SKM: Writing original draft, review and editing, data curation; LNSV: Formal analysis, supervision, review and editing; PC: Review and editing; MKA: Review and editing; ZZ Review and editing; RS: Review and editing; PB: review and editing; RRS: Review and editing; VK: Review and editing.

Corresponding author Correspondence to <u>Sunita Varjani</u>.

Ethics declarations

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval Not required.

Consent to participate

None.

Consent for publication

None.

# Additional information

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

# Rights and permissions

**Reprints and Permissions** 

# About this article

### Cite this article

Mishra, B., Mohanta, Y.K., Varjani, S. *et al.* A critical review on valorization of food processing wastes and byproducts for pullulan production. *J Food Sci Technol* (2022). https://doi.org/10.1007/s13197-022-05490-5 RevisedAcceptedPublished13 April 202215 May 202223 June 2022

DOI

https://doi.org/10.1007/s13197-022-05490-5

### Share this article

Anyone you share the following link with will be able to read this content:

Get shareable link

Provided by the Springer Nature SharedIt content-sharing initiative

Keywords

Pullulan Aureobasidium pullulans

Food processing wastes Sustainability

Not logged in - 202.65.141.230

AICTE Electrical & Electronics & Computer Science Engineering (3000684219) - CBIT-Library & Information Centre Hyderabad (3000950898)

#### **SPRINGER NATURE**

 $\ensuremath{\mathbb{C}}$  2022 Springer Nature Switzerland AG. Part of Springer Nature.





Environmental Microbiology and Biotechnology pp 309–336

# Film Based Packaging for Food Safety and Preservation: Issues and Perspectives

<u>Bishwambhar Mishra</u>, <u>Sunita Varjani</u>, <u>Monali Parida</u>, <u>Gayathri Priya Iragavarapu</u>, <u>Mukesh Kumar Awasthi</u>, <u>Sanjeev Kumar Awasthi</u> & <u>Zengqiang Zhang</u> <u>Chapter | <u>First Online: 01 December 2020</u></u>

486 Accesses 1 <u>Citations</u>

### Abstract

The extensive production of conventional plastics and their use in various food industries as packaging materials create a significant threat to the environment. This ends up creating problems concerned with performance, processing, and overall cost, thus being a big question in dealing with these non-renewable materials. The bioplastics evolved during development of renewable resources. As a part of the consequences to the dynamic changes in the present demand of customer and market scenario, the film-based active packaging system is of huge importance. The application of packaging systems is not to pose as a "wrap on," hence lowering the quality control. It should, anyway, serve as an "add on" for the protective measures taken to assure the safety and best quality of foods. This chapter aims to compile information on types of active food packaging systems, its commercial applications meant for improving food safety and quality with the extension of its life. It also describes various critical factors to be considered for commercialization, current market strategy, and legislative considerations, and application of bioplastic as packaging materials to meet ever-growing consumer demands with comparatively high quality fresh produce.

### This is a preview of subscription content, <u>access via</u> <u>your institution</u>.

| ✓ Chapter                               | EUR                | 29.95   |
|---|--------------------|---------|
|   | Price includes VAT | (India) |
| • DOI: 10.1007/978-981-15-7493-1_1      | 5                  |         |
| Chapter length: 28 pages                | -                  |         |
| Instant PDF download                    |                    |         |
| Readable on all devices                 |                    |         |
| Own it forever                          |                    |         |
| • Exclusive offer for individuals only  |                    |         |
| Tax calculation will be finalised durin | a checkout         |         |
|   | ig checkout        |         |
| Ruy Chapter                             |                    |         |
| Buy Chapter                             |                    |         |
| > eBook                                 |                    | 106.99  |
| > Softcover Book                        |                    | 129.99  |
|   |                    |         |

### References

Aaron A, Erik L (2017) Produce growers' cost of complying with the food safety modernization act. Food Policy 74:23–38

Accinelli C, Saccà ML, Mencarelli M, Vicari A (2012) Deterioration of bioplastic carrier bags in the environment and assessment of a new recycling alternative. Chemosphere 89:136–143

Aguirre A, Borneo R, León AE (2013) Antimicrobial, mechanical and barrier properties of triticale protein films incorporated with oregano essential oil. Food Biosci 1:2–9

Agustín G, Cecilia IAL (2013) Soy protein – poly (lactic acid) bilayer films as biodegradable material for active food packaging. Food Hydrocoll 33:289– 296

Ahmad M, Benjakul S, Prodpran T, Agustini TW (2012) Physico-mechanical and antimicrobial properties of gelatin film from the skin of unicorn leatherjacket incorporated with essential oils. Food Hydrocoll 28:189–199

Alessia B, Cécilia M, Tatiana DR, Maurizio P, Alberto B (2013) Endowing carbon nanotubes with biological and biomedical properties by chemical modifications Adv. Drug Deliv Rev 65:1899–1920 Aloui H, Khwaldia K, Licciardello F, Mazzaglia A, Muratore G, Hamdi M, Restuccia C (2014) Efficacy of the combined application of chitosan and locust bean gum with different citrus essential oils to control postharvest spoilage caused by Aspergillus flavus in dates. Int J Food Microbiol 170:21–28

Amalini AN, Norziah MH, Khan I, Haafiz MKM (2018) Exploring the properties of modified fish gelatin films incorporated with different fatty acid sucrose esters. Food Packag Shelf Life 15:105–112

Amin MK, Seyed MBH, Sara L (2018) Antimicrobial agents and packaging systems in antimicrobial active food packaging: an overview of approaches and interactions. Food Bioprod Process 111:1–19

Attrey DP (2017) Food safety in international food trade—imports and exports. In: Food safety in the 21st century. Academic Press, Cambridge, pp 455– 468. <u>https://doi.org/10.1016/B978-0-12-801773-</u> <u>9.00037-6</u>

Atul PS, Bhushan RD, Darshana K, Mrunal J (2017) Cyclodextrin-based nanosponges: a critical review. Carbohydr Polym 173:37–49

Ayranci E, Tunc S (2004) The effect of edible coatings on water and vitamin C loss of apricots

(Armeniaca vulgaris lam.) and green peppers (Capsicum annuum L.). Food Chem 87:339–342

Barbiroli A, Bonomi F, Capretti G, Lametti S, Manzoni M, Piergiovanni L, Rollini M (2012) Antimicrobial activity of lysozyme and lactoferrin incorporated in cellulose-based food packaging. Food Control 26:387–392

Beshkova D, Frengova G (2012) Bacteriocins from lactic acid bacteria: microorganisms of potential biotechnological importance for the dairy industry. Eng Life Sci 12:419–432

Bitencourt CM, Favaro-Tridade CS, Sobral PJA, Carvalho RA (2014) Gelatin-based films additivated with curcuma ethanol extract: antioxidant activity and physical properties of films. Food Hydrocoll 40:145–152

Blakistone B, Sand CK (2007) Using sustainable packaging technologies to respond to consumer, retailer, and seafood industry needs. In: International smoked seafood conference proceedings. Alaska Sea Grant College Program, University of Alaska, Fairbanks, pp 75–79

Broek LM, Knoop RJI, Kappen FHJ, Boeriu CG (2015) Chitosan films and blends for packaging material. Carbohydr Polym 116:237–242 Buonocore GC, Del Nobile MA, Panizza A, Corbo MR, Nicolais L (2003) A general approach to describe the antimicrobial agent release from highly swellable films intended for food packaging applications. J Control Release 90:97–107

Busolo MA, Lagaron JM (2012) Oxygen scavenging polyolefin nanocomposite films containing an iron modified kaolinite of interest in active food packaging applications. Innov Food Sci Emerg Technol 16:211–217

Byun Y, Whiteside S (2012) Ascorbyl palmitatebeta-cyclodextrin inclusion complex as an oxygen scavenging microparticle. Carbohydr Polym 87:2114–2119

Byun Y, Bae HJ, Whiteside S (2012) Active warmwater fish gelatin film containing oxygen scavenging system. Food Hydrocoll 27:250–255

Campillo M, Sanchez I, Garai R, Nerin C (2009) Active packaging that inhibits food pathogens. US Patent EP 2025620 B1

Chana-Thaworn J, Chanthachum S, Wittaya T (2011) Properties and antimicrobial activity of edible films incorporated with kiam wood (Cotyleobium lanceotatum) extract. LWT-Food Sci Technol 44:284–292 Chau HTV, Keehoon W (2013) Novel waterresistant UV-activated oxygen indicator for intelligent food packaging. Food Chem 140:52–56

Chen J, Brody AL (2013) Use of active packaging structures to control the microbial quality of a ready-to-eat meat product. Food Control 30:306– 310

Chompoonoot R, Atchareeya N, Sudsai T, Tunyarut J, Panuwat S (2014) Development of a food spoilage indicator for monitoring freshness of skinless chicken breast. Talanta 130:547–554

Chua TK, Tseng M, Yang MK (2013) Degradation of poly(e-caprolactone) by thermophilic streptomyces thermoviolaceus subsp. thermoviolaceus 76T-2. AMB Express 3:8

Chun W, Hongwen H, Yongzhi Z, Hao M (2017) A comparative study on the applicability of ultracapacitor models for electric vehicles under different temperatures. Appl Energy 196:268–278

Dariusz K, Barbara B (2014) Effect of candelilla wax on functional properties of biopolymer emulsion films – a comparative study. Food Hydrocoll 41:195–209

Day BPF (2008) Active packaging of food. In: Kerry

JP, Butler P (eds) Smart packaging technologies for fast moving consumer goods. Wiley, Hoboken

Dobias J, Chudackova K, Voldrich M, Marek M (2000) Properties of polyethylene films with incorporated benzoic anhydride and/or ethyl and propyl esters of 4- hydroxybenzoic acid and their suitability for food packaging. Food Addit Contamin 17:1047–1053

Dobrucka R (2013) The future of active and intelligent packaging industry. Logforum 9:103– 110

Dou L, Li B, Zhang K, Chu X, Hou H (2018) Physical properties and antioxidant activity of gelatinsodium alginate edible films with tea polyphenols. Int J Biol Macromol 118:1377–1383

Echegoyen Y, Nerín C (2015) Performance of an active paper based on cinnamon essential oil in mushrooms quality. Food Chem 170:30–36

Elahe D, Hossein T, Mehran M, Mehrdad F (2018) Characterization of cellulosic paper coated with chitosan-zinc oxide nanocomposite containing nisin and its application in packaging of UF cheese. Int J Biol Macromol 109:1311–1318 Recent advances on intelligent packaging as tools to reduce food waste. J Clean Prod 172:3398–3409

Eun-Jung J, Jong-Hyun J, Dong-Ho S, Dong-Hyun J, Cheon-Seok P (2014) Bioinformatic and biochemical analysis of a novel maltose-forming α-amylase of the GH57 family in the hyperthermophilic archaeon Thermococcus sp. CL1. Enzym Microb Technol 60:9–15

Fabien B, Carole G, Nathalie G, Brice S (2017) A review: RFID technology having sensing aptitudes for food industry and their contribution to tracking and monitoring of food products. Trends Food Sci Technol 62:91–103

Farmer N (2013) Trends in packaging of food,beverages and other fast-moving consumer goods—FMCG. Woodhead Publishing Limited,Cambridge

Ferhat Ş, İrem U, Emre B, Memet VK (2017) Antimicrobial agent-free hybrid cationic starch/sodium alginate polyelectrolyte films for food packaging materials. Carbohydr Polym 170:264–270

Fernandez-Pan I, Carrion-Granda X, Mate JI (2014) Antimicrobial efficiency of edible coatings on the preservation of chicken breast fillets. Food Control 36:69–75

Garcia MA, Pinotti A, Martino MN, Zaritzky NE (2004) Characterization of composite hydrocolloid films. Carbohydr Polym 56:339–345

Ghaani M, Cozzolino CA, Castelli G, Farris S (2016) An overview of the intelligent packaging technologies in the food sector. Trends Food Sci Technol 51:1–11

Giménez B, Gómez-Guillén MC, López-Caballero ME, Gómez-Estaca J, Montero P (2012) Role of sepiolite in the release of active compounds from gelatin egg white films. Food Hydrocoll 27:475– 486

Giuseppe A, Francesco G, Attilio M, Antonella T, Giovanni CDR (2018) Characterization of an innovative device controlling gaseous exchange in packages for food products. Postharvest Biol Technol 138:64–73

Goldsmith RM, Goldsmith C, Woodaman JG, Park DL, Ayala CE (1999) Food Sentinel System TM. WO1999014598A1

Gomez-Estaca J, Lacey LA, Lopez-Caballero ME, Gomez-Guillen MC, Montero P (2010) Biodegradable gelatinechitosan films incorporated with essential oils as antimicrobial agents for fish preservation. Food Microbiol 27:889–896

Hatice K, Hasan Y, Mehmet D (2019) Production of polyhedral oligomeric silsesquioxane (POSS) containing low density polyethylene (LDPE) based nanocomposite films for minced beef packaging for extension of shelf life. LWT 108:385–391

Haugaard VK, Danielsen B, Bertelsen G (2003) Impact of polylactate and poly(hydroxybutyrate) on food quality. Eur Food Res Technol 216:233–240

Holck AL, Pettersen MK, Moen MH, Sørheim O (2014) Prolonged shelf life and reduced drip loss of chicken filets by the use of carbon dioxide emitters and modified atmosphere packaging. J Food Prot 77:1133–1141

Ishfaq A, Hong L, Long Z, Aaron LB, Zhenxing L, Ihsan MQ, Tushar RP, Liangtao L (2017) A comprehensive review on the application of active packaging technologies to muscle foods. Food Control 82:163–178

Ishrat M, Gulzar AN, Shuaib MD, Vikas N (2018) Novel food packaging technologies: innovations and future prospective. J Saudi Soc Agric Sci 17:454–462 Järnström L, Johansson K, Jönsson LJ, Winestrand S, Chatterjee R, Nielsen T et al (2013) ENZYCOAT II - enzymes embedded in barrier coatings for active packaging. Nordic Innovation Publication, Oslo

Jeannine B, Talita P, Rodrigo VL, Sobral PJA (2018) Antioxidant potential of eugenol and ginger essential oils with gelatin/chitosan films. Food Biosci 23:107–114

Jian-Hua L, Jing M, Jiu-Lin W, Shan-Fei C, Qi-Qing Z (2014) Preparation and characterization of active gelatin-based films incorporated with natural antioxidants. Food Hydrocoll 37:166–173

Joaquín G, Carol L, Pilar Hernández M, Ramón C, Rafael G (2014) Advances in antioxidant active food packaging. Trends Food Sci Technol 35:42–51

Johnson CPS, Rita CSS, Caio GO et al (2018) Nisin and other antimicrobial peptides: production, mechanisms of action, and application in active food packaging. Innovative Food Sci Emerg Technol 48:179–194

Jong-Whan R, Hwan-Man P, Chang-Sik H (2013) Bio-nanocomposites for food packaging applications. Prog Polym Sci 38:1629–1652

Kalliopi M, Petros M, Ladislav M, Anne-Katrin B,

Franz U (2018) Viewpoint: future of food safety and nutrition - seeking win-wins, coping with trade-offs. Food Policy 74:143–146

Kenneth WM (2017) Advancements in meat packaging. Meat Sci 132:153–162

Kim E, Choi DY, Kim HC, Kim K, Lee SJ (2013) Calibrations between the variables of microbial TTI response and ground pork qualities. Meat Sci 95:362–367

Kim JU, Ghafoor K, Ahn J (2016) Kinetic modeling and characterization of a diffusion-based timetemperature indicator (TTI) for monitoring microbial quality of non-pasteurized angelica juice. LWT-Food Sci Technol 67:143–150

Kirschweng B, Tátraaljai D, Földes E, Pukánszky B (2017) Natural antioxidants as stabilizers for polymers. Polym Degrad Stab 145:25–40

Koide S, Shi J (2007) Microbial and quality evaluation of green peppers stored in biodegradable film packaging. Food Control 18:1121–1125

Koutsoumanis K, Skandamis P (2013) New research on organic acids and pathogen behavior. In: Sofos J (ed) Advances in microbial food safety. Woodhead Publishing, Cambridge

Kuswandi B, Jayus A, Restyana A, Abdullah LYH, Ahmad M (2012) A novel colorimetric food package label for fish spoilage based on polyaniline film. Food Control 25:184–189

Lecoq L, Flick D, Derens E, Hoang HM, Laguerrea O (2016) Simplified heat and mass transfer modeling in a food processing plant. J Food Eng 171:1–13

Lee K, Ko S (2014) Proof-of-concept study of a whey protein isolate based carbon dioxide indicator to measure the shelf-life of packaged foods. Food Sci Biotechnol 23:115–120

Lee SY, Lee SJ, Choi DS, Hur SJ (2015) Current topics in active and intelligent food packaging for preservation of fresh foods. J Sci Food Agric 95:2799–2810

Levkane V, Muizniece-Brasava S, Dukalska L (2008) Pasteurization effect to quality of salad with meat and mayonnaise. In: Foodbalt Conference Proceedings, pp 69–73

Li TT, Hu WZ, Li JR, Zhang XG, Zhu JL, Li XP (2012) Coating effects of tea polyphenol and rosemary extract combined with chitosan on the storage quality of large yellow croaker (Pseudosciaena crocea). Food Control 25:101–106

Lim GO, Hong YH, Song KB (2010) Application of Gelidium corneum edible films containing carvacrol for ham packages. J Food Sci 75:90–93

Lina X, Wen W, Yunlong G, Guangqing L, Pengbo W (2017) Flexible polyaniline/carbon nanotube nanocomposite film-based electronic gas sensors. Sens Actuators B Chem 244:47–53

Lindh H, Olsson A, Williams H (2016) Consumer perceptions of food packaging: contributing to or counteracting environmentally sustainable development. Packag Technol Sci 29:3–23

Lindsey KF, Ning Y (2013) RFID tags for wireless electrochemical detection of volatile chemicals. Sens Actuators B Chem 186:817–823

Lindsey KF, James C, Ning Y (2014) Electrochemical detection of biogenic amines during food spoilage using an integrated sensing RFID tag. Sens Actuators B Chem 202:1298–1304

Liu F, Antoniou J, Li Y, Yi J, Yokoyama W, Ma J (2015) Preparation of gelatin films incorporated with tea polyphenol nanoparticles for enhancing controlled-release antioxidant properties. J Agric Food Chem 63:3987–3995

Liz K, Keyla L, Kelly JKG (2013) Natural antioxidants in meat and poultry products. Meat Sci 94:220–227

Magnea GK, Sigurjon A, Hordur GK, Kolbrun S (2014) The application of near infrared spectroscopy to study lipid characteristics and deterioration of frozen lean fish muscles. Food Chem 159:420–427

Maria AB, Jose ML (2012) Oxygen scavenging polyolefin nanocomposite films containing an iron modified kaolinite of interest in active food packaging applications. Innov Food Sci Emerg Technol 16:211–217

Marta Á, Natalia GT, Marta H, Sonia G (2014) Inhibitory activity of reuterin, nisin, lysozyme and nitrite against vegetative cells and spores of dairyrelated clostridium species. Int J Food Microbiol 172:70–75

Marta M, Yong-Jin YDOU, Hyun-Gyun Y (2017) Volatile chemical spoilage indexes of raw Atlantic salmon (Salmo salar) stored under aerobic condition in relation to microbiological and sensory shelf lives. Food Microbiol 53:182–191 Mila W, Carmen IM (2013) Physical and chemical methods used to enhance the structure and mechanical properties of protein films: a review. J Food Eng 114:292–302

Min Z, Peichong L (2012) RFID application strategy in Agri-food supply chain based on safety and benefit analysis. Phys Procedia 25:636–642

Natrajan N, Sheldon BW (2000) Inhibition of Salmonella on poultry skin using protein- and polysaccharide-based films containing a nisin formulation. J Food Prot 63:1268–1272

Nie X, Gong Y, Wang N, Meng X (2015) Preparation and characterization of edible myofibrillar protein-based film incorporated with grape seed procyanidins and green tea polyphenol. Food Sci Technol 64:1042–1046

Nora F, Frank JA, Rooij V, Bram PP, Mary FF, Andrew PM (2012) Discovery and fine mapping of serum protein loci through transethnic metaanalysis. Am J Hum Genet 91:744–753

Noushin E, Pascal D, Nadia O, Mohammad SY, Mohammad EM, Adem G (2017) Low methoxyl pectin/sodium caseinate interactions and composite film formation at neutral pH. Food Hydrocoll 69:132–140 Nydia MKB, Hongchao Z, Gustavo V (2017) Barbosa-Cánovas Headspace oxygen as a hurdle to improve the safety of in-pack pasteurized chilled food during storage at different temperatures. Int J Food Microbiol 253:29–35

Ouattara B, Simard RE, Piette G, Begin A, Holley RA (2000) Inhibition of surface spoilage bacteria in processed meats by application of antimicrobial films prepared with chitosan. Int J Food Microbiol 62:139–148

Ozdemir M, Floros JD (2001) Analysis and modeling of potassium sorbate diffusion through edible whey protein films. J Food Eng 47:149–155

Padgett T, Han IY, Dawson PL (2000) Effect of lauric acid addition on the antimicrobial efficacy and water permeability of corn zein films containing nisin. J Food Proc Preserv 24:423–432

Pastor C, Sanchez-Gonzalez L, Chafer M, Chiralt A, Martinez CG (2010) Physical and antifungal properties of hydroxypropylmethylcellulose based films containing propolis as affected by moisture content. Carbohydr Polym 82:1174–1183

Peelman N, Ragaert P, De Meulenaer B, Adons D, Peeters R, Cardon L, Van Impe F, Devlieghere F (2013) Review: application of bioplastics for food packaging. Trends Food Sci Technol 32:128–141

Penkhrue W, Khanongnuch C, Masaki K, Pathomaree W, Punyodom W, Lumyong S (2015) Isolation and screening of biopolymer-degrading microorganisms from northern Thailand. World J Microbiol Biotechnol 31:1431–1442

Perdones A, Sanchez-Gonzalez L, Chiralt A, Vargas M (2012) Effect of chitosan–lemon essential oil coatings on storage-keeping quality of strawberry. Postharvest Biol Technol 70:32–41

Pereira de Abreu DA, Cruz JM, Paseiro Losada P (2012) Active and intelligent packaging for the food industry. Food Rev Int 28:146–187

Pereira de ADA, Paseiro P, Maroto J, Cruz JM (2010) Evaluation of the effectiveness of a new active packaging film containing natural antioxidants (from barley husks) that retard lipid damage in frozen Atlantic salmon (Salmo salar L.). Food Res Int 43:1277–1282

Phakawat T, Soottawat B, Thummanoon P, Krisana N (2015) Emulsion film based on fish skin gelatin and palm oil: physical, structural and thermal properties. Food Hydrocoll 48:248–259 Pradeep P, Junho J, Sanghoon K (2012) Carbon dioxide sensors for intelligent food packaging applications. Food Control 25:328–333

Rabin G, Salam AI (2014) Natural products as antimicrobial agents. Food Control 46:412–429

Rahul G, Agnisha S, Karthik K, Pandey S, Tiwari MK (2017) Traceability using RFID and its formulation for a kiwifruit supply chain. Comput Ind Eng 103:46–58

Ramos OL, Silva SI, Soares JC, Fernandes JC, Poças MF, Pintado ME, Malcata FX (2012) Features and performance of edible films, obtained from whey protein isolate formulated with antimicrobial compounds. Food Res Int 45:351–361

Realini CE, Marcos B (2014) Active and intelligent packaging systems for a modern society. Meat Sci 98:404–419

Reyhan I, Ozlem KE (2015) Novel food packaging systems with natural antimicrobial agents. J Food Sci Technol 52:6095–6111

Rodriguez-Lafuente A, Nerin C, Batlle R (2010) Active paraffin based paper packaging for extending the shelf life of cherry tomatoes. J Agric Food Chem 58:6780–6786 Rukhsana R, Monika S, Neeraj G, Julie DB, Fozia H, Shafia A (2019) Bioplastics for food packaging: a review. Int J Curr Microbiol App Sci 8:2311–2321

Sánchez-González L, Saavedra JIQ, Chiralt A (2013) Physical properties and antilisterial activity of bioactive edible films containing Lactobacillus plantarum. Food Hydrocoll 33:92–98

Sayanjali S, Ghanbarzadeh B, Ghiassifar S (2011) Evaluation of antimicrobial and physical properties of edible film based on carboxymethyl cellulose containing potassium sorbate on some mycotoxigenic Aspergillus species in fresh pistachios. LWT- Food Sci Technol 44:1133–1138

Shao P, Niu B, Chen HJ, Sun PL (2018) Fabrication and characterization of teapolyphenols pullulan-CMC electrospun nanofiber for fruit preservation. Int J Biol Macromol 107:1908–1914

Silvia MM, Caroline M, Thiago C, Josué A, Ismael CB, Ana CPDP, Pedro LMB, Valdir S (2017) Edible carboxymethyl cellulose films containing natural antioxidant and surfactants: α-tocopherol stability, in vitro release and film properties. LWT-Food Sci Technol 77:21–29

Sivarooban T, Hettiarachchy NS, Johnson MG (2008) Physical and antimicrobial properties of

grape seed extract, nisin, and EDTA incorporated soy protein edible films. Food Res Int 41:781–785

Soares N, Silva P, Barbosa C, Pinheiro R, Vicente AA (2017) Comparing the effects of glazing and chitosan-based coating applied on frozen salmon on its organoleptic and physicochemical characteristics over six-months storage. J Food Eng 194:79–86

Tachibana K, Urano Y, Numata K (2013) Biodegradability of nylon 4 film in a marine environment. Polym Degrad Stab 98:1847–1851

Toorn SID, Broek MAVD, Worrell E (2017) Decarbonising meat: exploring greenhouse gas emissions in the meat sector. Energy Procedia 123:353–360

Trivedi P, Hasan A, Akhtar S, Siddiqui MH, Sayeed U, Khan MKA (2016) Role of microbes in degradation of synthetic plastics and manufacture of bioplastics. J Chem Pharm Res 8:211–216

Tsironi T, Stamatiou A, Giannoglou M, Velliou E, Taoukis PS (2011) Predictive modelling and selection of time temperature integrators for monitoring the shelf life of modified atmosphere packed gilthead seabream fillets. LWT-Food Sci Technol 44:1156–1163 Tumwesigye KS, Sousa AR, Oliveira JC, Sousa-Gallagher MJ (2017) Evaluation of novel bitter cassava film for equilibrium modified atmosphere packaging of cherry tomatoes. Food Packag Shelf Life 13:1–14

Türe H, Gallstedt M, Hedenqvist MK (2012) Antimicrobial compression-moulded wheat gluten films containing potassium sorbate. Food Res Int 45:109–115

Vanderroost M, Ragaert P, Devlieghere F, De Meulenaer B (2014) Intelligent food packaging: the next generation. Trends Food Sci Technol 39:47–62

Volpe S, Cavella S, Masi P, Torrieri E (2017) Effect of solid concentration on structure and properties of chitosan-caseinate blend films. Food Packag Shelf Life 13:76–84

Wu D, Hou S, Chen J et al (2015) Development and characterization of an enzymatic time-temperature indicator (TTI) based on Aspergillus niger lipase. LWT-Food Sci Technol 60:1100–1104

Xiaowei Z, Samar KM, Hisashi K (2012) A review of RFID technology and its managerial applications in different industries. J Eng Technol Manag 29:152– 167 Ye Y (2016) Enhancement of mass transfer by ultrasound: application to adsorbent regeneration and food drying/dehydration. Ultrason Sonochem 31:512–531

Ye-Chong Y, Shou-Wei Y, Xiao-Quan Y, Chuan-He T, Shao-Hong W, Zhuo C, Bang-jie X, Lei-Yan W (2014) Surface modification of sodium caseinate films by zein coatings. Food Hydrocoll 36:1–8

Yingchun Z, Lizhen M, Hua Y, Yan X, Youling LX (2016) Super-chilling (–0.7°C) with high-CO2 packaging inhibits biochemical changes of microbial origin in catfish (Clarias gariepinus) muscle during storage. Food Chem 206:182–190

Yong-Shin K, Heeju J, Okhyun R, Yong-Han L (2012) A simulation approach for optimal design of RFID sensor tag-based cold chain systems. J Food Eng 113:1–10

Yuyue Q, Wenhui L, Dong L, Minglong Y, Lin L (2017) Development of active packaging film made from poly (lactic acid) incorporated essential oil. Prog Org Coat 103:76–82

Zabala S, Castán J, Martínez C (2015) Development of a time temperature indicator (TTI) label by rotary printing technologies. Food Control 50:57– 64 Zárate-Ramírez LS, Romero A, Bengoechea C, Partal P, Guerrero A (2014) Thermo-mechanical and hydrophilic properties of polysaccharide/gluten-based bioplastics. Carbohydr Polym 112:24–31

Zhongxiang F, Yanyun Z, Robyn DW, Stuart KJ (2017) Active and intelligent packaging in meat industry. Trends Food Sci Technol 61:60–71

Zoran P, Vesna D, Dragan M, Ivan N, Nenad P (2015) Meat production and consumption: environmental consequences. Procedia Food Sci 5:235–238

## Author information

Authors and Affiliations

Department of Biotechnology, Chaitanya

Bharathi Institute of Technology, Hyderabad,

India

Bishwambhar Mishra

Gujarat Pollution Control Board, Gandhinagar,

Gujarat, India

Sunita Varjani

Department of Biotechnology, Centurion University of Technology and Management, Bhubaneswar, India

Monali Parida

Department of Biotechnology, Sreenidhi Institute of Science and Technology, Hyderabad, India Gayathri Priya Iragavarapu

College of Natural Resources and Environment, Northwest A&F University, Yangling, Shaanxi Province, People's Republic of China Mukesh Kumar Awasthi, Sanjeev Kumar Awasthi & Zengqiang Zhang

Editor information

**Editors and Affiliations** 

Department of Scientific & Industrial Research (DSIR), Ministry of Science and Technology, Government of India, New Delhi, Delhi, India Dr. Anoop Singh

Amity School of Earth and Environmental Sciences, Amity University Haryana, Gurugram, Haryana, India Dr. Shaili Srivastava

School of Environment and Sustainable Development, Central University of Gujarat, Gandhinagar, Gujarat, India Dr. Dheeraj Rathore

Separation and Conversion Technology, Flemish Institute for Technological Research (VITO), Mol, Antwerpen, Belgium

Dr. Deepak Pant

**Reprints and Permissions** 

# Copyright information

© 2021 Springer Nature Singapore Pte Ltd.

# About this chapter

## Cite this chapter

Mishra, B. *et al.* (2021). Film Based Packaging for Food Safety and Preservation: Issues and Perspectives. In: Singh, A., Srivastava, S., Rathore, D., Pant, D. (eds) Environmental Microbiology and Biotechnology. Springer, Singapore. https://doi.org/10.1007/978-981-15-7493-1\_15

## <u>.RIS</u> <u>↓</u> <u>.ENW</u> <u>↓</u> <u>.BIB</u> <u>↓</u>

### DOI

https://doi.org/10.1007/978-981-15-7493-1\_15

| Published   | Publisher Name       | Print ISBN  |
|-------------|----------------------|-------------|
| 01 December | Springer,            | 978-981-15- |
| 2020        | Singapore            | 7492-4      |
|             |                      |             |
| Online ISBN | eBook Packages       |             |
| 978-981-15- | Earth and            |             |
| 7493-1      | <u>Environmental</u> |             |
|             | <u>Science</u>       |             |
|             | Earth and            |             |
|             | <u>Environmental</u> |             |
|             | <u>Science (R0)</u>  |             |
|             |                      |             |

Not logged in - 202.65.141.230

AICTE Electrical & Electronics & Computer Science Engineering (3000684219) - CBIT-Library & Information Centre Hyderabad (3000950898)

#### **SPRINGER NATURE**

© 2022 Springer Nature Switzerland AG. Part of Springer Nature.



Waste Biorefinery

Value Addition Through Resource Utilization

2021, Pages 375-389

## Chapter 13 - Petroleum waste biorefinery: A way towards circular economy

Sunita Varjani <sup>a</sup>, Bishwambhar Mishra <sup>b</sup> A, Rajasri Yadavalli <sup>b</sup>, Xuan-Thanh Bui <sup>c, d</sup>, Mohammad J. Taherzadeh <sup>e</sup>, Dinesh Chand Agrawal <sup>f</sup>, Siming You <sup>g</sup>, Jo-Shu Chang <sup>h, i, j</sup>

Show more  $\$ 

📃 Outline 🛛 😪 Share 🍠 Cite

https://doi.org/10.1016/B978-0-12-821879-2.00013-2

Get rights and content

Next

>

#### Abstract

The petroleum industry is one of the fastest-growing sectors in the world owing to their increasing energy needs. Petroleum refinery produces a large number of waste products like volatile organic compounds, oily sludge, wastewater, heavy metals, waste catalyst, etc. The major ecological challenge for this refinery process is to manage the enormous amount of waste considering the nature of the waste and the changing strict environmental regulations. Disposal and spillage of petroleum products in the underground storage sites have also posed significant risks to groundwater sources in many oil-contaminated areas. This chapter provides comprehensive information about recent developments, advancements, barriers associated, and major challenges associated with the process control of petroleum waste management. Circularizing the economy in the petroleum waste biorefinery model for the production of various products has been discussed. Finally, this chapter also highlights the challenges and perspectives in the area of a petroleum refinery to comply with resource recovery and waste management practices.



#### Keywords

petroleum industry; oily sludge; biorefinery; recycling; waste management

Recommended articles

Cited by (3)

Employing newly developed plastic bubble wrap technique for biofuel production from diatoms cultivated in discarded plastic waste

2022, Science of the Total Environment

Show abstract  $\checkmark$ 

# The role of saline-related species in the electrochemical treatment of produced water using Ti/IrO<inf>2</inf>-Ta<inf>2</inf>O<inf>5</inf> anode

2022, Journal of Electroanalytical Chemistry

Show abstract  $\checkmark$ 

#### Organic solid waste: Biorefinery approach as a sustainable strategy in circular bioeconomy

2022, Bioresource Technology

#### Show abstract $\checkmark$

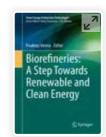
Copyright © 2021 Elsevier Inc. All rights reserved.



Copyright  $\bigodot$  2022 Elsevier B.V. or its licensors or contributors. ScienceDirect^ is a registered trademark of Elsevier B.V.

**RELX**<sup>™</sup>





Biorefineries: A Step Towards Renewable and Clean Energy pp 417–436

# Electro-Fermentation of Biomass for High-Value Organic Acids

C. Nagendranatha Reddy, Sanjeet Mehariya, S. Kavitha, R. Yukesh Kannah, K. Jayaprakash, Rajasri Yadavalli, J. Rajesh Banu & Parthiba Karthikeyan Obulisamy

Chapter | First Online: 05 January 2021

404 Accesses

Part of the <u>Clean Energy Production Technologies</u> book series (CEPT)

## Abstract

Microbial fermentations are well recognized process for large-scale bioconversion of organic waste biomass into high-value organic acids. It requires processes optimization, i.e., that should reach at maximum productivity and no feedback inhibition, to reduce the cost of up- and downstream processing for commercialization. To achieve this, triggered metabolic activities are often needed that maximize the conversion of organic carbon into organic acids under non-sterile conditions. By regulating the redox balance in-situ, the specific organic acid production could be tailored in fermentation systems under mixed/mono-culture conditions. In recent years, bio-electro-fermentations (BEF) has developed as a promising approach for organic waste conversion into value products due to its sustainable nature but yet required better understand for further development. In BEF, the fermentative metabolic pathways are enhanced with poising electrodes that facilitate effective electron transfers towards endproduct recovery. It is expected to maintain the required redox conditions and buffer the system by regulating reducing equivalents e.g. NADH<sup>+</sup> during fermentation. Moreover, microorganisms extract energy required to build biomass (anabolic process) from redox reactions (catabolism) through syntrophic interactions in BEF, while feedback inhibition of process could be overcome. In this chapter, we will elaborate the BEF process for organic acid production (mainly succinic, acetic, and muconic acids) and techno-economics of the process for commercialization.

Keywords

**Bio-electro-fermentations** 

High-value organic acids

Microbial fermentations Redox reaction

This is a preview of subscription content, <u>access via</u> <u>your institution</u>.

|   |   |     | . ,    |  |
|---|---|-----|--------|--|
|   | • DOI: 10.1007/978-981-15-9593-6_16                 |     |        |  |
|   | Chapter length: 20 pages                            |     |        |  |
|   | Instant PDF download                                |     |        |  |
|   | Readable on all devices                             |     |        |  |
|   | • Own it forever                                    |     |        |  |
|   | • Exclusive offer for individuals only              |     |        |  |
|   | • Tax calculation will be finalised during checkout |     |        |  |
|   |   |     |        |  |
|   | Buy Chapter   |     |        |  |
| L |   |     |        |  |
|   |   |     |        |  |
| > | > eBook   |     | 139.09 |  |
| > | Softcover Book                                      | EUR | 169.99 |  |
|   |   |     |        |  |
| > | Hardcover Book                                      | EUR | 169.99 |  |
|   |   |     |        |  |

Learn about institutional subscriptions

## Abbreviations

- AA: Acetic acid
- **AD:** Anaerobic digestion
- **BEF:** Bio-electro-fermentations
- CA: Citric acid
- **CAPEX:** Capital expenditure
- ccMA: cis,cis-muconic acid
- ctMA: cis,trans-muconic acid
- **EET:** Extracellular electron transfer
- **EF:** Electro-fermentation

### frd :

Fumarate reductase

- *fum*: Fumarase
- LA: Lactic acid
- LCA: Life cycle assessment
- **MA:** Muconic acid
- mdh: Malate dehydrogenase
- **MMC:** Mixed microbial cultures
- **OW:** Organic waste
- **ppc**: PEP carboxylase
- pck: PEP carboxykinase
- pyc: Pyruvate carboxylase
- SA: Succinic acid
- TEA: Techno-economic analysis
- ttMA: trans,trans-muconic acid

## References

Alexandri M, Venus J (2017) Feedstock flexibility in sustainable chemistry: bridging sectors still not sufficiently familiar with each other – showcases of ongoing and emerging initiatives. Curr Opin Green Sustain Chem 8:24–29 Alexandri M, Schneider R, Venus J (2018) Membrane technologies for lactic acid separation from fermentation broths derived from renewable resources. Membranes 8(4):94

Alves de Oliveira R, Komesu A, Vaz Rossell CE, Maciel Filho R (2018) Challenges and opportunities in lactic acid bioprocess design—from economic to production aspects. Biochem Eng J 133:219–239

Appels L, Baeyens J, Degre`ve J, Dewil R (2008) Principles and potential of the anaerobic digestion of waste-activated sludge. Prog Energ Combust Sci 34:755–781

Awate B, Steidl RJ, Hamlischer T, Reguera G (2017) Stimulation of electro-fermentation in singlechamber microbial electrolysis cells driven by genetically engineered anode bio films. J Power Sources 356:510–518

Batlle-Vilanova P, Puig S, Gonzalez-Olmos R, Colprim J (2016) Continuous acetate production through microbial electrosynthesis from CO with microbial mixed culture. J Chem Technol Biotechnol 91:921–927

Becker J, Wittmann C (2012) Systems and synthetic metabolic engineering for amino acid production-

the heartbeat of industrial strain development. Curr Opin Biotechnol 23:718–726

Becker J, Kuhl M, Kohlstedt M, Starck S, Wittmann C (2018) Metabolic engineering of *Corynebacterium glutamicum* for the production of cis,cis-muconic acid from lignin. Microb Cell Fact 17:115–128

Bentley GJ, Narayanan N, Jha RK et al (2020) Engineering glucose metabolism for enhanced muconic acid production in Pseudomonas putida KT2440. Metab Eng 59:64–75

Cao Y, Zhang R, Sun C, Cheng T, Liu Y, Xian M (2013) Fermentative succinate production: an emerging technology to replace the traditional petrochemical processes. Biomed Res Int 2013:1– 12

Cavallo E, Charreau H, Cerrutti P, Foresti ML (2017) Yarrowia lipolytica: a model yeast for citric acid production. FEMS Yeast Res 17(8):84. <u>https://doi.org/10.1093/femsyr/fox084</u>

Caxiano IN, Junqueira PG, Mangili PV, Prata DM (2020) Eco-efficiency analysis and intensification of the acetic acid purification process. Chem Eng Process - Process Intensif 147:107784 Chavas J-P, Kim K (2010) Economies of diversification: a generalization and decomposition of economies of scope. Int J Prod Econ 126:229– 235

Cheng S, Xing D, Call DF, Logan BE (2009) Direct biological conversion of electrical current into methane by electromethanogenesis. Environ Sci Technol 43:3953–3958

Choi O, Sang BI (2016) Extracellular electron transfer from cathode to microbes: application for biofuel production. Biotechnol Biofuel 9(1):11

Choi KS, Kondaveeti S, Min B (2017) Bioelectrochemical methane (CH<sub>4</sub>) production in anaerobic digestion at different supplemental voltages. Bioresour Technol 245:826–883

Christodoulou X, Velasquez-Orta SB (2016) Microbial electrosynthesis and anaerobic fermentation: an economic evaluation for acetic acid production from CO<sub>2</sub> and CO. Environ Sci Technol 50(20):11234–11242

Chu N, Liang Q, Jiang Y, Zeng RJ (2020) Microbial electrochemical platform for the production of renewable fuels and chemicals. Biosens Bioelectron 150:111922 Chua JW, Hsieh JH (1990) Oxidative bioconversion of toluene to 1,3-butadiene-1,4-dicarboxylic acid (cis,cis-muconic acid). World J Microbiol Biotechnol 6:127–143

De Corato U, De Bari I, Viola E, Pugliese M (2018) Assessing the main opportunities of integrated biorefining from agro-bioenergy co/by-products and agroindustrial residues into high-value added products associated to some emerging markets: a review. Renew Sustain Energy Rev 88:326–346

Desloover J, Arends JB, Hennebel T, Rabaey K (2012) Operational and technical considerations for microbial electrosynthesis. Biochem Soc Trans 40:1233–1238

Frost JW, Miermont A, Schweitzer D, Bui V (2013) Preparation of trans, trans muconic acid and trans, trans muconates. US Patent US8426639B2

Ghaffar T, Irshad M, Anwar Z et al (2014) Recent trends in lactic acid biotechnology: a brief review on production to purification. J Radiat Res Appl Sci 7:222–229

Gorby YA, Yanina S, McLean JS, Rosso KM, Moyles D et al (2006) Electrically conductive bacterial nanowires produced by *Shewanella oneidensis*  strain MR-1 and other exoelectrogens. Proc Natl Acad Sci 103:11358–11363

Grootscholten TIM, Borgo F, Hamelers HVM, Buisman CJN (2013) Promoting chain elongation in mixed culture acidification reactors by addition of ethanol. Biomass Bioenerg 48:10–16

Jiang Y, Su M, Zhang Y, Zhan G, Tao Y, Li D (2013a) Bioelectrochemical systems for simultaneously production of methane and acetate from carbon dioxide at relatively high rate. Int J Hydrogen Energy 38:3497–3502

Jiang J, Zhang Y, Li K, Wang Q, Gong C, Li M (2013b) Volatile fatty acids production from food waste: effects of pH, temperature and organic loading rate. Bioresour Technol 143:525–530

Jiang Y, Lu L, Wang H et al (2018) Electrochemical control of redox potential arrests methanogenesis and regulates products in mixed culture electrofermentation. ACS Sustain Chem Eng 6:8650–8658

Jiang Y, May HD, Lu L et al (2019) Carbon dioxide and organic waste valorization by microbial electrosynthesis and electro-fermentation. Water Res 149:42–55

Jiang Y, Chu N, Zhang W et al (2020) Electro-

fermentation regulates mixed culture chain elongation with fresh and acclimated cathode. Energy Convers Manag 204:112285. https://doi.org/10.1016/j.enconman.2019.112285

Karthikeyan OP, Visvanathan C (2013) Bio-energy recovery from high-solid organic substrates by dry anaerobic bio-conversion processes: a review. Rev Environ Sci Bio/Technol 12(3):257–284

Khalil I, Quintens G, Junkers T, Dusselier M (2020) Muconic acid isomers as platform chemicals and monomers in the biobased economy. Green Chem 22:1517–1541

Khosravanipour Mostafazadeh A, Drogui P, Brar SK et al (2017) Microbial electrosynthesis of solvents and alcoholic biofuels from nutrient waste: A review. J Environ Chem Eng 5:940–954

Kiely PD, Regan JM, Logan BE (2011) The electric picnic: synergistic requirements for exoelectrogenic microbial communities. Curr Opin Biotechnol 22:378–385

Kotloski NJ, Gralnick JA (2013) Flavin electron shuttles dominate extracellular electron transfer by *Shewanella oneidensis*. mBio 4:00553-12

Kucek LA, Xu J, Nguyen M, Angenent LT (2016)

Waste conversion into n-Caprylate and n-Caproate: resource recovery from wine lees using anaerobic reactor microbiomes and in-line extraction. Front Microbiol 7:1892

Kumar P, Pant DC, Mehariya S et al (2014a) Ecobiotechnological strategy to enhance efficiency of bioconversion of wastes into hydrogen and methane. Indian J Microbiol 54:262–267. <u>https://doi.org/10.1007/s12088-014-0467-7</u>

Kumar P, Singh M, Mehariya S et al (2014b) Ecobiotechnological approach for exploiting the abilities of bacillus to produce co-polymer of polyhydroxyalkanoate. Indian J Microbiol 54:151– 157

Kumar A, Hsu LHH, Paul K, Barriere F, Lens PNL et al (2017) The ins and outs of microorganismelectrode electron transfer reactions. Nat Rev Chem 1:0024

LaBelle EV, May HD (2017) Energy efficiency and productivity enhancement of microbial electrosynthesis of acetate. Front Microbiol 8:756. <u>https://doi.org/10.3389/fmicb.2017.00756</u>

Lee WS, Chua ASM, Yeoh HK, Ngoh GC (2014) A review of the production and applications of waste-derived volatile fatty acids. Chem Eng J 235:83–99 Liu H, Grot S, Logan BE (2005) Electrochemically assisted microbial production of hydrogen from acetate. Environ Sci Technol 39:4317–4320

Lovley DR (2011) Electrosynthesis of organic compounds from carbon dioxide is catalyzed by a diversity of acetogenic microorganisms. Appl Environ Microbiol 77:2882–2886

Marshall CW, Ross DE, Fichot EB, Norman RS, May HD (2012) Electrosynthesis of commodity chemicals by an autotrophic microbial community. Appl Environ Microbiol 78(23):8412–8420

Mehariya S, Patel AK, Obulisamy PK et al (2018) Co-digestion of food waste and sewage sludge for methane production: current status and perspective. Bioresour Technol 265:519–531

Mika LT, Cséfalvay E, Németh Á (2018) Catalytic conversion of carbohydrates to initial platform chemicals: chemistry and sustainability. Chem Rev 118:505–613.

https://doi.org/10.1021/acs.chemrev.7b00395

Mizuno S, Yoshikawa N, Seki M, Mikawa T, Imada Y (1988) Microbial production of cis, cis-muconic acid from benzoic acid. Appl Microbiol Biotechnol 28:20–25 Mohanakrishna G, Seelam JS, Vanbroekhoven K, Pant D (2015) An enriched electroactive homoacetogenic biocathode for the microbial electrosynthesis of acetate through carbon dioxide reduction. Faraday Discuss 183:445–462

Moscoviz R, Toledo-Alarcn J, Trably E, Bernet N (2016) Electro-fermentation: how to drive fermentation using electrochemical systems. Trends Biotechnol 34:856–865

Moscoviz R, Trably E, Bernet N (2018) Electrofermentation triggering population selection in mixed-culture glycerol fermentation. Microb Biotechnol 11:74–83

Nevin KP, Hensley SA, Franks AE, Summers ZM, Ou J, Woodard TL, Lovley DR (2011) Electrosynthesis of organic compounds from carbon dioxide is catalyzed by a diversity of acetogenic microorganisms. Appl Environ Microbial 77(9):2882–2886

Nevin KP, Hensley SA, Franks AE, Summers ZM, Ou J, Woodard TL, Snoeyenbos-West OL, Nikhil GN, Subhash GV, Dileep Y, Venkata Mohan S (2015) Synergistic yield of dual energy forms through biocatalyzed electrofermentation of waste: stoichiometric analysis of electron and carbon distribution. Energy 88:281–191 Nevin KP, Woodard TL, Franks AE, Summers ZM, Lovley DR (2010) Microbial electrosynthesis: feeding microbes electricity to convert carbon dioxide and water to multicarbon extracellular organic compounds. MBio 1:e00103–e00110. https://doi.org/10.1128/mBio.00103-10

Park DH, Zeikus JG (1999) Utilization of electrically reduced neutral Red by Actinobacillus succinogenes: physiological function of neutral Red in membrane-driven fumarate reduction and energy conservation. J Bacteriol 181(8):2403–2410

Patil SA, Arends JBA, Vanwonterghem I, van Meerbergen J, Guo K, Tyson GW, Rabaey K (2015) Selective enrichment establishes a stable performing community for microbial electrosynthesis of acetate from CO<sub>2</sub>. Environ Sci Technol 49:8833–8843

Rabaey K, Rozendal RA (2010) Microbial electrosynthesis - revisiting the electrical route for microbial production. Nat Rev Microbiol 8:706–716

Rabaey K, Girguis P, Nielsen LK (2011) Metabolic and practical considerations on microbial electrosynthesis. Curr Opin Biotechnol 22:371–377

Rago L, Pant D, Schievano A (2019) Chapter 14 electro-fermentation—microbial electrochemistry as new frontier in biomass refineries and industrial fermentations. In: Hosseini M (ed) Advanced bioprocessing for alternative fuels, biobased chemicals, and bioproducts. Woodhead Publishing, Sawston, pp 265–287

Reguera G, Nevin KP, Nicoll JS, Covalla SF, Woodard TL, Lovley DR (2006) Biofilm and nanowire production leads to increased current in *Geobacter sulfurreducens* fuel cells. Appl Environ Microbiol 72:7345–7348

Sasaki K, Sasaki D, Kamiya K et al (2018) Electrochemical biotechnologies minimizing the required electrode assemblies. Curr Opin Biotechnol 50:182–188

Schievano A, PepéSciarria T, Vanbroekhoven K, De Wever H, Puig S, Andersen SJ, Rabaey K, Pant D (2016) Electro-fermentation-merging electrochemistry with fermentation in industrial applications. Trends Biotechnol 34:866–878

Schmidt FR (2005) Optimization and scale up of industrial fermentation processes. Appl Microbiol Biotechnol 68(4):425–435

Shanthi Sravan J, Butti SK, Sarkar O et al (2018) Electrofermentation of food waste – regulating acidogenesis towards enhanced volatile fatty acids production. Chem Eng J 334:1709–1718 Srikanth S, Maesen M, Dominguez-Benetton X, Vanbroekhoven K, Pant D (2014) Enzymatic electrosynthesis of formate through CO<sub>2</sub> sequestration/reduction in a bioelectrochemical system (BES). Bioresour Technol 165:350–354

Srikanth S, Kumar M, Singh MP, Das BP (2016) Bioelectro chemical systems: a sustainable and potential platform for treating waste. Procedia Environ Sci 35:853–859

Stamenkovic VR, Strmcnik D, Lopes PP, Markovic NM (2016) Energy and fuels from electrochemical interfaces. Nat Mater 16:57–69

Steinbusch KJJ, Hamelers HVM, Plugge CM, Buisman CJN (2011) Biological formation of caproate and caprylate from acetate: fuel and chemical production from low grade biomass. Energ Environ Sci 4:216

Su M, Jiang Y, Li D (2013) Production of acetate from carbon dioxide in bioelectrochemical systems based on autotrophic mixed culture. J Microbiol Biotechnol 23:1140–1146

Summers ZM, Fogarty HE, Leang C, Franks AE, Malvankar NS, Lovley DR (2010) Direct exchange of electrons within aggregates of an evolved syntrophic coculture of Anaerobic bacteria. Science 330:1413–1415

Teigiserova DA, Hamelin L, Thomsen M (2019) Review of high-value food waste and food residues biorefineries with focus on unavoidable wastes from processing. Resour Conserv Recycl 149:413–426

Uçkun Kiran E, Trzcinski AP, Ng WJ, Liu Y (2014) Enzyme production from food wastes using a biorefinery concept. Waste Biomass Valoriz 5:903– 917

Van Eerten-Jansen MC, TerHeijne A, Grootscholten TI, Steinbusch KJ et al (2013) Bioelectrochemical production of caproate and caprylate from acetate by mixed cultures. ACS Sustain Chem Eng 1:513– 518

Venkata Mohan S, Butti SK, Amulya K, Dahiya S, Modestra JA (2016) Waste biorefinery: a new paradigm for a sustainable bioelectro economy. Trends Biotechnol 34:852–855

Villano M, Paiano P, Palma E, Miccheli A, Majone M (2017) Electrochemically-driven fermentation of organic substrates with undefined mixed microbial cultures. Chem Sus Chem. 10(15):3091–3097. https://doi.org/10.1002/cssc.201700360 Xafenias N, Kmezik C, Mapelli V (2017) Enhancement of anaerobic lysine production in Corynebacterium glutamicum electrofermentations. Bioelectrochemistry 117:40– 47.

https://doi.org/10.1016/j.bioelechem.2017.06.001

Zhao Y, Cao W, Wang Z, Zhang B, Chen K, Ouyang P (2016) Enhanced succinic acid production from corncob hydrolysate by microbial electrolysis cells. Bioresour Technol 202:152–157

Zhou M, Yan B, Wong JWC, Zhang Y (2017) Enhanced volatile fatty acids production from anaerobic fermentation of food waste: a minireview focusing on acidogenic metabolic pathways. Bioresour Technol 248:68–78

# **Competing Interests**

All the authors declare that they have no competing interests.

# Author information

Authors and Affiliations

Department of Biotechnology, Chaitanya

#### Bharathi Institute of Technology (Autonomous),

## Hyderabad, Telangana, India

C. Nagendranatha Reddy & Rajasri Yadavalli

Department of Sustainability - CR Portici, ENEA, Italian National Agency for New Technologies, Energy and Sustainable Economic Development, Portici, Italy Sanjeet Mehariya

Department of Engineering, University of Campania "L.Vanvitelli", Aversa, Italy Sanjeet Mehariya

Department of Civil Engineering, Anna University Regional Campus, Tirunelveli, Tamil Nadu, India S. Kavitha & R. Yukesh Kannah

Department of Biotechnology, Shanmuga Industries Arts and Science College, Tiruvannamalai, Tamil Nadu, India K. Jayaprakash

Department of Life sciences, Central University of Tamil Nadu, Thiruvarur, Tamil Nadu, India J. Rajesh Banu Department of Engineering Technology, College

of Technology, University of Houston, Houston, TX, USA Parthiba Karthikeyan Obulisamy

Corresponding author

Correspondence to Parthiba Karthikeyan Obulisamy

Editor information

**Editors and Affiliations** 

**Bioprocess and Bioenergy Laboratory, Department of Microbiology, Central University of Rajasthan, Ajmer, Rajasthan, India** Prof. Pradeep Verma

Rights and permissions

**Reprints and Permissions** 

# Copyright information

© 2020 The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd.

# About this chapter

#### Cite this chapter

Nagendranatha Reddy, C. *et al.* (2020). Electro-Fermentation of Biomass for High-Value Organic Acids. In: Verma, P. (eds) Biorefineries: A Step Towards Renewable and Clean Energy. Clean Energy Production Technologies. Springer, Singapore. https://doi.org/10.1007/978-981-15-9593-6\_16

<u>.RIS</u> <u>↓</u> <u>.ENW</u> <u>↓</u> <u>.BIB</u> <u>↓</u>

DOI https://doi.org/10.1007/978-981-15-9593-6\_16

| Publisher Name | Print ISBN  |
|----------------|-------------|
| Springer,      | 978-981-15- |
| Singapore      | 9592-9      |
|                | Springer,   |

Online ISBN eBook Packages

978-981-15- Biomedical and 9593-6 Life Sciences Biomedical and

Life Sciences (R0)

Not logged in - 202.65.141.230 AICTE Electrical & Electronics & Computer Science Engineering (3000684219) - CBIT-Library & Information Centre Hyderabad (3000950898)

#### **SPRINGER NATURE**

© 2022 Springer Nature Switzerland AG. Part of Springer Nature.





Bio-Clean Energy Technologies: Volume 1 pp 81–112

# Role of Enzymes in Biofuel Production: Recent Developments and Challenges

Arvind Bangaru, Kamasani Aarya Sree, Chandana Kruthiventi, Meenakshi Banala, Vadapalli Shreya, Y. Vineetha, A. Shalini, Bishwambhar Mishra, Rajasri Yadavalli, K. Chandrasekhar & C. Nagendranatha Reddy 🖂

Chapter | First Online: 31 May 2022

178 Accesses

Part of the <u>Clean Energy Production Technologies</u> book series (CEPT)

# Abstract

The increasing interest in the production of renewable and clean fuel has led to various costeffective and efficient strategies with minimal impact on the environment. One such strategy of producing biofuels using enzyme-mediated catalysis has gained much attention globally. This chapter aims at improving the overall yield in a less energy-intensive and more environmentally friendly way compared to its production by conventional processes. The production of various clean fuels, various enzymes used so far for biohydrogen and biodiesel production, the significance of immobilization and improving the biofuel efficiency by identifying novel enzymes through metagenomic approach and enhancing the enzyme/metabolite production, and various obstacles faced and future perspectives have been elaborated in this chapter.

#### Keywords

Enzymes Biofuel Novel enzymes

Biohydrogen Biodiesel Immobilization

This is a preview of subscription content, <u>access via</u> <u>your institution</u>.

| Hardcover Book  | EUR                       | 179.99                  |
|---|---------------------------|-------------------------|
| eBook   | EUR                       | 149.79                  |
| Buy Chapter   |                           |                         |
| <ul> <li>Own it forever</li> <li>Exclusive offer for individuals only</li> <li>Tax calculation will be finalised durin</li> </ul>                     | g checkout                |                         |
| <ul> <li>DOI: 10.1007/978-981-16-8090-8_4</li> <li>Chapter length: 32 pages</li> <li>Instant PDF download</li> <li>Readable on all devices</li> </ul> |                           |                         |
| r Chapter   | EUR<br>Price includes VAT | <b>29.95</b><br>(India) |

Learn about institutional subscriptions

#### References

Ajita S, Pandurangappa T, Murthy K (2014) α-Amylase production and applications: a review. J Appl Environ Microbiol 2(4):166–175. <u>https://doi.org/10.12691/jaem-2-4-10</u>

AL-Darkazali H, Meevootisom V, Isarangkul D, Wiyakrutta S (2017) Gene expression and molecular characterization of a xylanase from chicken cecum metagenome. Int J Microbiol 2017:4018398.

https://www.hindawi.com/journals/ijmicro/2017/40 18398/

Amore A, Giacobbe S, Faraco V (2013) Regulation of cellulase and hemicellulase gene expression in fungi. Curr Genomics 14(4):230–249

Ariffin H, Hassan MA, Shah UK, Abdullah N, Ghazali FM, Shirai Y (2008) Production of bacterial endoglucanase from pretreated oil palm empty fruit bunch by *Bacillus pumilus* EB3. J Biosci Bioeng 106(3):231–236

Auer L, Lazuka A, Sillam-Dussès D et al (2017) Uncovering the potential of termite gut microbiome for lignocellulose bioconversion in anaerobic batch bioreactors. Front Microbiol 8:2623

Ausec L, Berini F, Casciello C et al (2017) The first

acidobacterial laccase-like multicopper oxidase revealed by metagenomics shows high salt and thermo-tolerance. Appl Microbiol Biotechnol 101(15):6261–6276

Azwar MY, Hussain MA, Abdul-Wahab AK (2014) Development of biohydrogen production by photobiological, fermentation and electrochemical processes: a review. Renew Sust Energ Rev 31:158– 173

Badgujar KC, Bhanage BM (2014) Enhanced biocatalytic activity of lipase immobilized on biodegradable copolymer of chitosan and polyvinyl alcohol support for synthesis of propionate ester: kinetic approach. Indust Eng Chem Res 53:18806–18815

Basotra N, Joshi S, Satyanarayana T et al (2018) Expression of catalytically efficient xylanases from thermophilic fungus *Malbranchea cinnamomea* for synergistically enhancing hydrolysis of lignocellulosics. Int J Biol Macromol 108:185–192

Beg QK, Kapoor M, Mahajan L, Hoondal GS (2001) Microbial xylanases and their industrial applications: a review. Appl Microbiol Biotechnol 56:326–338

Bhari R, Singh R (2017) Novel enzymes in biofuel

production. In: Biofuels: production and future perspectives. CRC Press, Boca Raton, pp 461–490

Bogani L, Wernsdorfer W (2008) Molecular spintronics using single-molecule magnets. Nat Mater 7:179–186

Bugg TDH, Ahmad M, Hardiman EM, Rahmanpour R (2011) Pathways for degradation of lignin in bacteria and fungi. Nat Prod Rep 28:1883–1896. <u>https://doi.org/10.1039/C1NP00042J</u>

Bunker CE, Smith MJ (2011) Nanoparticles for hydrogen generation. J Mat Chem 21(121):73–80

Cacicedo ML, Manzo RM, Municoy S, Bonazza HL, Islan GA, Desimone M, Bellino M, Mammarella EJ, Castro GR (2019) Chapter 7: Immobilized enzymes and their applications. In: Advances in enzyme technology biomass, biofuels, biochemicals. Elsevier, Amsterdam, pp 169–200

Chowdhary P, Raj A (2020) Contaminants and clean technologies. CRC Press, Boca Raton, FL

Chowdhary P, Raj A, Verma D, Yusuf A (2020) Microorganisms for sustainable environment and health. Elsevier, Amsterdam

Daniel KM, Piotr OP, Simmons BA, Blanch HW

(2012) The challenge of enzyme cost in the production of lignocellulosic, biofuels. Biotechnol Bioeng 109:1083–1087

Datta A, Hossain A, Roy S (2019) An overview on biofuels and their advantages and disadvantages. Asian J Chem 31:8. <u>https://doi.org/10.14233/ajchem.2019.22098</u>

De Andrades D, Graebin NG, Ayub MAZ, Fernandez-Lafuente R, Rodrigues RC (2019) Physicochemical properties, kinetic parameters, and glucose inhibition of several betaglucosidases for industrial applications. Process Biochem 78:008.

https://doi.org/10.1016/j.procbio.2019.01.008

Domsalla A, Melzig M (2008) Occurrence and properties of proteases in plant latices. Planta Med 74(07):699–711

Fang H, Xia L (2013) High activity cellulase production by recombinant *Trichoderma reesei* ZU-02 with the enhanced cellobiohydrolase production. Bioresour Technol 144:693–697

Maria Manuela Camino Feltes, Débora de Oliveira, Jorge Luiz Ninow and José Vladimir de Oliveira (2011) An overview of enzyme-catalyzed reactions and alternative feedstock for biodiesel production, Alternative fuel, Maximino Manzanera, IntechOpen, London DOI: <u>https://doi.org/10.5772/24057</u>

Ferrer M, Ghazi A, Beloqui A et al (2012) Functional metagenomics unveils a multifunctional Glycosyl hydrolase from the family 43 catalysing the breakdown of plant polymers in the calf rumen. PLoS One 7(6):e38134

Fonseca LM, Parreiras LS, Murakami MT (2020) Rational engineering of the *Trichoderma reesei* RUT-C30 strain into an industrially relevant platform for cellulase production. Biotechnol Biofuels 13(1):93

Garg S (2016) Xylanase: applications in biofuel production. Curr Metabolomics 4(1):23–37. <u>https://doi.org/10.2174/2213235x03666150915211</u> 224

Garvey M, Klose H, Fischer R, Lambertz C, Commandeur U (2013) Cellulases for biomass degradation: comparing recombinant cellulase expression platforms. Trends Biotechnol 31(10):581–593

Ghadi A, Tabandeh F, Mahjoub S, Mohsenifar A, Roshan FT, Alavije RS (2015) Fabrication and characterization of core-shell magnetic chitosan nanoparticles as a novel carrier for immobilization Haas MJ (1997) Patent No:5697986

Haslam RP, Hamilton ML, Economou CK et al (2020) Overexpression of an endogenous type 2 diacylglycerol acyltransferase in the marine diatom *Phaeodactylum tricornutum* enhances lipid production and omega-3 long-chain polyunsaturated fatty acid content. Biotechnol Biofuels 13(1):87

Hirayama K, Watanabe H, Tokuda G et al (2010) Purification and characterization of termite endogenous beta-1,4-endoglucanases produced in *Aspergillus oryzae*. Biosci Biotechnol Biochem 74(8):1680–1686

Horn SJ, Vaaje-Kolstad G, Westereng B, Eijsink VGH (2012) Novel enzymes for the degradation of cellulose. Biotechnol Biofuels 5:45. <u>https://doi.org/10.1186/1754-6834-5-45</u>

Huo YX, Cho KM, Rivera JGL, Monte E, Shen CR, Yan Y et al (2011) Conversion of proteins into biofuels by engineering nitrogen flux. Nat Biotechnol 29:346–351 characterization of cellulase-producing bacteria from sugar industry waste. Am J Bio Sci 7(1):16–24

Ivanova V, Petrova P, Hristov J (2011) Application in the ethanol fermentation of immobilized yeast cells in matrix of alginate/magnetic nanoparticles, on chitosan-magnetite microparticles and cellulose-coated magnetic nanoparticles. Int Rev Chem Eng 3:289–299

Jahirul MI, Rasul MG, Chowdhury AA, Ashwath N (2012) Biofuels production through biomass pyrolysis—a technological review. Energies 5(12):4952–5001

Jayanath G, Mohandas SP, Kachiprath B et al (2018) A novel solvent tolerant esterase of GDSGG motif subfamily from solar saltern through metagenomic approach: recombinant expression and characterization. Int J Biol Macromol 119:393– 401

Jouanin L, Lapierre C (2012) Lignins: biosynthesis, biodegradation and bioengineering (Volume 61) (advances in botanical research, Volume 61). Academic Press, London, p 491

Jünemann S, Kleinbölting N, Jaenicke S et al (2017) Bioinformatics for NGS-based metagenomics and Juturu V, Wu JC (2014) Microbial cellulases: engineering, production and applications. Renew Sustain Energy Rev 33:188203.

https://doi.org/10.1016/j.rser.2014.01.077

Kasana RC (2010) Proteases from psychrotrophs: an overview. Crit Rev Microbiol 36:134–145

Khan N, Chowdhary P, Ahmad A, Giri BS, Chaturvedi P (2020) Hydrothermal liquefaction of rice husk and cow dung in mixed-bed-rotating Pyrolyzer and application of biochar for dye removal. Bioresour Technol 309:123294

Khan N, Chowdhary P, Gnansounou E, Chaturvedi P (2021) Biochar and environmental sustainability: emerging trends and techno-economic perspectives. Bioresour Technol 332:125102

Khoo KS, Chia WY, Tang DYY, Show PL, Chew KW, Chen W-H (2020) Nanomaterials utilization in biomass for biofuel and bioenergy production. Crit Rev Biotechnol Energies 13:892

Khoshnevisana K, Vakhshitehc F, Barkhid M, Baharifare H, Akbarf EP, Zari N et al (2017) Immobilization of cellulase enzyme onto magnetic nanoparticles: applications and recent advances.

Elsevier, Amsterdam

Lamberti M, Zappavigna S, Sannolo N, Porto S, Caraglia M (2014) Advantages and risks of nanotechnologies in cancer patients and occupationally exposed workers. Expert Opin Drug Deliv 11:1087–1101

Lee S, Speight JG, Loyalka SK (2007) Handbook of alternative fuel technologies. CRC, Taylor & Francis Group, Boca Raton, FL

Leong W-H, Lim J-W, Lam M-K et al (2018) Third generation biofuels: a nutritional perspective in enhancing microbial lipid production. Renew Sust Energ Rev 91:950–961

Levin D (2004) Biohydrogen production: prospects and limitations to practical application. Int J Hydrog Energy 29(2):173–185.

https://doi.org/10.1016/s0360-3199(03)00094-6

Li X, Guo J, Hu Y et al (2019a) Identification of a novel feruloyl esterase by functional screening of a soil metagenomic library. Appl Biochem Biotechnol 187(1):424–437

Li Z, Li X, Liu T et al (2019b) The critical roles of exposed surface residues for the thermostability and halotolerance of a novel GH11 xylanase from the metagenomic library of a saline-alkaline soil. Int J Biol Macromol 133:316–323

Li H, Zhang L, Shu L et al (2015) Sustainable photosynthetic H2-production mediated by artificial miRNA silencing of OEE2 gene in green alga *Chlamydomonas reinhardtii*. Int J Hydrog Energy 40(16):5609–5616

Lin R, Cheng J, Ding L, Song W, Liu M, Zhou J et al (2016) Enhanced dark hydrogen fermentation by addition of ferric oxide nanoparticles using *Enterobacter aerogenes*. Bioresour Technol 207:213–219

Linde M, Galbe M, Zacchi G (2007) Simultaneous saccharification and fermentation of steampretreated barley straw at low enzyme loadings and low yeast concentration. Enzym Microb Technol 40:1100–1107

Liu YS, Baker JO, Zeng Y, Himmel ME, Haas T, Ding SY (2011b) Cellobiohydrolase hydrolyzes crystalline cellulose on hydrophobic faces. J Biol Chem 286(13):11195–11201

Liu N, Yan X, Zhang M et al (2011a) Microbiome of fungus-growing termites: a new reservoir for

Lignocellulase genes. Appl Environ Microbiol 77(1):48–56

Liu B, Zhang H, Xue W, Qi Z, Tian Z, Tai Q (2010) Preparation of alginate/chitosan microcapsule with lipase immobilization. Chem Indust Eng Prog 9:1541

Matsuzawa T, Yaoi K (2017) Screening, identification, and characterization of a novel saccharide-stimulated β-glycosidase from a soil metagenomic library. Appl Microbiol Biotechnol 101(2):633–646

Mattéotti C, Bauwens J, Brasseur C et al (2012) Identification and characterization of a new xylanase from gram-positive bacteria isolated from termite gut (*Reticulitermes santonensis*). Protein Expr Purif 83(2):117–127

Mohanraj S, Anbalagan K, Rajaguru P, Pugalenthi V (2016) Effects of phytogenic copper nanoparticles on fermentative hydrogen production by Enterobacter cloacae and *Clostridium acetobutylicum*. Int J Hydrog Energy 41:10639– 10645

Morra S, Valetti F, Gilardi G (2017) [FeFe]hydrogenases as biocatalysts in bio-hydrogen production. Rend Fis. Acc Lincei 28:183–194. https://doi.org/10.1007/s12210-016-0584-9

Muhammad J, Buthe A, Rashid M, Wang P (2016) Cost-efficient entrapment of b-glucosidase in nanoscale latex and silicone polymeric thin films for use as stable biocatalysts. Food Chem 190:1078–1085.

https://doi.org/10.1016/j.foodchem.2015.06.040

Munarin F, Tanzi MC, Petrini P (2013) Corrigendum to 'advances in biomedical applications of pectin gels'. Int J Biol Macromol 55:307

Narra M, Dixit G, Divecha J, Kumar K, Madamwar D, Shah AR (2014) Production, purification and characterization of a novel GH 12 family endoglucanase from *Aspergillus terreus* and its application in enzymatic degradation of delignified rice straw. Int Biodeterioration Biodegrad 88:150– 161

Neha S, Manish S, MishrabVijai PK, Guptad K, Molina G, Rodriguez-Couto S, AmbepuManikantab PWR (2018) Applications of fungal cellulases in biofuel production: advances and limitations. Renew Sust Energ Rev 82:2379–2386

Neha S, Mishra PK, Upadhyay SN (2020a) 1 significance of lignocellulosic biomass waste in the biofuel production process. In: Industrial enzymes for biofuels production recent updates and future trends. Springer, New York, pp 1–18

Neha S, Mishra PK, Upadhyay SN (2020b) 7 laccase: use in removal of lignin in cellulosic biomass. In: Industrial enzymes for biofuels production recent updates and future trends. Springer, New York, pp 133–157

Nevena L, Zorica K-J, Dejan B (2011) Biodiesel fuel production by enzymatic transesterification of oils: recent trends. In: Challenges and future perspectives, alternative fuel, maximino manzanera. IntechOpen, London. <u>https://doi.org/10.5772/21905</u>

Ni J, Tokuda G, Takehara M, Watanabe H (2007) Heterologous expression and enzymatic characterization of β-glucosidase from the drywood-eating termite, *Neotermes koshunensis*. Appl Entomol Zool 42(3):457–463

Nizami AS, Rehan M (2018) Towards nanotechnology-based biofuel industry. Biofuel Res J 5:798–799

Noone S, Ratcliff K, Davis R et al (2017) Expression of a clostridial [FeFe]-hydrogenase in *Chlamydomonas reinhardtii* prolongs photoproduction of hydrogen from water splitting. Algal Res 22:116–121

Oh Y-K, Raj SM, Jung GY, Park S (2011) Current status of the metabolic engineering of microorganisms for biohydrogen production. Bioresour Technol 102(18):8357–8367. https://doi.org/10.1016/j.biortech.2011.04.054

Ohkuma M (2003) Termite symbiotic systems: efficient bio-recycling of lignocellulose. Appl Microbiol Biotechnol 61(1):1–9

Østergaard LH, Olsen HS (2011) Industrial applications of fungal enzymes. In: Hofrichter M (ed) Industrial applications. Springer, Berlin, Heidelberg, pp 269–290

Paritosh K, Kushwaha SK, Yadav M, Pareek N, Chawade A, Vivekanand V (2017) Food waste to energy: an overview of sustainable approaches for food waste management and nutrient recycling. Biomed Res Int 2017:2370927

Patil NP, Chaudhari BL (2010) Production and purification of pectinase by soil isolate *Penicillium* sp. and search for better agro-residue for its SSF. Recent Res Sci Technol 2(7):36–42

Patel SKS, Kalia VC (2012) Integrative biological

hydrogen production: an overview. Indian J Microbiol 53:3–10

Peña L, Hohn K, Li J, Sun X, Wang D (2014) Synthesis of propyl-sulfonic acid-functionalized nanoparticles as catalysts for cellobiose hydrolysis. J Biomater Nanobiotechnol 5:241

Prajapati AS, Panchal KJ, Pawar VA, Noronha MJ, Patel DH, Subramanian RB (2018) Review on Cellulase and xylanase engineering for biofuel production. Ind Biotechnol 14:1

Ramnath L, Sithole B, Govinden R (2017) Classification of lipolytic enzymes and their biotechnological applications in the pulping industry. Can J Microbiol 63(3):179–192

Ranganathan S, Narasimhan S, Muthukumar K (2008) An overview of enzymatic production of biodiesel. Bioresour Technol 99:3975–3981. <u>https://doi.org/10.1016/j.biortech.2007.04.060</u>

Rantasalo A, Vitikainen M, Paasikallio T et al (2019) Novel genetic tools that enable highly pure protein production in *Trichoderma reesei*. Sci Rep 9(1):5032

Rodionova MV et al (2016) Biofuel production: challenges and opportunities. Int J Hydr Energ

#### 42(12):125.

https://doi.org/10.1016/j.ijhydene.2016.11.125

Runguphan W, Keasling JD (2014) Metabolic engineering of Saccharomyces cerevisiae for production of fatty acid-derived biofuels and chemicals. Metab Eng 21:103–113

Sadhu S, Maiti TK (2013) Cellulase production by bacteria: a review. Br Microbiol Res J 3(3):235–258

Sakthiselvan P, Naveena B, Partha N (2015) Molecular characterization of a Xylanaseproducing fungus isolated from fouled soil. Braz J Microbiol 45(4):1293–1302. Published 2015 Mar 4

Sánchez MM, Pastor FJ, Diaz P (2003) Exo-mode of action of cellobiohydrolase Cel48C from *Paenibacillus* sp. BP-23: a unique type of cellulase among *Bacillales*. Eur J Biochem 270(13):2913– 2919

Satenik M, Pablo Maria R-P, Maria Dolores C, Armen T, Karen T (2017) Evidence for hydrogenase-4 catalyzed biohydrogen production in *Escherichia coli*. Int J Hydrog Energy 42(34):21697–21703., ISSN 0360-3199. https://doi.org/10.1016/j.ijhydene

Savla N, Shinde A, Sonawane K, Mekuto L,

Chowdhary P, Pandit S (2020) Microbial hydrogen production: fundamentals to application. Microorgan Sustain Environ Health 21:343

Sevil Y, Pınar T, Didem Ö (2012) Lipase applications in biodiesel production. In: Fang Z (ed) Biodiesel feedstocks, production and applications. IntechOpen, London.

https://doi.org/10.5772/52662

Show KY, Lee DJ, Chang JS (2011) Bioreactor and process design for biohydrogen production. Bioresour Technol 102:8524e33

Show KY, Lee DJ, Tay JH, Lin CY, Chang JS (2012) Biohydrogen production: current perspectives and the way forward. Int J Hydrog Energy 37(20):15616–15631.

https://doi.org/10.1016/j.ijhydene.2012.04.109

Shweta A (2014) Cellulases of bacterial origin and their applications: a review. Int J Sci Res (IJSR) 358:2319–7064

Simon C, Daniel R (2009) Achievements and new knowledge unraveled by metagenomic approaches. Appl Microbiol Biotechnol 85(2):265– 276

Singh J, Behal A, Singla N et al (2009)

Metagenomics: concept, methodology, ecological inference and recent advances. Biotechnol J 4(4):480–494

Sivagurunathan P, Kadier A, Mudhoo A, Kumar G, Chandrasekhar K, Kobayashi T, Xu K (2018) Nanomaterials for biohydrogen production. In: Nanomaterials: biomedical, environmental, and engineering applications. John Wiley & Sons, New York, pp 217–238

Song Y, Kong W, Song H, Hua S, Xia C (2012) Preparation of magnetic chitosan microspheres and their application to immobilization of formate dehydrogenase. Indust Catal 8:5

Srivastava N, Mishra PK, Upadhyay SN (2020a) Microbial cellulase production. In: Industrial enzymes for biofuels production, pp 19–35. <u>https://doi.org/10.1016/B978-0-12-821010-</u> <u>9.00002-4</u>

Srivastava N, Mishra PK, Upadhyay SN (2020b) Laccase: use in removal of lignin in cellulosic biomass. In: Industrial enzymes for biofuels production, pp 133–157, doi: <u>https://doi.org/10.1016/B978-0-12-821010-</u> <u>9.00007-3</u>

Srivastava N, Mishra PK, Upadhyay SN (2020c) Pectinases: significance in the digestion of pectinrich agrowaste. In: Industrial enzymes for biofuels production, pp 183–204, doi: <u>https://doi.org/10.1016/B978-0-12-821010-</u> <u>9.00009-7</u>

Srivastava N, Mishra PK, Upadhyay SN (2020d) Xylanases: for digestion of hemicellulose. In: Industrial enzymes for biofuels production, doi: <u>https://doi.org/10.1016/B978-0-12-821010-</u> <u>9.00006-1</u>

Srivastava N, Mishra PK, Upadhyay SN (2020e) Cellobiohydrolase: role in cellulosic bioconversion. In: Industrial enzymes for biofuels production, pp 63–79, <u>https://doi.org/10.1016/B978-0-12-821010-</u> 9.00004-8

Srivastava N, Mishra PK, Upadhyay SN (2020f) Endoglucanase: revealing participation in open cellulosic chains. In: Industrial enzymes for biofuels production, pp 37–62. <u>https://doi.org/10.1016/B978-0-12-821010-</u>

<u>9.00003-6</u>

Srivastava N, Rawat R, Oberoi HS, Pramod W (2015b) A review on fuel ethanol production from lignocellulosic biomass a review on fuel ethanol production from lignocellulosic biomass. Int J Green Energy 12(9):949–960

Srivastava G, Roy S, Kayastha AM (2015c)

Immobilisation of fenugreek β-amylase on chitosan/PVP blend and chitosan coated PVC beads: a comparative study. Food Chem 172:844– 851

Srivastava N, Srivastava M, Mishra PK, Singh P (2015a) Application of cellulases in biofuels industries: an overview. J Biofuels Bioenergy 1(1):55–63

Sulaiman A-Z, Ramachandran KB, Farid M, KheireddineAroua M, Vadlani P, Ramakrishnan S, Gardossi L (2011) Enzymes in biofuels production. Enzyme Res 2011:658263. 2 pages. <u>https://doi.org/10.4061/2011/658263</u>

Tang L, Xia Y, Wu X et al (2017) Screening and characterization of a novel thermostable lipase with detergent-additive potential from the metagenomic library of a mangrove soil. Gene 625:64–71

Ueno Y, Fukui H, Goto M (2007) Operation of a two-stage fermentation process producing hydrogen and methane from organic waste. Environ Sci Technol 41:1413e9

Underlin EN, Frommhagen M, Dilokpimol A et al (2020) Feruloyl esterases for biorefineries: subfamily classified specificity for natural substrates. Front Bioeng Biotechnol 8:332

Vester JK, Glaring MA, Stougaard P (2015) An exceptionally cold-adapted alpha-amylase from a metagenomic library of a cold and alkaline environment. Appl Microbiol Biotechnol 99(2):717– 727

Vieira DC, Lima LN, Mendes AA, Adriano WS, Giordano RC, Giordano RLC et al (2013) Hydrolysis of lactose in whole milk catalyzed by βgalactosidase from *Kluyveromyces fragilis* immobilized on chitosan-based matrix. Biochem Eng J 81:54–64

Villalba LL, Fonseca MI, Giorgio M, Zapata PD (2010) White rot fungi laccases for biotechnological applications. Recent Pat DNA Gene Seq 4(2):106–112.

https://doi.org/10.2174/187221510793205728

Visioli LJ, Enzweiler H, Kuhn RC, Schwaab M, Mazutti MA (2014) Recent advances on biobutanol production. Sustain Chem Process 2:15

Wang C, Chen X, Li H et al (2017b) Artificial miRNA inhibition of phosphoenolpyruvate carboxylase increases fatty acid production in a green microalga *Chlamydomonas reinhardtii*. Biotechnol Biofuels 10(1):91

Wang H, Hart DJ, An Y (2019) Functional metagenomic technologies for the discovery of novel enzymes for biomass degradation and biofuel production. Bioenergy Res 12(3):457–470

Wang M, Li Z, Fang X, Wang L, Qu Y (2012a) Cellulolytic enzyme production and enzymatic hydrolysis for second-generation bioethanol production. In: Biotechnology in China III: Biofuels and bioenergy. Springer, Berlin, Heidelberg, pp 1– 24

Wang Z, Liu J, Ning Y, Liao X, Jia Y (2017a) Eichhornia crassipes: agro-waster for a novel thermostable laccase production by *Pycnoporus sanguineus* SYBC-L1. J Biosci Bioeng 123(2):163– 169. <u>https://doi.org/10.1016/j.jbiosc.2016.09.005</u>

Wang Q, Qian C, Zhang X-Z et al (2012b) Characterization of a novel thermostable  $\beta$ glucosidase from a metagenomic library of termite gut. Enzyme Microb Technol 51(6–7):319–324

Xu B, Yang F, Xiong C et al (2014) Cloning and characterization of a novel α-amylase from a fecal microbial metagenome. J Microbiol Biotechnol 24(4):447–452 Yang C, Xia Y, Qu H et al (2016) Discovery of new cellulases from the metagenome by a metagenomics-guided strategy. Biotechnol Biofuels 9(1):138

Zhang D, Lax AR, Bland JM, Allen AB (2011) Characterization of a new endogenous endoβ-1,4-glucanase of Formosan subterranean termite (*Coptotermes formosanus*). Insect Biochem Mol Biol 41(4):211–218

Zhao C, Denga L, Fang H (2018) Mixed culture of recombinant *Trichoderma reesei* and *Aspergillus niger* for cellulase production to increase the cellulose degrading capability. Biomass Bioenergy 112:93–98.

https://doi.org/10.1016/j.biombioe.2018.03.001

Zuliani A, Ivars F, Luque R (2018) Advances in nanocatalyst design for biofuel production. Chem Cat Chem 10(9):1968–1981

# Author information

Arvind Bangaru, Kamasani Aarya Sree and Chandana Kruthiventi contributed equally with all other contributors.

Authors and Affiliations

Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad,

#### Telangana, India

Arvind Bangaru, Kamasani Aarya Sree, Chandana Kruthiventi, Meenakshi Banala, Vadapalli Shreya, Y. Vineetha, A. Shalini, Bishwambhar Mishra, Rajasri Yadavalli & C. Nagendranatha Reddy

Green Processing, Bioremediation and Alternative Energies Research Group, Faculty of Environment and Labour Safety, Ton Duc Thang University, Ho Chi Minh City, Vietnam

K. Chandrasekhar

Corresponding author

Correspondence to C. Nagendranatha Reddy.

Editor information

**Editors and Affiliations** 

Environmental Microbiology Laboratory, CSIR-Indian Institute of Toxicology Research, Lucknow, Uttar Pradesh, India Dr. Pankaj Chowdhary

Department of Biotechnology, Birla Institute of Technology and Science, Pilani, Dubai Campus, Dubai, United Arab Emirates Namita Khanna

Department of Life Sciences, School of Basic Sciences and Research, Sharda University, Greater Noida, India Soumya Pandit

Department of Microbiology, Babasaheb Bhimrao Ambedkar University, Lucknow, Uttar

### Pradesh, India

Rajesh Kumar

# Rights and permissions

**Reprints and Permissions** 

# Copyright information

© 2022 The Author(s), under exclusive license to Springer Nature Singapore Pte Ltd.

# About this chapter

#### Cite this chapter

Bangaru, A. *et al.* (2022). Role of Enzymes in Biofuel Production: Recent Developments and Challenges. In: Chowdhary, P., Khanna, N., Pandit, S., Kumar, R. (eds) Bio-Clean Energy Technologies: Volume 1. Clean Energy Production Technologies. Springer, Singapore. https://doi.org/10.1007/978-981-16-8090-8\_4

#### <u>.RIS</u> <u>↓</u> <u>.ENW</u> <u>↓</u> <u>.BIB</u> <u>↓</u>

#### DOI

https://doi.org/10.1007/978-981-16-8090-8\_4

| Published   | Publisher Name       | Print ISBN  |
|-------------|----------------------|-------------|
| 31 May 2022 | Springer,            | 978-981-16- |
|             | Singapore            | 8089-2      |
|             |                      |             |
| Online ISBN | eBook Packages       |             |
| 978-981-16- | Earth and            |             |
| 8090-8      | <b>Environmental</b> |             |
|             | <u>Science</u>       |             |
|             | Earth and            |             |
|             | <u>Environmental</u> |             |

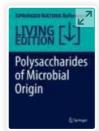
Not logged in - 202.65.141.230

AICTE Electrical & Electronics & Computer Science Engineering (3000684219) - CBIT-Library & Information Centre Hyderabad (3000950898)

#### **SPRINGER NATURE**

© 2022 Springer Nature Switzerland AG. Part of Springer Nature.





Polysaccharides of Microbial Origin pp 1–32

# An Insight into Pullulan and Its Potential Applications

<u>C. Nagendranatha Reddy</u>, <u>Bishwambhar Mishra</u>, <u>Sanjeeb</u> <u>Kumar Mandal</u>, <u>Dinesh Chand Agrawal</u> & <u>Chandana</u> <u>Kruthiventi</u>

Living reference work entry First Online: 10 October 2021

68 Accesses

## Abstract

Pullulan is the one of the most potent biocompatible polymer, which is basically synthesized by the *Aureobasidium pullulans*. This polymer appears to be a linear  $\alpha$ -glucan of maltotriose units with occasional branching of glucosyl or maltosyl substitution. The employment and application of pullulan in biomedical and tissue engineering field is emerging owing to its biocompatible, nontoxic, non-immunogenic, and inert nature. It can be derivatized via various chemical reactions to increase its utility in the field of pharmaceuticals. In addition, pullulan and its derivatives have photographic, lithographic, and electronic applications in the biomedical instrumentation. This chapter provides comprehensive information about "pullulan" considering its microbial sources, biosynthesis aspects, characterization, and functionalization. It also highlights the various applications of pullulan and its derivatives in the pharmaceutical and biomedical fields.

Keywords

Polysaccharide Pullulan

Aureobasidium pullulans

Surface modification Application

This is a preview of subscription content, <u>access via</u> <u>your institution</u>.

#### References

Bender H, Lehmann J, Wallenfels K. Pullulan, ein extracelluläres Glucan von Pullularia pullulans. Biochim Biophys Acta. 1959;36:309–16. https://doi.org/10.1016/0006-3002(59)90172-6.

Chen J, Wu S, Pan S. Optimization of medium for pullulan production using a novel strain of *Auerobasidium pullulans* isolated from sea mud through response surface methodology. Carbohydr Polym. 2012;87:771–4. <u>https://doi.org/10.1016/j.carbpol.2011.08.062</u>. Chen L, Wang X, Ji F, Bao Y, Wang J, Wang X, Guo L, Li Y. New bifunctional-pullulan-based micelles with good biocompatibility for efficient co-delivery of cancer-suppressing p53 gene and doxorubicin to cancer cells. RSC Adv. 2015;5:94719–31.

Chen L, Qian M, Zhang L, Xia J, Bao Y, Wang J, Guo L, Li Y. Co-delivery of doxorubicin and shRNA of Beclin1 by folate receptor targeted pullulan-based multifunctional nanomicelles for combinational cancer therapy. RSC Adv. 2018;8:17710–22.

Cheng KC, Catchmark JM, Demirci A. Enhanced pullulan production in a biofilm reactor by using response surface methodology. J Ind Microbiol Biotechnol. 2010;37:587–94. https://doi.org/10.13031/2013.29694.

Chi Z, Wang F, Chi Z, Yue L, Liu G, Zhang T. Bioproducts from Aureobasidium pullulans, a biotechnologically important yeast. Appl Microbiol Biotechnol. 2009;82:793–804. https://doi.org/10.1007/s00253-009-1882-2.

Choudhury AR, Saluja P, Prasad G. Pullulan production by an osmotolerant Aureobasidium pullulans RBF-4A3 isolated from flowers of Caesulia axillaris. Carbohydr Polym. 2011;83:1547– 52. <u>https://doi.org/10.1016/j.carbpol.2010.10.003</u>. Constantin M, Bucătariu S, Stoica I, Fundueanu G. Smart nanoparticles based on pullulan-g-poly (Nisopropylacrylamide) for controlled delivery of indomethacin. Int J Biol Macromol. 2017;94:698– 708.

https://doi.org/10.1016/j.ijbiomac.2016.10.064.

Dailin DJ, Low LZMI, Kumar K, Malek RA, Natasya KH, Keat HC, Sukmawati D, Enshasy HE. Agroindustrial waste: a potential feedstock for pullulan production. Biosci Biotechnol Res Asia. 2019;16:229–50.

https://doi.org/10.13005/bbra/2740.

Dubey KK. Insights of microbial pullulan production: a bioprocess engineer assessment. Current Biotechnol. 2018;7:262–72.

Eslaminejad T, Nematollahi-Mahani SN, Ansari M. Synthesis, characterization, and cytotoxicity of the plasmid EGFP-p53 loaded on pullulan–spermine magnetic nanoparticles. J Magn Magn Mater. 2016;402:34–43.

Fujioka-Kobayashi M, Ota MS, Shimoda A, K-i N, Akiyoshi K, Miyamoto Y, Iseki S. Cholesteryl groupand acryloyl group-bearing pullulan nanogel to deliver BMP2 and FGF18 for bone tissue engineering. Biomaterials. 2012;33:7613–20. https://doi.org/10.1016/j.biomaterials.2012.06.075. Haifeng L, Yunyi Z, Yunyun G, Yuanyang L, Xiaopu Y, Lifeng H. Characterization of UGPase from Aureobasidium pullulans NRRLY-12974 and application in enhanced pullula production. Appl Biochem Biotechnol. 2016;178:1141–53. https://doi.org/10.1007/s12010-0151934-2.

Han Y, Lv S. Synthesis of chemically crosslinked pullulan/gelatin-based extracellular matrixmimetic gels. Int J Biol Macromol. 2019;122:1262– 70. <u>https://doi.org/10.1016/j.ijbiomac.2018.09.080</u>.

Hussain MA, Abbas K, Lodhi BA, Sher M, Ali M, Tahir MN, Tremel W, Iqbal S. Fabrication, characterization, thermal stability and nanoassemblies of novel pullulan-aspirin conjugates. Arab J Chem. 2017;10:1597–603.

Iswariya S, Bhanukeerthi A, Velswamy P, Uma T, Perumal PT. Design and development of a piscine collagen blended pullulan hydrogel for skin tissue engineering. RSC Adv. 2016;6:57863–71. https://doi.org/10.1039/c6ra03578g.

Jafari A, Sun H, Sun B, Mohamed MA, Cui H, Cheng C. Layer-by-layer preparation of polyelectrolyte multilayer nanocapsules via crystallized miniemulsions. Chem Commun. 2019;55:1267–70. https://doi.org/10.1039/c8cc08043g. Kulkarni A, Madane T, Aloorkar N, Mujumdar S. Enhancement of solubility of BCS class II drug (pioglitazone) using natural polymer (pullulan). Current Pharma Res. 2019;9:3321–34.

Lepoittevin B, Elzein T, Dragoe D, Bejjani A, Lemee F, Levillain J, Bazin P, Roger P, Dez I. Hydrophobization of chitosan films by surface grafting with fluorinated polymer brushes. Carbohydr Polym. 2019;205:437–46. https://doi.org/10.1016/j.carbpol.2018.10.044.

Leung V, Mapletoft J, Zhang A, Lee A, Vahedi F, Chew M, Szewczyk A, Jahanshahi-Anbuhi S, Ang J, Cowbrough B. Thermal stabilization of viral vaccines in low-cost sugar films. Sci Rep. 2019;9:1– 11. <u>https://doi.org/10.1038/s41598-019-44020-w</u>.

Liu J, J-i J, Kawai Y, Aoki I, Tanaka C, Yamamoto M, Tabata Y. Preparation of polymer-based multimodal imaging agent to visualize the process of bone regeneration. J Control Release. 2012;157:398–405.

https://doi.org/10.1016/j.jconrel.2011.09.090.

Mishra B, Suneetha V. Biosynthesis and hyper production of pullulan by a newly isolated strain of Aspergillus japonicus-VIT-SB1. World J Microbiol Biotechnol. 2014;30:2045–52.

https://doi.org/10.1007/s11274-014-1629-9.

Mishra B, Varjani S. Evaluation of pullulan production by a newly isolated Micrococcus luteus. Indian J Exp Biol. 2019;57:813–20.

Mishra B, Vuppu S, Rath K. The role of microbial pullulan, a biopolymer in pharmaceutical approaches: a review. J Appl Pharm Sci. 2011;01:45–50.

Mishra B, Manikanta A, Zamare D. Preparation of Maltotriose syrup from microbial pullulan by using pullulanase enzyme. Biosci Biotech Res Asia. 2016;13:481–5.

Mishra B, Zamare D, Manikanta A. Selection and utilization of agro-industrial waste for biosynthesis and hyper-production of pullulan: a review. In: Varjani S, Parameswaran B, Kumar S, Khare S, editors. Biosynthetic technology and environmental challenges. Energy, environment, and sustainability. Singapore: Springer; 2018. p. 89–103. https://doi.org/10.1007/978-981-10-7434-<u>9\_6</u>.

Morimoto N, Winnik FM, Akiyoshi K. Botryoidal assembly of cholesteryl– pullulan/poly (Nisopropylacrylamide) nanogels. Langmuir. 2007;23:217–23. https://doi.org/10.1021/la0616045. Shu CH, Lin KJ, Wen BJ. Effects of culture temperature on the production of bioactive polysaccharides by Agaricus blazei in batch cultures. J Chem Technol Biotechnol. 2007;82:831– 6. <u>https://doi.org/10.1002/jctb.1748</u>.

Singh R, Saini G. Pullulan-hyperproducing color variant strain of Aureobasidium pullulans FB-1 newly isolated from phylloplane of Ficus sp. Bioresour Technol. 2008;99:3896–9. https://doi.org/10.1016/j.biortech.2007.08.003.

Singh RS, Saini GK, Kennedy JF. Downstream processing and characterization of pullulan from a novel colour variant strain of Aureobasidium pullulans FB-1. Carbohydr Polym. 2009;78:89–94. <u>https://doi.org/10.1016/j.carbpol.2009.03.040</u>.

Singh RS, Kaur N, Kennedy JF. Pullulan production from agro-industrial waste and its applications in food industry: a review. Carbohydr Polym. 2019;217:46–57.

https://doi.org/10.1016/j.carbpol.2019.04.050.

Soto KM, Hernández-Iturriaga M, Loarca-Piña G, Luna-Bárcenas G, Mendoza S. Antimicrobial effect of nisin electrospun amaranth: pullulan nanofibers in apple juice and fresh cheese. Int J Food Microbiol. 2019;295:25–32.

https://doi.org/10.1016/j.ijfoodmicro.2019.02.001.

Spatareanu A, Bercea M, Budtova T, Harabagiu V, Sacarescu L, Coseri S. Synthesis, characterization and solution behaviour of oxidized pullulan. Carbohydr Polym. 2014;111:63–71. <u>https://doi.org/10.1016/j.carbpol.2014.04.060</u>.

Sugumaran KR, Ponnusami V. Downstream processing studies for pullulan recovery in solid state fermentation using asian palmyra palm kernelinexpensive substrate. Biotechnology. 2014;9(2):79–82.

Sugumaran K, Ponnusami V. Review on production, downstream processing and characterization of microbial pullulan. Carbohydr Polym. 2017;173:573–91. https://doi.org/10.1016/j.carbpol.2017.06.022.

Sugumaran K, Sindhu R, Sukanya S, Aiswarya N, Ponnusami V. Statistical studies on high molecular weight pullulan production in solid state fermentation using jack fruit seed. Carbohydr Polym. 2013;98:854–60.

https://doi.org/10.1016/j.carbpol.2013.06.071.

Takahata T, Okihara T, Yoshida Y, Yoshihara K, Shiozaki Y, Yoshida A, Yamane K, Watanabe N, Yoshimura M, Nakamura M. Bone engineering by phosphorylated-pullulan and β-TCP composite. Biomed Mater. 2015;10:065009. Teekamp N, Tian Y, Visser JC, Olinga P, Frijlink HW, Woerdenbag HJ, Hinrichs WL. Addition of pullulan to trehalose glasses improves the stability of βgalactosidase at high moisture conditions. Carbohydr Polym. 2017;176:374–80. https://doi.org/10.1016/j.carbpol.2017.08.084.

Thirumavalavan K, Manikkadan T, Dhanasekar R. Pullulan production from coconut by-products by *Aureobasidium pullulans*. Afr J Biotechnol. 2009;8:254–8.

Tian Y, Visser JC, Klever JS, Woerdenbag HJ, Frijlink HW, Hinrichs WL. Orodispersible films based on blends of trehalose and pullulan for protein delivery. Eur J Pharm Biopharm. 2018;133:104–11.

Tiwari S, Bahadur P. Modified hyaluronic acid based materials for biomedical applications. Int J Biol Macromol. 2019;121:556–71.

https://doi.org/10.1016/j.ijbiomac.2018.10.049.

Wang J, Cui S, Bao Y, Xing J, Hao W. Tocopheryl pullulan-based self assembling nanomicelles for anti-cancer drug delivery. Mater Sci Eng C. 2014;43:614–21.

https://doi.org/10.1016/j.msec.2014.07.066.

Wang D, Bian J, Wei G, Jiang M, Dong M. Simultaneously enhanced production and molecular weight of pullulan using a two-stage agitation speed control strategy. J Chem Technol Biotechnol. 2016;91:467–75. https://doi.org/10.1002/jctb.4600.

Xiao Q, Tong Q, Lim L-T. Pullulan-sodium alginate based edible films 2012 rheological properties of film forming solutions. Carbohydr Polym. 2012;87:1689–95.

Yu X, Wang Y, Wei G, Dong Y. Media optimization for elevated molecular weight and mass production of pigment-free pullulan. Carbohydr Polym. 2012;89:928–34.

https://doi.org/10.1016/j.carbpol.2012.04.038.

Zan Z, Zou X. Efficient production of polymalic acid from raw sweet potato hydrolysate with immobilized cells of *Aureobasidium pullulans* CCTCC M2012223 in aerobic fibrous bed bioreactor. J Chem Technol Biotechnol. 2013;88:1822–7. <u>https://doi.org/10.1002/jctb.4033</u>.

Zhou J, Mohamed Wali AR, Ma S, He Y, Yue D, Tang JZ, Gu Z. Tailoring the supramolecular structure of guanidinylated pullulan toward enhanced genetic photodynamic therapy. Biomacromolecules. 2018;19:2214–26.

# Author information

# Authors and Affiliations

Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad, Telangana, India C. Nagendranatha Reddy, Bishwambhar Mishra & Chandana Kruthiventi

Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad, Telangana, India Sanjeeb Kumar Mandal

Department of Biotechnology, Faculty of Engineering & Technology, Rama University, Kanpur, Uttar Pradesh, India Dinesh Chand Agrawal

Editor information

**Editors and Affiliations** 

**3Bs Research Grp, Zona Indus da Gan, University of Minho, BARCO GMR, Portugal** Joaquim Oliveira

**3Bs Research Grp, Zona Indus da Gan, University of Minho, BARCO GMR, Portugal** Dr. Hajer Radhouani

**3Bs Research Grp, Zona Indus da Gan, University of Minho, BARCO GMR, Portugal** Prof. Rui L. Reis

Rights and permissions

# Copyright information

© 2021 Springer Nature Switzerland AG

# About this entry

# Cite this entry

Reddy, C.N., Mishra, B., Mandal, S.K., Agrawal, D.C., Kruthiventi, C. (2021). An Insight into Pullulan and Its Potential Applications. In: Oliveira, J., Radhouani, H., Reis, R.L. (eds) Polysaccharides of Microbial Origin. Springer, Cham. https://doi.org/10.1007/978-3-030-35734-4\_15-1

# <u>.RIS</u> <u>↓</u> <u>.ENW</u> <u>↓</u> <u>.BIB</u> <u>↓</u>

# DOI

https://doi.org/10.1007/978-3-030-35734-4\_15-1

| Received        | Accepted    | Published       |
|-----------------|-------------|-----------------|
| 15 October 2020 | 17 November | 10 October 2021 |
|                 | 2020        |                 |
|                 |             |                 |
| Publisher Name  | Print ISBN  | Online ISBN     |
| Springer, Cham  | 978-3-030-  | 978-3-030-      |
|                 | 35734-4     | 35734-4         |
|                 |             |                 |
| eBook Packages  |             |                 |
|                 |             |                 |

Springer Reference

Biomedicine & Life

Sciences

**Reference Module** 

Biomedical and

Life Sciences

Not logged in - 202.65.141.230

AICTE Electrical & Electronics & Computer Science Engineering (3000684219) - CBIT-Library & Information Centre Hyderabad (3000950898)

# **SPRINGER NATURE**

© 2022 Springer Nature Switzerland AG. Part of Springer Nature.



CENTRAL FORENSIC SCIENCE LABORATORY DIRECTORATE OF FORENSIC SCIENCE SERVICES MINISTRY OF HOME AFFAIRS, GOVT. OF INDIA RAMANTHAPUR, HYDERABAD- 500013.

# **CERTIFICATE**

This is to certify that Ms. Chunduru Sai Hari Hara Sudheshna (Roll No. 1601-20-805-008), student of B. Tech. (Biotechnology), 'Chaitanya Bharathi Institute of Technology', Gandipet, Hyderabad, Telangana was provided training in "Examination of body fluids by Chemical and Immunological techniques, DNA extraction from body fluids, Gel electrophoresis, and was also introduced to PCR amplification and fragment analysis by Genetic Analyzer" under the supervision and guidance of Ms. Sadhna Sahu, Senior Scientific Assistant, Biology and DNA Division, CFSL, Hyderabad, from 06/09/2021 to 24/09/2021

(3 weeks) as part of their internship.

Sadhuseaky

Ms. Sadhna Sahu Senior Scientific Assistant (BIOLOGY & DNA) CFSL, HYDERABAD Dr. Rajiv Giroti Head of Division (BIOLOGY & DNA) CFSL, HYDERABAD

Mr. M. C. Joshi DIRECTOR CFSL, HYDERABAD





21.10.2021

# TO WHOM SO EVER IT MAY CONCERN

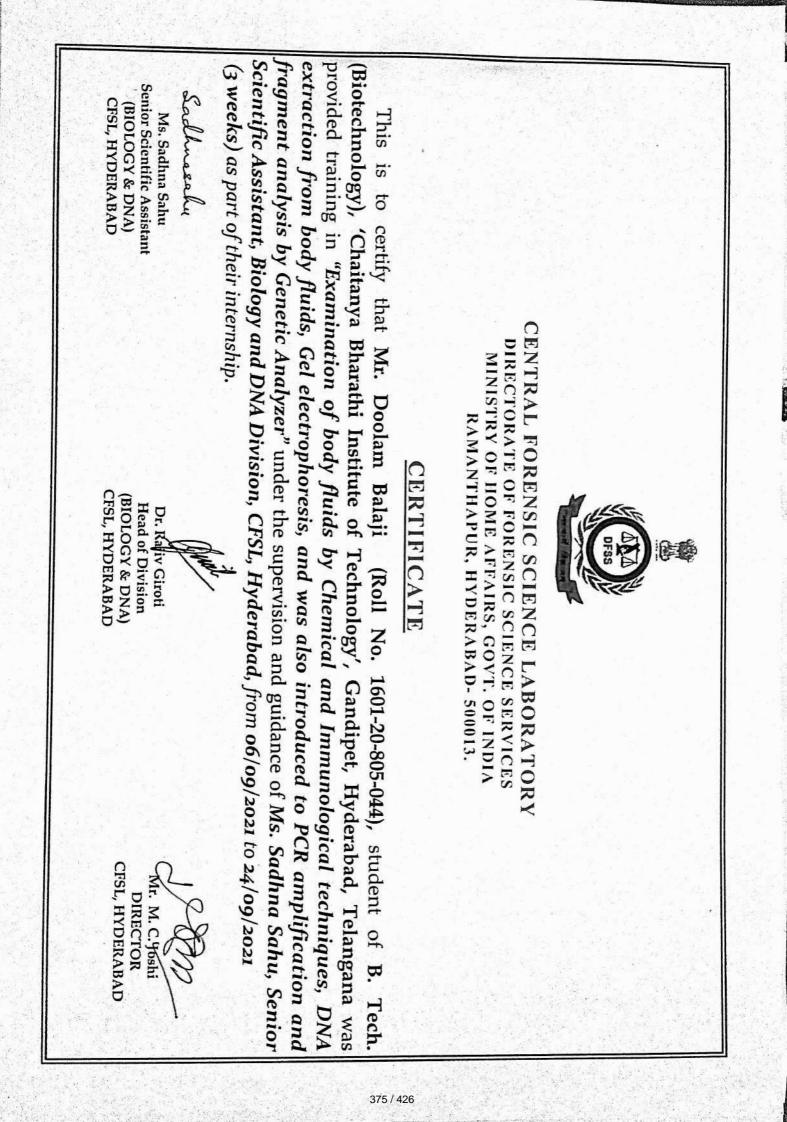
This is to certify that Ms. Sada Spoorthi B.Tech Biotechnology student of Chaitanya Bharathi Institute of technology from Gandipet, Telangana has successfully undergone internship programme of 11.09.2021-25.09.2021 at R&D department Unit I under Dr. V.V.Surya Narayana, Project titled- "SDS Gel & Agarose Gel Electrophoresis and Usage of UV- vis Spectrophotometer" in Virchow biotech Private Limited. This work is a property of Virchow Biotech Private Limited, Hyderabad. It should not be published or copied further without permission.

Her candidature during the Project was satisfactory and we wish her all success in future endeavours.

Regards For Virchow Biotech Pvt. Ltd.

Sr.Manager - HR & Adam

 Factory : Survey No. 172 Part, Gagillapur Village, Dundigal Gandimaisamma Mandal, Medchal-Malkajgiri District, Telangana - 500 043, INDIA.
 Phone : 09700017820, 09700017883 E-mail : hr@virchowbiotech.com, regulatory.vbpl@gmail.com
 Head Office : # 319 & 320, III<sup>rd</sup> Floor, Swamy Ayyappa Co-op. Housing Society Ltd, Madhapur, Hyderabad-500 081. Phone : +91-40-23119481, Fax : +937404263119486. GSTIN : 36AABCV2578A1ZI





DP-150/

**CENTRAL FORENSIC SCIENCE LABORATORY** DIRECTORATE OF FORENSIC SCIENCE SERVICES MINISTRY OF HOME AFFAIRS, GOVT. OF INDIA **RAMANTHAPUR, HYDERABAD- 500013.** 

# CERTIFICATE

Scientific Assistant, Biology and DNA Division, CFSL, Hyderabad, from 06/09/2021 to 24/09/2021 extraction from body fluids, Gel electrophoresis, and was also introduced to PCR amplification and was provided training in "Examination of body fluids by Chemical and Immunological techniques, DNA B. Tech. (Biotechnology), 'Chaitanya Bharathi Institute of Technology', Gandipet, Hyderabad, Telangana fragment analysis by Genetic Analyzer" under the supervision and guidance of Ms. Sadhna Sahu, Senior (3 weeks) as part of their internship. This is to certify that Mr. Matta Chenna Keshava Charan (Roll No. 1601-20-805-046), student of

Sadhusshu

Senior Scientific Assistant CESU HVDERABAD (BIOLOGY & DNA) Ms. Sadhna Sahu

Dr. Rajly Giroti

CFSL, HYDERABAD (BIOLOGY & DNA) Head of Division

Mr. M. C. Josh DIRECTOR

CFSL, HYDERABAD

कर्मचारी राज्य बीमा निगम चिकित्सा महाविद्यालय (श्रम एवं रोजगार मंत्रालय, भारत सरकार) EMPLOYEES' STATE INSURANCE CORPORATION MEDICAL COLLEGE (Ministry of Labour & Employment, Govt. of India)



सनतनगर, हैदराबाद - 500 038 Sanathnagar, Hyderabad - 500 038 Tel. 040-67872002, 29804857. E-mail: dean-hyd@esic.nic.in, website: www.esic.nic.in

## CERTIFICATE

This is to certify that the project entitled "In silico Identification and Analysis of the Deleterious SNPs in HRAS Gene Associated with Head and Neck Squamous Cell Carcinoma" submitted by Mohith Reddy Arikatla (Roll No.: 1601-18-805-037) & Kaushik Chunduri (Roll No.: 1601-17-805-042) in partial fulfillment of the requirement for the award of the degree of B.Tech Biotechnology at Chaitanya Bharathi Institute of Technology (A), Affiliated to Osmania University is a record of Bonafide work carried out by him under my guidance during the internship period (31-01-2022 to 31-06-2022). The project fulfils the requirements as per the regulations and of this Institute and in my opinion meets the standards for submission. The content of this report has not been submitted and will not be submitted either in part or in full for the award of Degree or Diploma in this institute or University.

K. Madh

(Dr. Madhumohan Katika)

Mobile Virology Research & Diagnostic Laboratory, (MVDRL) BioSafety Laboratory (BSL-II & III) ESIC, Sanathnagar, Hyderabad – 500038 E-mail: maddycdfd@gmail.com Phone No: +918501020960





# **CERTIFICATE**

This is to certify that the project entitled "Upstream Processing of Industrial Scale Manufacturing of Biosimilar Macromolecules" submitted by Ms.A.Jahnavi (1601-18-805-010), under the guidance of Dr. B. Sumithra, in partial fulfilment for the degree of "Bachelor of Technology" in Biotechnology, Osmania University is a bonafide record of work carried under the supervision of Nalla Jeevan Kumar, Dr. Reddy's Laboratories and the same has not been submitted to any other university or institute for award of degree or diploma.

| Internal Guide      | External Guide      |
|---------------------|---------------------|
| Name:               | Name:               |
| Signature:          | Signature:          |
| Date:               | Date:               |
| Internal Examiner 1 | Internal Examiner 2 |
| Name:               | Name:               |
| Signature:          | Signature:          |
| Date:               | Date:               |
| External Examiner   | HOD                 |
| Name:               | Name:               |
| Signature:          | Signature:          |
| Date:               | Date:               |
|                     |                     |

# **EXTERNAL CERTIFICATE**

Dr.Reddy's

Dr. Reddy's Laboratories Ltd. 8-2-337, Road No. 3, Banjara Hills, Hyderabad - 500 034, Telangana, India. CIN: L85195TG1984PLC004507

Tel :+91 40 4900 2900 Fax :+91 40 4900 2999 Email :mail@drreddys.com www.drreddys.com

January 17, 2022 Name: Kiranmai Dornala

#### Internship Programme - 2022

#### Dear Kiranmai Dornala,

#### **Congratulations!**

I take great pleasure in offering you a **Project internship** in our organization starting from 17- Jan 2022 till 15-July- 2022.

The base location for your internship shall be **Hyderabad/Vizag/Baddi** and you could be asked to work out of any of our office premises.

You will be paid a consolidated stipend amount of INR 18,000 (INR Eighteen Thousand only) per month.

The company shall have no liability for compensation whatsoever for any injury/accident arising out of or in thecourse of the project.

It is also understood that you shall adhere to all rules and regulations applicable to you for the successful and timely completion of your assignment.

We welcome you to Dr. Reddy's and hope that the structured learning experience provided to you will benefityou and contribute towards your professional growth.

With best wishes,

DocuSigned by: **Tiyash Mazumder Bagchi** . Authorized Signatory

DocuSigned by:

Kiranmai Dornala C65601891B3046D... Name & Signature of the Intern



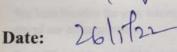


0 NR 0 NAME 0 100 0001 2015

This is to certify that the project entitled "Production of a monoclonal antibody on an industrial scale" submitted by Ms Vennamaneni Krishna Priya Rao (160118805014) in partial fulfilment for the degree of "Bachelor of Technology" in Biotechnology, Osmania University is a bonafide record of work under the supervision of Dr Rajasri Yadavalli, Associate Professor, I/C Head of Department, CBIT and the same has not been submitted to any other university for award of degree or diploma.

# **Internal Guide**

Name: Dr Rająsri Yadavalli Signature: Yay



Internal Examiner-I Name: Dr C Nagendranatha Reddy Signature:

Date: 22/01/2022

**External Examiner-I** Name: Signature: A saithe Rai

Date: 11/06/22

**External Guide** Name: Mahesh Verma ND Signature:

Date: 25/05/22

**Internal Examiner-II** Name: Dr Rajaşri Yadavalli Signature: Ylay

Date: 26/12

# **Head of Department** Name: Dr Rajasri, Yadavalli Signature: 4/a

Date:

2611922

HEAD Dept. of Bio-Technology Chaitanya Bharathi Institute of Technology Gandipet, Hyderabad-500 075

Π

380 / 426



Dr. Reddy's Laboratories Ltd. 8-2-337, Road No. 3, Banjara Hills, Hyderabad - 500 034, Telangana, India. CIN: L85195TG1984PLC004507

Tel :+91 40 4900 2900 Fax :+91 40 4900 2999 Email :mail@drreddys.com www.drreddys.com

January 17, 2022 Name: D Niveditha

#### Internship Programme - 2022

Dear D Niveditha,

**Congratulations!** 

I take great pleasure in offering you **Project internship** in our organization starting from 17- Jan -2022 till 15-July- 2022.

The base location for your internship shall be **Hyderabad/Vizag/Baddi** and you could be asked to work out of any of our office premises.

You will be paid a consolidated stipend amount of INR 18,000 (INR Eighteen Thousand only) per month.

The company shall have no liability for compensation whatsoever for any injury/accident arising out of or in the course of the project.

It is also understood that you shall adhere to all rules and regulations applicable to you for the successful and timely completion of your assignment.

We welcome you to Dr. Reddy's and hope that the structured learning experience provided to you will benefit you and contribute towards your professional growth.

With best wishes,



Authorized Signatory

D - Niveditha 431FBE9C7F204CC

Name & Signature of the Intern





# **CERTIFICATE**

This is to certify that the project titled "Pre formulation study of a Humanized therapeutic monoclonal antibody" submitted by Sucheta Rajaraman (1601-18-805-026), in partial fulfilment for the degree of "Bachelor of Technology" in Biotechnology, Osmania University is a bonafide record of work carried under the supervision of Dr.Rajasri Yadavalli Pendem, Department of Biotechnology, CBIT and the same has not been submitted to any other university or institute for award of degree or diploma.

# **Internal Guide**

Name: Dr.Rajasri Yadavalli Pendem Signature:

Date:

26/1/22

# External Guide

Name: Dr.Ravi Kumar Marikanti Signature: (Laus 25/05/2022

Date:

# <u> Internal Examiner – 1</u>

Name: Dr. C. Nagendranatha Reddy Signature:

09/06/2022

**1**1201

Date:

## **External Examiner**

Name: Signature: A Santa Kan

Date: 1Mob/22

# Internal Examiner - 2

Name: Dr. Rajasri Yadavalli Signature:

Date:

26/fis

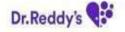
# HOD

Name: Dr. Rajasri Yadavalli Signature:

Date:

Dultze

Dept. of Bio-rechnology Chaitanya Bharathi Institute of Technology Gandipet, Hyderabad-500 075



Dr. Reddy's Laboratories Ltd. 8-2-337, Road No. 3, Banjara Hills, Hyderabad - 500 034, Telangana, India. CIN: L85195TG1984PLC004507

Tel :+91 40 4900 2900 Fax :+91 40 4900 2999 Email :mail@drreddys.com www.drreddys.com

January 17, 2022

Name: Ushaswini Sunkara

#### Internship Programme - 2022

#### Dear Ushaswini Sunkara,

#### Congratulations!

I take great pleasure in offering you Project internship in our organization starting from 17- Jan -2022 till 15-July- 2022.

The base location for your internship shall be Hyderabad/Vizag/Baddi and you could be asked to work out of any of our office premises.

You will be paid a consolidated stipend amount of INR 18,000 (INR Eighteen Thousand only) per month.

The company shall have no liability for compensation whatsoever for any injury/accident arising out of or in the course of the project.

It is also understood that you shall adhere to all rules and regulations applicable to you for the successful and timely completion of your assignment.

We welcome you to Dr. Reddy's and hope that the structured learning experience provided to you will benefit you and contribute towards your professional growth.

With best wishes,



Ushaswini Sunkara 784CE55800FD4FD. Name & Signature of the Intern





# CERTIFICATE

This is to certify that the project entitled "*Production of "X" monoclonal antibody as a part* of *Cell line development*" submitted by **Yamini Arlibandi (1601-18-805-032)**, in partial fulfillment for the degree of "Bachelor of Technology" in Biotechnology, Osmania University is a bonafide record of work carried under the supervision of Dr. Shailja Dwivedi, Lead of Cell Line Development, Dr. Reddy's Laboratories and the same has not been submitted to any other university or institute for the award of degree or diploma.

## **External Guide**

Name: Dr. Shailja Dwivedi Signature: Suite and the second second

Internal Guide

Name: Dr. Dharmalingam Signature: K'. DRam

Date:

20105 12022

#### Internal Examiner – 1

Name: Dr. C. Nagendranatha Reddy Signature:

09/01/1000

Date:

#### **External Examiner**

Name: Signature: A sats the Pari

Date: 11/06/22

Date: 23 5 2022.

Internal Examiner - 2

Name: Dr. Rajasri, Yadavalli Signature: Date:

HOD

Name: Dr. Rajasri Yadavalli Signature:

Date:

Dept. of Bio-Technology Chaitanya Bharathi Institute of Technology Gandipet, Hyderabad-500 075.





(वैज्ञानिक तथा औघोगिक अनुसंधान परिषद)
 (Council of Scientific & Industrial Research)
 विज्ञान और प्रौद्योगिकी मंत्रालय, भारत सरकार / Ministry of Science & Technology Govt. of India

तारनाका Tarnaka, हैदराबाद Hyderabad - 500 007. भारत India

# CERTIFICATE

This is to certify that the project entitled "Determining the lysine residue site of IDH2 protein responsible for its Ubiquitination" submitted by S Deepak Mohan Reddy in partial fulfillment of the requirement for the award of the degree of B.Tech Biotechnology at Chaitanya Bharathi Institute of Technology (A), Affiliated to Osmania University is a record of Bonafide work carried out by him under my guidance during the internship period (17-01-2022 to 10-05-2022). The project fulfills the requirements as per the regulations of this Institute and in my opinion meets the standards for submission. The content of this report has not been submitted and will not be submitted either in part or in full for the award of Degree or Diploma in this Institute or any other Institute or University.

Dr. Nishant S. Jain Senior Scientist Department of Applied Biology CSIR-Indian Institute of Chemical Technology Hyderabad - 500 007.

Dr. S Nishant Jain Principal Scientist , Department of Applied Biology, CSIR-IICT, Tarnaka, Hyderabad - 500007 E-mail: nishant@iict.res.in

Date: 25.05.2022





# CERTIFICATE

This is to certify that the project entitled "Aggregate analysis of fusion protein using SDS-PAGE and SE-HPLC" submitted by Mr. Jaligama Dhanish Daaman Rau (1601-18-805-035) in partial fulfilment for the degree of "Bachelor of Technology" in Biotechnology, Osmania University is a bonafide record of work carried under the supervision of Dr. Dharmalingam, Asst. professor, Department of Biotechnology, CBIT and the same has not been submitted to any other university or institute for award of degree or diploma.

#### **External Guide**

Name: Dr. Pandiaraja P Signature: huh

Date: 20/05/2022

#### Internal Examiner - 1

Name: Dr. C. Nagendranatha Reddy

Signature:

oslo6/won

Date:

#### **External Examiner**

Name:

Signature: A Sabathe Rai

Date: 11106 22

#### Internal Guide

Name: Dr. Dharmalingam Signature: K. Dhan

23 5 2022. Date:

#### Internal Examiner – 2

Name: Dr. Rajasri Yadavalli Signature: Date:

HOD

Name: Dr. Rajasri Yadavalli Signature:

Date:

Dept. of Bio-Technology II Chaitanya Bharathi Institute of Technology Gandipet, Hyderabad-500 075

कर्मचारी राज्य बीमा निगम चिकित्सा महाविद्यालय (श्रम एवं रोजगार मंत्रालय, भारत सरकार) EMPLOYEES' STATE INSURANCE CORPORATION MEDICAL COLLEGE (Ministry of Labour & Employment, Govt. of India)



सनतनगर, हैदराबाद - 500 038 Sanathnagar, Hyderabad - 500 038 Tel. 040-67872002, 29804857. E-mail: dean-hyd@esic.nic.in, website: www.esic.nic.in

## CERTIFICATE

This is to certify that the project entitled "In silico Identification and Analysis of the Deleterious SNPs in HRAS Gene Associated with Head and Neck Squamous Cell Carcinoma" submitted by Mohith Reddy Arikatla (Roll No.: 1601-18-805-037) & Kaushik Chunduri (Roll No.: 1601-17-805-042) in partial fulfillment of the requirement for the award of the degree of B.Tech Biotechnology at Chaitanya Bharathi Institute of Technology (A), Affiliated to Osmania University is a record of Bonafide work carried out by him under my guidance during the internship period (31-01-2022 to 31-06-2022). The project fulfils the requirements as per the regulations and of this Institute and in my opinion meets the standards for submission. The content of this report has not been submitted and will not be submitted either in part or in full for the award of Degree or Diploma in this institute or University.

K. Madh

(Dr. Madhumohan Katika)

Mobile Virology Research & Diagnostic Laboratory, (MVDRL) BioSafety Laboratory (BSL-II & III) ESIC, Sanathnagar, Hyderabad – 500038 E-mail: maddycdfd@gmail.com Phone No: +918501020960



# CERTIFICATE

This is to certify that the seminar report entitled " Down Stream Processiong of Monoclonal Antibodies by using Chromatographic columns." submitted by Mr.Sourab Mashetty (1601-18-805-042) in partial fulfilment for the degree of "Bachelor of Technology" in Biotechnology, Chaitanya Bharathi Institute of Technology, Osmania University is a bonafide record of work carried under the supervision of Dr.C.Nagendranatha Reddy, Department of Biotechnology, CBIT and the same has not been submitted to any other university or institute for award of degree and diploma.

| External Guide             | Internal Guide  |
|----------------------------|---|
| Name: Paidamnaidu Y        | Name: Dr.C.Nagendranatha Reddy  |
| Signature: y. Bridan naid  | Signature: 09/05/1012   |
| Date: 24th May 22          | Date:   |
| Internal Examiner – 1      | Internal Examiner – 2   |
| Name: Dr.Rajasri Yadavalli | Name: Dr.C.Nagendranatha Reddy  |
| Signature: Yla             | Signature: A Jeg  |
| Date: 26/122               | Date: 09/06/1000  |
| External Examiner          | HOD   |
| Name:                      | Name: Dr. Rajasri Yadavalli   |
| Signature: A sawitchar.    | Signature: You  |
| Date: 11/08/ 22            | Date: Fi2-bill<br>Dept. of Bio-Technology<br>Chaltanya Bhatalhi Institute of Technology<br>Gandipet, Hyderabod 500 ochology |

# Scanned by CamScanner

Gandipet, Hyderabad-500 075.



# **BIOAXIS DNA RESEARCH CENTRE (P) LTD**

Centre for Biological Research !

# **CERTIFICATE**

This is to confirm that Ms. D Deepika, Reg no. 21HBT-3/2916 has successfully completed the project entitled "Isolation and Production of Antineoplastic Drugs from Soil Microorganisms", at the Department of Biotechnology, Hyderabad, during the tenure of 45 Days from 22<sup>nd</sup> March 2021 to 05<sup>th</sup> May 2021.

Best Regards!



Plot No 33, Road No 3, D V S N Colony, Munuganoor, Hayat Nagar, Hyderabad - 501 511. Telangana State. Ph : 040-29706983 . Email: info@dnares.in Website: www.dnares.in

Scanned with CamScanner



# **BIOAXIS DNA RESEARCH CENTRE (P) LTD**

Centre for Biological Research !

# CERTIFICATE

This is to confirm that Ms. Ganga Divya, Reg no. 21HBT-3/2917 has successfully completed the project entitled "Isolation and Production of Antineoplastic Drugs from Soil Microorganisms", at the Department of Biotechnology, Hyderabad, during the tenure of 45 Days from 22<sup>nd</sup> March 2021 to 05<sup>th</sup> May 2021.

· CALANATARIA VILLA



÷

In a realized to a factor of the toron of the

Plot No 33, Road No 3, D V S N Colony, Munuganoor, Hayat Nagar, Hyderabad - 501 511. Telangana State. Ph : 040-29706983 Email: info@dnares.in Website: www.dnares.in

Scanned with CamScanner



**二级时间成为3%现场中的分子的合合常长的中心。为于自由的合同的第三人称单位** 

# **BIOAXIS DNA RESEARCH CENTRE (P) LTD**

Centre for Biological Research !

# CERTIFICATE

This is to confirm that Ms. G Divya Teja, Reg no. 21HBT-3/2915 has successfully completed the project entitled "Isolation and Production of Antineoplastic Drugs from Soil Microorganisms", at the Department of Biotechnology, Hyderabad, during the tenure of 45 Days from 22<sup>nd</sup> March 2021 to 05<sup>th</sup> May 2021.

Best Regarder Jyothsmr Sundlapster Sr. Research Centre Pvt Ltd Hyderabad

Plot No 33, Road No 3, D V S N Colony, Munuganoor, Hayat Nagar, Hyderabad - 501 511. Telangana State. Ph : 040-29706983 Email: info@dnares.in Website: www.dnares.in

Scanned with CamScanner



# Students academic project Nishath Naaz and R.P.S. Bhavana - reg

1 message

Greentech Enviros <greentechenviros@gmail.com> To: rajasriy\_biotech@cbit.ac.in Cc: ashalini biotech@cbit.ac.in, nagendranath biotech@cbit.ac.in

Thu, May 20, 2021 at 10:48 PM

Respected Madam,

Warm Greetings to you.

Greentech Enviros is pioneer in Training, R&D and Consultancy works in the field of Environment and Biotechnology registered in 2016. I am working as Managing Partner and Dr.Kezia doing her post doctoral work in the field of Biotechnology in IICT, Hyderabad. We have NABET accredited "A" Grade staff. We have MoU with labs having MoEF and NABL certifications. We did a good number of projects for students throughout India. I feel proud to have an opportunity to interact with you at this juncture. We play a key role in research, teaching, organizing seminars & training programmes. Some of the students for your esteemed college approached us to guide them for their academic project work.

In this connection, I would like to inform you that the following students from Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad worked as project trainees in M/s Greentech Enviros, Hyderabad. They have attended the lab from **05.04.2021 to 10.05.2021** under my guidance. During the project period, I found them sincere at work and completed all the project activities with enthusiasm. They have submitted draft thesis on the project entitled "Bioaccumulation of toxic metals in two leafy vegetables cultivating near River Musi, Hyderabad". I wish them all the best for future endeavors.

Student details:

| S.No | Name of the student              | Contact details  | Project period                 |
|------|----------------------------------|--|--------------------------------|
| 1    | Nishath Naaz<br>(160117805012)   | Phone number : 9502840568<br>Email : nishathnaaz1999@gmail.com<br>Official Email :ugs17012_biotech.nishath@<br>cbit.org.in | 05.04.2021<br>to<br>10.05.2021 |
| 2    | R.P.S. Bhavana<br>(160117805015) | Phone Number :6300646223<br>Email :rongalabhavana@gmail.com  |                                |

Letter and project information are attached herewith for your kind perusal.

Thanking you,

Regards, Dr. I. Siva Rama Krishna, Managing Director, Greentech Enviros, Hyderabad, Telangana Ph:9290516935 greentechenviros@gmail.com www.greentechenviros.in



# Students academic project Nishath Naaz and R.P.S. Bhavana - reg

1 message

Greentech Enviros <greentechenviros@gmail.com> To: rajasriy\_biotech@cbit.ac.in Cc: ashalini biotech@cbit.ac.in, nagendranath biotech@cbit.ac.in

Thu, May 20, 2021 at 10:48 PM

Respected Madam,

Warm Greetings to you.

Greentech Enviros is pioneer in Training, R&D and Consultancy works in the field of Environment and Biotechnology registered in 2016. I am working as Managing Partner and Dr.Kezia doing her post doctoral work in the field of Biotechnology in IICT, Hyderabad. We have NABET accredited "A" Grade staff. We have MoU with labs having MoEF and NABL certifications. We did a good number of projects for students throughout India. I feel proud to have an opportunity to interact with you at this juncture. We play a key role in research, teaching, organizing seminars & training programmes. Some of the students for your esteemed college approached us to guide them for their academic project work.

In this connection, I would like to inform you that the following students from Department of Biotechnology, Chaitanya Bharathi Institute of Technology, Hyderabad worked as project trainees in M/s Greentech Enviros, Hyderabad. They have attended the lab from **05.04.2021 to 10.05.2021** under my guidance. During the project period, I found them sincere at work and completed all the project activities with enthusiasm. They have submitted draft thesis on the project entitled "Bioaccumulation of toxic metals in two leafy vegetables cultivating near River Musi, Hyderabad". I wish them all the best for future endeavors.

Student details:

| S.No | Name of the student              | Contact details  | Project period                 |
|------|----------------------------------|--|--------------------------------|
| 1    | Nishath Naaz<br>(160117805012)   | Phone number : 9502840568<br>Email : nishathnaaz1999@gmail.com<br>Official Email :ugs17012_biotech.nishath@<br>cbit.org.in | 05.04.2021<br>to<br>10.05.2021 |
| 2    | R.P.S. Bhavana<br>(160117805015) | Phone Number :6300646223<br>Email :rongalabhavana@gmail.com  |                                |

Letter and project information are attached herewith for your kind perusal.

Thanking you,

Regards, Dr. I. Siva Rama Krishna, Managing Director, Greentech Enviros, Hyderabad, Telangana Ph:9290516935 greentechenviros@gmail.com www.greentechenviros.in

# CERTIFICATE

This is to certify that the project proposal entitled Design of a compact, efficient, economical treatment approach for household waste water treatment submitted by Ms.Sphoorthy Nadimpalli(1601178050278) in Osmania university, is a bonafide record of the work carried out under the supervision of **Dr. C Nagendranatha Reddy**, Assistant professor, Department of Biotechnology, CBIT and **N Raveendher**, Chief Scientist, EPTRI Hyderabad, has not been submitted to any other university or institution for the award of any degree or diploma.

Internal Guide Name: Dr. C Nagendranatha Reddy

Signature:

Head of the Department Name: Dr. Y.Rajasri Signature:

External Guide: Name: N Raveendher, EPTRI, Hyderabad

svendly

Signature:

Internal Examiner Name: Dr. C Nagendranatha Reddy

Signature:

External examiner Name: KSR Siva Sai

Signature: /

|       |                 |                             |                                     | <i>,</i> ,    |                     | Title of the           | Specializatio |
|-------|-----------------|-----------------------------|-------------------------------------|---------------|---------------------|------------------------|---------------|
| S.No. | R.No.           | Name of the Student         | Student Email and                   | Internship    | Company in          | Internship given to    | n on          |
| •     |                 |                             | Contact Number                      | (online/offli | which internship    | student(ex:seo         | internship    |
|       |                 |                             |                                     | ne)           | done                | analyst)               | done          |
| 1     | 2               | 3                           | 4                                   | 5             | 6                   | 7                      | 8             |
| 1     | 1601-20-672-001 | AKHILA ANNASARAM            | akhila2198@gmail.com,<br>9640614291 | online        | Buzibrains          | online HR Co-ordinato  | HR            |
| 2     | 1601-20-672-002 | ASHFIYA NASEERUDDIN<br>SYED | Ashfiyasyed2000mj@gmail             | online        | IFORTIS WORLDW      | HR, DIGITAL MARKET     | HR            |
| 3     | 1601-20-672-003 | BHAGYASREE<br>KADIMICHERLA  |                                     |               |                     |                        |               |
| 4     | 1601-20-672-004 | HARSHITHA MUTHYALA          | 8008680589                          |               | Trivision integrate | Taxation, Bank Recon   | Fin & Market  |
| 5     | 1601-20-672-005 | LAHARI ANUMANDLA            | laharianumandla99@gmail             | online        | AIM India           | Intern                 | Finance and   |
| 6     | 1601-20-672-006 | MEGHANA REDDY SANVE         | meghana.sanvelli@gmail.co           | online        | FITIG Association   | HR                     | HR and LOGI   |
| 7     | 1601-20-672-007 | MONICA AKUNOORI             | monica13.aku@gmail.com              | offline       | Gratisol Labs       | Digital Marketing inte | Finance and   |
| 8     | 1601-20-672-008 | MOUNIKA JARAPLA             | mounikareddy5589@gmail              | offline       | Gratisol Labs       | Digital Marketing inte | Finance and   |
| 9     | 1601-20-672-009 | NANDINI BADIKE              | nandinibadike4@gmail.con            | offline       | Chemtopes           | Marketing and sales    | Marketing     |
| 10    | 1601-20-672-010 | NAVYA PRIYADARSHIINI        | navya0636@gmail.com                 | Part time     | Ifortis             | Human Resources        | HR            |
| 11    | 1601-20-672-011 | NAZNEEN INTESHA             | inteshanazneen@gmail.cor            | online        | FITIG Association   | Human resource inter   | Finance and   |
| 12    | 1601-20-672-012 | NISMA                       | nisma206aijaz@gmail.com             | HR            | shubham nari mah    | nila kaylan samiti NGO | Finance and I |
| 13    | 1601-20-672-013 | PRINCESS GADDAMEEDI         | princessg561@gmail.com,             | online        | ifortis world wide  | Hr trainee             | HR            |
| 14    | 1601-20-672-014 | REVATHI J                   | pgs20116_mba.trishul@cb             | online        | BuziBrAlns          | online HR Co-ordinato  | HR            |
| 15    | 1601-20-672-015 | RINKU KUMARI                | rinkukumari3843@gmail.co            | HR internship | CBIT                | Recruitment            | HR            |
| 16    | 1601-20-672-016 | RUCHITHA MUCHARLA           | reddy.ruchitha8@gmail.coi           | HR            | career dreams edu   | Human resource and a   | HR n marketi  |
| 17    | 1601-20-672-017 | SAHADEV KANCHAN<br>SINGH    | pgs20017_mba.sahadev@c              | Offline       | CBIT                | Recruitment            | HR            |
| 18    | 1601-20-672-018 | SAMYUKTHA<br>YADAVELLY      | samyukthayadavelly@gmai             | online        | Ifortis world wide  | Hr trainee             | HR            |
| 19    | 1601-20-672-019 | SATYAVENI BODASINGU         | bodasingukanchan@gma                | Summer Inte   | Havoc Therapy p     | HR Intern              | Finance & H   |
| 20    | 1601-20-672-020 | SIREESHA N                  | shirishashirisha84932@gm            | Online        | Vasista Enterprise  | Account Manager        | Finance & Lo  |
| 21    | 1601-20-672-021 | SOUMYA SRI BAGGAM           | s.sri.s.soumya@gmail.com            | Offline       | Studio Vriksh       | On site finance manag  | Finance       |
| 22    | 1601-20-672-022 | SUPRIYA                     | 2022supriya@gmail.com               | online        | GTM & sons pvt. It  | Financial trainee      | Finance       |
| 23    | 1601-20-672-023 | SUPRIYA MANDADA             |                                     |               |                     |                        |               |
| 24    | 1601-20-672-025 | SWETHA EMMIDI N S           | 9489729226                          | Sales and Ma  | TIMES OF INDIA      | Sales and Marketing    | Fin & Analy   |
| 25    | 1601-20-672-026 | TANUJA GUDAPATI             | tanujagudapati99@gmail.c            | online        | Bajaj Allianz       | HR                     | HR            |

| 26 | 1601-20-672-027 | TEJASWINI R                                    |                            |              |                      |                           |                |
|----|-----------------|--|----------------------------|--------------|----------------------|---------------------------|----------------|
| 27 | 1601-20-672-028 | VAISHNAVI BANDARU                              | Vaishnavibandaru02@gma     | Online       | Prudhviraj& assoc    | Financial Trainee         | Finance        |
| 28 | 1601-20-672-029 | VAISHNAVI REDDY MADI                           | Vaishnavireddy947@gmail.   | offline      | Rane Engine Valve    | HR                        | FInance and    |
| 29 | 1601-20-672-030 | VIHARI S                                       | 8096741467                 | HR Associate | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 30 | 1601-20-672-031 | ABHILASH MALYALA                               | pgs20031_mba.abhilash@o    | offline      | CBIT (A)             | HR Trainee                | HR             |
| 31 | 1601-20-672-032 | ANIL P   | pgs20032_mba.anil@cbit.c   | online       | Deloitte-USI         | Tax intern                | Finance        |
| 32 | 1601-20-672-033 | AVINASH BIRADAR                                | avinashbiradar23@gmail.co  | om           | growth arrow         | equity research ana       | finance        |
| 33 | 1601-20-672-034 | BHARATH KUMAR<br>ALLADI                        | kumar74469@gmail.com       | online       | NVR consultancy      | hr                        | hr and analyt  |
| 34 | 1601-20-672-035 | CHANDU NARAPARAJU                              |                            |              |                      |                           |                |
| 35 | 1601-20-672-036 | ESHWAR KIRAN ARPULA                            | eshwarkiran04@gmail.com    | Online       | Prudhviraj&associ    | Financial Trainee         | Finance        |
| 36 | 1601-20-672-037 | FAYAZ SK                                       | pgs20037_mba.fayaz@cbit    | Offline      | Diagnostic BioSyst   | Finance                   | Finance        |
| 37 | 1601-20-672-038 | GANESH KUMAR G                                 | pgs20038_ganesh@cbit.org   | Offline      | CBIT                 | Recruitment               | HR             |
| 38 | 1601-20-672-039 | HEMANTH SALPRASAD<br>RAJU PORANKI              | hemanth.poranki546@gma     | Part time    | Times of India       | Business developmen       | marketing      |
| 39 | 1601-20-672-040 | JAGADISH LAVUDYA                               |                            |              |                      |                           |                |
| 40 | 1601-20-672-041 | KODANDA SAI NIKHIL<br>PADAM                    | sainikhilpadam7@gmail.co   | HR           | Gao Tek Inc          | Human Resource Inte       | HR & Logistic: |
| 41 | 1601-20-672-042 | MOHAN S  |                            |              |                      |                           |                |
| 42 | 0               | NAVEEN KUMAR<br>MANTHRI<br>PAAVANA VENKATA SAI | 7780510001                 | Recruitment  | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 43 | 1601-20-672-044 | PAAVANA VENKATA SAI<br>MANIKONDA               | pgs20044_mba.paavana@o     | Offline      | R Krishna & Ass      | Auditing and Taxation     | Finance        |
| 44 | 1601-20-672-045 | PRASHANTH DAPPU                                |                            |              |                      |                           |                |
| 45 | 1601-20-672-046 | PRUDHVI ANUGULA                                | pgs20046_mba.prudhvi@c     | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 46 | 1601-20-672-047 | PRUDHVI RAJ MIRYALA                            | miryalaprudhviraj@gmail.c  | Summer Inte  | Learnovate ecomr     | Finance Intern            | Finance        |
| 47 | 1601-20-672-048 | PRUDHVI RAJ<br>PILLI ALAMARRI                  | pillalamarriprudhviraj@gm  | online       | Learnovate ecomr     | Finance intern            | Finance        |
| 48 | 1601-20-672-049 | RAJARAM BHUKYA                                 | pgs20049_mba.rajaram@c     | Offline      | Star Fitness Studio  | <b>Operations</b> Manager | Finance        |
| 49 | 1601-20-672-050 | RAMESH JAKKULA                                 | pgs20050_mba.ramesh@cl     | oit.org.in   | Sids farm private li | Sales and Marketing       | Marketing      |
| 50 | 1601-20-672-051 | SAI KIRAN VEMULA                               | pgs20051_mba.sai@cbit.or   | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 51 | 1601-20-672-052 |  | pgs20052_mba.samara@ct     | Offline      | Dhanavanthari Pvt    | Accounts Intern           | Finance        |
| 52 | 1601-20-672-053 | SRAVAN KUMAR<br>RENUKUNTI A                    | pgs20053_mba.sravan@cb     | part time    | Ifortis              | corporate ambassado       | marketing      |
| 53 | 1601-20-672-054 | SRI DATTA CHARAN K                             |                            |              |                      |                           |                |
| 54 | 1601-20-672-055 | SRINIVAS POSHETTI                              | poshettisrinivas5@gmail.co | Finance      | Suman chemical ir    | Financial Analyst and     | FINANCE        |
| 55 | 1601-20-672-056 | SUMANTH GORULA                                 | pgs20056_mba.sumanth@      |              | -                    | Marketing & Sales I       | -              |
| 56 | 1601-20-672-057 | VAMSHI SHIV VENAKATA<br>RAMESH TOOPATI         | pgs20057_mba.vamshi@cb     | Human Resou  | Oil and Natural Ga   | Human Resource Proc       | HR             |
| 57 | 1601-20-672-058 | VINAY KRISHNA KONJETI                          | pgs20058_mba.vinay@cbit    | Online       | Deloitte             | Tax Intern                | Finance        |
| 58 | 1601-20-672-059 | YASHWANTH GADDAM                               | pgs20059_mba.yashwanth     | offline      | Dhanavanthari P      | Accounts Intern           | Finance        |

| 59 | 1601-20-672-060 | YASHWANTH REDDY B                                  |                            | Online        | finaltics         | Investment Banking A   | finance      |
|----|-----------------|--|----------------------------|---------------|-------------------|------------------------|--------------|
| 60 | 1601-20-672-061 | ANUSHA REDDY M                                     |                            |               |                   |                        |              |
| 61 | 1601-20-672-062 | BRUNDAVANI HINDU S                                 | pgs20062_mba.brundavani    | online        | Times of India    | sales and marketing    | marketing ar |
| 62 | 1601-20-672-063 | CHAITANYA CHIRRA                                   | chirra.chaitanya1998@gma   | Summer Inte   | Times Of India    | Marketing Intern       | Finance & Bu |
| 63 | 1601-20-672-064 | CHANDANA PUNNA                                     | chandupunna2000@gmail.     | social media  | IMUN Campus Am    | Matketing              | Finance and  |
| 64 | 1601-20-672-065 | KEERTHANA MADGULA                                  | 6303692849                 | Sales and Ma  | TIMES OF INDIA    | Sales and Marketing    | Fin & Market |
| 65 | 1601-20-672-066 | LAKSHMI PRIYA K                                    |                            |               |                   |                        |              |
| 66 | 1601-20-672-067 | NAGA KEERTHI MAKAM                                 |                            |               |                   |                        |              |
| 67 | 1601-20-672-068 | NEEHARIKA DESETTI                                  | pgs20068_mba.neeharika@    | online        | ICICI bank        | counselor              | marketing    |
| 68 | 1601-20-672-069 | NIHARIKA M   | pgs20069_mba.niharika@c    | Online        | Times of India    | sales and Marketing    | Marketing    |
| 69 | 1601-20-672-070 | NIKITHA TELUGU                                     | pgs20070_mba.nikitha@cb    | Online        | shubham naari sha | Human resource         | HR           |
| 70 | 1601-20-672-071 | PRAVALLIKA REDDY<br>TRAIMELA<br>PREM KUMAR KEERTHI | pgs20071_mba.pravallika@   | Online        | iFortis Corporate | Marketing              | Marketing    |
| 71 | 1601-20-672-072 | PREM KUMAR KEERTHI<br>BAMAGALLA<br>PRIYALEKHA      | pgs20072_mba.prem@cbit     | part time     | Youth Empowerm    | HR                     | Human Reso   |
| 72 | 1601-20-672-073 | PRIYALEKHA<br>LINGAPLIRAM<br>SATYA SAI GOVERDHANI  | pgs20073_mba.priyalekha@   | online        | TIMES OF INDIA    | Sales and marketing    | Marketing    |
| 73 | 1601-20-672-074 | SATYA SAI GOVERDHANI<br>VINEELA AINAPURAPU         | pgs20074_mba.satya@cbit    | offline       | AFCONS INFRASTR   | Accounts & Finance     | Finance      |
| 74 | 1601-20-672-075 | SHAIK NOOREAFSHA                                   | Pgs20075_mba.shaik@cbit    | Online        | Shubham Naari Sh  | HR intern              | HR           |
| 75 | 1601-20-672-076 | SHIRISHA GOVULA                                    |                            |               |                   |                        |              |
| 76 | 1601-20-672-077 | SRAVYA BOINDALA                                    | pgs20077_mba.sravya@cb     | online        | Times Of India    | sales and marketing    | Finance and  |
| 77 | 1601-20-672-078 | SWARNALIKA<br>VARUKOLU                             | pgs20078_mba.swarnalika    | Online        | Shine projects    | Human Resource inter   | Human Reso   |
| 78 | 1601-20-672-079 | SWATHI BUCHANPALLI                                 | Pgs20079_mba.swathi@cb     | Sales and ma  | Times of india    | Sales and marketing    | Fin& HR      |
| 79 | 1601-20-672-081 | VARA LAKSHMI PETERU                                | pgs20081_mba.varalakshm    | online        | Exposys Data Labs | Data Science           | Finance & BA |
| 80 | 1601-20-672-082 | VIJAYA LAKSHMI NALLAB                              | nvlakshminirula@gmail.cor  | HR            | shubham nari mah  | nila kaylan samiti NGO | HR and Busin |
| 81 | 1601-20-672-083 | VIJETHA KURUVA                                     |                            |               |                   |                        |              |
| 82 | 1601-20-672-084 | VINEETHA EEGA                                      | pgs20084_mba.vineetha@     | online        | Bajaj             | Recruitment and seled  | HR           |
| 83 | 1601-20-672-085 | ARUN KUMAR MATTAM                                  | 9398132821                 | Digital Marke | Exposys Data Labs | Digital Marketing      | Finance & LS |
| 84 | 1601-20-672-086 | BHANU PRAKASH<br>RAGAM<br>CHAITANYA JWALA          |                            |               |                   |                        |              |
| 85 | 1601-20-672-087 | CHAITANYA JWALA<br>MIDASALA                        | chaitanyajwala.cj.6@gmail. | Sales and Ma  | Times Of India    | Sales and Marketing    | Marketing    |
| 86 | 1601-20-672-088 | GANGADHAR ORAGANTI                                 | pgs20088_mba.ganmgadha     | Summer Inte   | Shubham Naari Sh  | Marketing Intern       | Finance and  |
| 87 | 1601-20-672-089 | HRUSHIKESH KANDALA                                 |                            |               |                   |                        |              |
| 88 | 1601-20-672-090 | KALYAN BANDI                                       | pgs20090_mba.kalyan@cb     | Teli marketin | g                 |                        |              |
| 89 | 1601-20-672-091 | KISHORE KUMAR D                                    |                            |               |                   |                        |              |
| 90 | 1601-20-672-093 | MAHENDER KORRA                                     | korramahender.1803@gma     | USER ENGAG    | WHITEHATJR        | USER ENGAGEMENT I      | MARKETING    |
| 91 | 1601-20-672-095 | MOHAMMED RASHAD ALI                                | pgs20095_mba.mohamme       | online        | Shubham Nari Sha  | Supply chain and Mar   | Supply chain |

| 92  | 1601-20-672-096 | MOHAN SWARGAM                           |                          |               |                     |                       |               |
|-----|-----------------|---|--------------------------|---------------|---------------------|-----------------------|---------------|
| 93  | 1601-20-672-097 | PAVAN KUMAR<br>SUDDALA                  | pavansuddala01@gmail.co  | Online        | Times of India      | Sales and Marketing i | Marketing     |
| 94  | 1601-20-672-098 | SUDDALA<br>RAJASHEKAR REDDY<br>VUDTHURU | pgs20098_mba.rajashekar( | Online        | Shubham Nari Sha    | Human Resources       | HR            |
| 95  | 1601-20-672-099 | RAVI SAI CHINNI<br>PRAKASH              |                          |               |                     |                       |               |
| 96  | 1601-20-672-100 | RAVI TEJA KANUGANTI                     | 8686665939               | A Report on S | Sumega Technolog    | A Report on Social Me | Marketing     |
| 97  | 1601-20-672-101 | RISHI SAI VIGNESH G S                   |                          |               |                     |                       |               |
| 98  | 1601-20-672-102 | ROCHAN KOTA                             | pgs200102_mba.rochan@c   | Online        | Shriman Shares Ar   | Finance Intern        | Finance       |
| 99  | 1601-20-672-103 | ROHITH T                                | rohitht23@gmail.com, 837 | Summer Inte   | Times Of India      | Marketing Intern      | Finance & M   |
| 100 | 1601-20-672-104 | SAHADEVUDU<br>UNGARALA                  | pgs20104_mba.sahadevud   | Online        | AVISHKAR TECH SO    | DATA SCIENCE          | Business Ana  |
| 101 | 1601-20-672-105 | SAI KUMAR TALARI                        | pgs20105_mba.saikumar@   | Online        | TATA MOTORS         | Marketing Intern      | Marketing     |
| 102 | 1601-20-672-106 | SAI RAM NALLOLLA                        | pgs20106_mba.sai@cbit.or | Online        | ΤΟΙ                 | Tele Marketing        | Marketing     |
| 103 | 1601-20-672-107 | SAI TEJA SAMALA                         | pgs20107_mba.sai@cbit.or | Online        | IfortisTimes of ind | Sales and Marketing   | Sales         |
| 104 | 1601-20-672-108 | SAI VARUN REDDY<br>DOMA                 |                          |               |                     |                       |               |
| 105 | 1601-20-672-109 | SAM SOURABH KINNERA                     | pgs20109_mba.sam@cbit.o  | Offline       | Oriental Insurance  | Marketing             | Marketing     |
| 106 | 1601-20-672-110 | SHAIK LATHEEF SAHEB                     | pgs20110_mba.shaik@cbit  | Summer Inte   | VIBGYOR             | Finance& Hr Intern    | Finance & HF  |
| 107 | 1601-20-672-111 | SHARATH KUMAR REDDY                     | bollaramsharathreddy22@  | gmail.com     |                     |                       |               |
| 108 | 1601-20-672-112 | SHIVA KUMAR NIMMA                       |                          |               |                     |                       |               |
| 109 | 1601-20-672-113 | SHIVA SANTHOSH<br>CHOLLETI              | pgs20113_mba.shiva@c     | Online        | Exposys data labsL  | Digital Marketing     | Marketing     |
| 110 | 1601-20-672-114 | SRICHARAN VELETI                        |                          |               |                     |                       |               |
| 111 | 1601-20-672-115 | SRIKANTH NAYAK                          | pgs200115_mba.srikanth@  | Offline       | Divya Textiles      | Supervisor for Produc | Finance       |
| 112 | 1601-20-672-116 | TRISHUL KOTAM                           | pgs20116_mba.trishul@cbi | offline       | Lexiko Infra Syster | HR co-ordinator       | HR            |
| 113 | 1601-20-672-117 | VENKATAKRISHNA REDDY ANNAPUREDDY        | pgs20117_mba.venkatakris | online        | Times Of India      | Sales and Marketing   | Marketing ar  |
| 114 | 1601-20-672-118 | VINAY PRAKASH<br>MADDIPATI              | pgs20118_mba.vinay@cbit  | Online        | Deloitte USI        | Tax intern            | Finance       |
| 115 | 1601-20-672-119 | VISHAL GOULIKAR                         | gowlikarvishal@gmail.com | Finance       | Shubham nari mał    | BDM                   | Finance and I |
| 116 | 1601-20-672-120 | VISHAL NAYANA                           |                          |               |                     |                       |               |

| Topic on<br>Internship<br>done(ex:<br>recuitment) | Duration of<br>internship<br>(start and End<br>dates) | Stipend      | Name of the<br>External<br>Guide | External guide Email address      | External guide Contact Number |
|---|---|--------------|----------------------------------|-----------------------------------|-------------------------------|
| 9   | 10  | 11           | 12                               | 13                                |                               |
| recruitment                                       | 2months(29/<br>06/2021 to<br>29/08/2021)              | nil          | sandhya                          | aims@buzibrains.com               |                               |
| recruiting, sales                                 | 45 days, 2 mor  | nths, 1 mont | h, 1 month                       |                                   |                               |
| Taxation, Bank F                                  |   |              |                                  | pgs20008_mba.harshita@cbit.org.in |                               |
| Sales   | 45 days   | No           |                                  |                                   |                               |
| recruitment                                       | 2 months  | 0            |                                  |                                   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20007_mba.monica@cbit.org.in   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20008_mba.mounika@cbit.org.in  |                               |
| Digital Marketin                                  |   |              | Mrs.Deepa                        | pgs20009_mba.nandini@cbit.org.in  |                               |
|   |   | nil          |                                  | 7337595637                        |                               |
| Recruitment                                       | 6th August 202  | nil          |                                  | pgs20011_mba.nazneen@cbit.org.in  |                               |
| HR  | 2 months  |              |                                  | 9111122118                        |                               |
| Recruitment                                       | 45 days(25/05,  |              | Nikhat                           |                                   |                               |
| Recruitment                                       | 16th May 2021   |              |                                  | aims@buzibrains.com               |                               |
| Recruitment                                       | 45days  | 21k          |                                  | hr@cbit.ac.in, 77022 18313        |                               |
| Recruitment                                       | 2 months  |              | shraddha                         | 7839517264                        |                               |
| Recruitment                                       | 45 days   |              | Anne Voilet                      | hr@cbit.ac.in, 77022 18313        |                               |
| recruitment                                       | 45 days(25/05,  | nil          | Nikhat                           |                                   |                               |
| NA  | 2 Months  | NA           | Siddharth                        | sidddharth@havoctherapy.com       |                               |
| Accountant  | 2 Months  | 10,000       | Sravani                          | 7981340263                        |                               |
| Accountant  | 2&1/2 months  | 10,000       | Swetha Gauta                     | 9966933908                        |                               |
| Teaching about                                    | 1 July to 1 Sept                                      | Nil          |                                  | hr@gtmandsons.com                 | 8825335493                    |
| Sales and Marke                                   | 17-06-2021 to   | Nil          |                                  | pgs20025_mba.swetha@cbit.org.in   |                               |
| Recruitment                                       | 2 months  | Nil          |                                  |                                   |                               |

| Accounting, Dra       | 16th june to 1 | Nil     |               | ca.prudhviraj009@gmail.com        |            |
|-----------------------|----------------|---------|---------------|-----------------------------------|------------|
| Learning and De       |                | Nil     | G Satish Kum  | guntur.satishkumar@ranegroup.com, | 8688692815 |
| HR Associate          | 15th June to 1 | Nil     |               | pgs20030_mba.vihari@cbit.org.in   |            |
| Recruitment           | 06-07-2021 to  | 21000/- | Anne Violet   | hr@cbit.ac.in                     |            |
| UK Tax reporting      | 1st June 2021  | 25000   | Prateek Kulka | arni                              |            |
|                       | 2 Months       |         |               |                                   | 7799891255 |
| recruitment           |                |         | raghu         |                                   | 6302860884 |
| Accounting, Dra       | 8 months(16th  | Nil     | Prudhviraj    | ca.prudhviraj009@gmail.com        | 8639630059 |
| Basic Finance & A     | 16th August to | Nil     |               |                                   |            |
| Recruitment           | 45 days        | 21000   | Anne Voilet   | hr@cbit.ac.in, 77022 18313        |            |
| sales                 | 2 months       | nil     | najesh        | 9677141888                        |            |
| HR Management         | 3 Months       |         | Aparna Nallur | aparnanalluri@yahoo               |            |
| HR Associate          | 17-08-2021-17  | Nil     |               | pgs20043_mba.naveen@cbit.org.in   |            |
| Finance Executiv      | 28th June 20   | 5000    | Prashanth     | prashanth@rkrishna.in             | 7995589596 |
| Finance Executiv      | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |
| NA                    | 2 Months       | NA      | Ravi Singh    |                                   |            |
|                       | 45 days        | NA      |               |                                   |            |
| <b>Operations</b> Man | 90 Days(12.07  | 20000   | Mr. Mohd. Ja  | 8883244445                        |            |
| Lead generation       | , Branding,    | 45 Days |               | 5K stipend                        |            |
| Finance Executiv      | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |
| Accounting Mar        | 45 days        | Nil     | Mr. Ramacha   | ndra Raju                         |            |
| sales funnel          | 2 months       | nil     | Architha      | 9.18247E+11                       |            |
| Indepth researc       | 2 months       |         | Sumeet maar   | 7434074794                        |            |
| sales and marl        | 45 Days        | nil     |               |                                   |            |
| Employees Perc        | 45days         | nil     | Rajesh Kaleku | 9490168003                        |            |
| UK Taxation           | 39 days        | 25000   | Mr. Amit Kun  | 9844178229                        |            |
| Accounting Mar        | 45 days        | nil     | Mr. Ramacha   | ndra Raju                         |            |

400 / 426

| Investment ban  | 2 months        | nil       | Nishika Sharn | 7208112389                          |
|-----------------|-----------------|-----------|---------------|-------------------------------------|
|                 |                 |           |               |                                     |
| sales and marke |                 | nill      | nagesh        |                                     |
| NA              | 2 Months        | NA        | Nagesh        | 9677141888                          |
| Marketing       | 5 weeks         | Nil       |               | pgs20064_mba.chandana@cbit.org.in   |
| Sales and Marke | 17-06-2021 to   | Nil       |               | pgs20065_mba.keerthana@cbit.org.in  |
|                 |                 |           |               |                                     |
| marketing       | 1-7-2021 to 1-9 |           | Dilip Kumar   | dilip17893@gmail.com                |
| sales           | 2 Months        | nil       | Nagesh        | 9.19677E+11                         |
| Recruitment     | 45Days          | Nil       |               |                                     |
| sales and marl  | 45 Days         | Nil       |               |                                     |
| Recruiting      |                 | nil       | Tapashya      | 9618267848                          |
| Sales and marke |                 | nill      | Nagesh        |                                     |
| Accounts & Fina | 12.08.2021 to   | nil       | Vaithy Krishn | vaithy@afcons.com                   |
| Recruiting      | 06.07.2021 to   | Nil       | Archie        |                                     |
| Sales and Marke | 2 months        |           | Nagesh        | 9677141888                          |
| Recruitment     | 22-06-2021 to   | NIL       | Sriharsha     | sriharsha@shineprojects.in          |
| Marketing       | 2months         | Nil       | Ravi          | Pgs20078_mba.swathi@cbit.org.in     |
| Data Science    | 1month          | nil       |               |                                     |
| ess analytics   | 2 months        |           |               |                                     |
| recruitment     | 6 weeks         | nill      |               |                                     |
| Marketing       | 1 month         | nil       | Vishnuvardha  | pgs20085_mba.arun@cbit.org.in       |
| Marketing       | 2 months        | Nil       | Ravi          | RaviKumar.Pasupuleti@timesgroup.cor |
| NA              | 45 days         | Na        | Anushka Priya | priyaanushka2002@gmail.com          |
|                 |                 |           |               |                                     |
| Presales        | 3 Months        | 12000/ Pm | Rahul Swami   | 7738772969                          |
| Promotion       | 2 months        | Nil       |               |                                     |

| Sales             | 2 months       | Nill       | Nagesh        |                               |  |
|-------------------|----------------|------------|---------------|-------------------------------|--|
| Recruitment       | 45 days(08-07- | Nil        |               |                               |  |
|                   |                |            |               |                               |  |
| A Report on Soc   | ial Media Mark | eting      |               | pgs20100_mba.ravi@cbit.org.in |  |
|                   |                |            |               |                               |  |
| Mutual Funds Po   | 45 days (02.08 | Nil        | Mr.Raja Reddy |                               |  |
| NA                | 2 Months       | NA         | Nagesh        | 9677141888                    |  |
| Data Science      | 45 days        | Nil        |               |                               |  |
| Customer Relati   | 45 days        | Nil        | Mr. Shashi    |                               |  |
| Tele Marketing    | 8 weeks        | Nil        | Mr. Ravi      | 9963090279                    |  |
| Sales             | 45 Days2 mont  | hs2 month: | onths         |                               |  |
|                   |                |            |               |                               |  |
| Marketing pract   | 45 days        | Nil        | D.satish Babu | L                             |  |
| NA                | 2 Months       | NA         | Eesh          | 9930238370                    |  |
|                   |                |            |               |                               |  |
|                   |                |            |               |                               |  |
| Digital Marketin  | 1 month1 mon   | Nil        |               |                               |  |
|                   |                |            |               |                               |  |
| Inventory Mana    | 70 days        | Nil        | Mr. Vijay     | 7069890949                    |  |
| Recruitment       | 45 days        | Nil        | Ms. Bachu Ra  | adhika                        |  |
| Sales and marke   | 2 months       | Nil        | Kiran Kumar   | 9885318862                    |  |
| UK Tax reporting  | 1st June 2021  | 25000      | ) Akshay Rao  | akshaymrao@gmail.com          |  |
| Business Analytic | 2months        | Nill       | Yashika       | 9642265734                    |  |
|                   |                |            |               |                               |  |

|       |                 |                             |                                     | <i>,</i> ,    |                     | Title of the           | Specializatio |
|-------|-----------------|-----------------------------|-------------------------------------|---------------|---------------------|------------------------|---------------|
| S.No. | R.No.           | Name of the Student         | Student Email and                   | Internship    | Company in          | Internship given to    | n on          |
|       |                 |                             | Contact Number                      | (online/offli | which internship    | student(ex:seo         | internship    |
|       |                 |                             |                                     | ne)           | done                | analyst)               | done          |
| 1     | 2               | 3                           | 4                                   | 5             | 6                   | 7                      | 8             |
| 1     | 1601-20-672-001 | AKHILA ANNASARAM            | akhila2198@gmail.com,<br>9640614291 | online        | Buzibrains          | online HR Co-ordinato  | HR            |
| 2     | 1601-20-672-002 | ASHFIYA NASEERUDDIN<br>SYED | Ashfiyasyed2000mj@gmail             | online        | IFORTIS WORLDW      | HR, DIGITAL MARKET     | HR            |
| 3     | 1601-20-672-003 | BHAGYASREE<br>KADIMICHERLA  |                                     |               |                     |                        |               |
| 4     | 1601-20-672-004 | HARSHITHA MUTHYALA          | 8008680589                          |               | Trivision integrate | Taxation, Bank Recon   | Fin & Market  |
| 5     | 1601-20-672-005 | LAHARI ANUMANDLA            | laharianumandla99@gmail             | online        | AIM India           | Intern                 | Finance and   |
| 6     | 1601-20-672-006 | MEGHANA REDDY SANVE         | meghana.sanvelli@gmail.co           | online        | FITIG Association   | HR                     | HR and LOGI   |
| 7     | 1601-20-672-007 | MONICA AKUNOORI             | monica13.aku@gmail.com              | offline       | Gratisol Labs       | Digital Marketing inte | Finance and   |
| 8     | 1601-20-672-008 | MOUNIKA JARAPLA             | mounikareddy5589@gmail              | offline       | Gratisol Labs       | Digital Marketing inte | Finance and   |
| 9     | 1601-20-672-009 | NANDINI BADIKE              | nandinibadike4@gmail.con            | offline       | Chemtopes           | Marketing and sales    | Marketing     |
| 10    | 1601-20-672-010 | NAVYA PRIYADARSHIINI        | navya0636@gmail.com                 | Part time     | Ifortis             | Human Resources        | HR            |
| 11    | 1601-20-672-011 | NAZNEEN INTESHA             | inteshanazneen@gmail.cor            | online        | FITIG Association   | Human resource inter   | Finance and   |
| 12    | 1601-20-672-012 | NISMA                       | nisma206aijaz@gmail.com             | HR            | shubham nari mah    | nila kaylan samiti NGO | Finance and I |
| 13    | 1601-20-672-013 | PRINCESS GADDAMEEDI         | princessg561@gmail.com,             | online        | ifortis world wide  | Hr trainee             | HR            |
| 14    | 1601-20-672-014 | REVATHI J                   | pgs20116_mba.trishul@cb             | online        | BuziBrAlns          | online HR Co-ordinato  | HR            |
| 15    | 1601-20-672-015 | RINKU KUMARI                | rinkukumari3843@gmail.co            | HR internship | CBIT                | Recruitment            | HR            |
| 16    | 1601-20-672-016 | RUCHITHA MUCHARLA           | reddy.ruchitha8@gmail.coi           | HR            | career dreams edu   | Human resource and a   | HR n marketi  |
| 17    | 1601-20-672-017 | SAHADEV KANCHAN<br>SINGH    | pgs20017_mba.sahadev@c              | Offline       | CBIT                | Recruitment            | HR            |
| 18    | 1601-20-672-018 | SAMYUKTHA<br>YADAVELLY      | samyukthayadavelly@gmai             | online        | Ifortis world wide  | Hr trainee             | HR            |
| 19    | 1601-20-672-019 | SATYAVENI BODASINGU         | bodasingukanchan@gma                | Summer Inte   | Havoc Therapy p     | HR Intern              | Finance & H   |
| 20    | 1601-20-672-020 | SIREESHA N                  | shirishashirisha84932@gm            | Online        | Vasista Enterprise  | Account Manager        | Finance & Lo  |
| 21    | 1601-20-672-021 | SOUMYA SRI BAGGAM           | s.sri.s.soumya@gmail.com            | Offline       | Studio Vriksh       | On site finance manag  | Finance       |
| 22    | 1601-20-672-022 | SUPRIYA                     | 2022supriya@gmail.com               | online        | GTM & sons pvt. It  | Financial trainee      | Finance       |
| 23    | 1601-20-672-023 | SUPRIYA MANDADA             |                                     |               |                     |                        |               |
| 24    | 1601-20-672-025 | SWETHA EMMIDI N S           | 9489729226                          | Sales and Ma  | TIMES OF INDIA      | Sales and Marketing    | Fin & Analy   |
| 25    | 1601-20-672-026 | TANUJA GUDAPATI             | tanujagudapati99@gmail.c            | online        | Bajaj Allianz       | HR                     | HR            |

| 26 | 1601-20-672-027 | TEJASWINI R                                    |                            |              |                      |                           |                |
|----|-----------------|--|----------------------------|--------------|----------------------|---------------------------|----------------|
| 27 | 1601-20-672-028 | VAISHNAVI BANDARU                              | Vaishnavibandaru02@gma     | Online       | Prudhviraj& assoc    | Financial Trainee         | Finance        |
| 28 | 1601-20-672-029 | VAISHNAVI REDDY MADI                           | Vaishnavireddy947@gmail.   | offline      | Rane Engine Valve    | HR                        | FInance and    |
| 29 | 1601-20-672-030 | VIHARI S                                       | 8096741467                 | HR Associate | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 30 | 1601-20-672-031 | ABHILASH MALYALA                               | pgs20031_mba.abhilash@o    | offline      | CBIT (A)             | HR Trainee                | HR             |
| 31 | 1601-20-672-032 | ANIL P   | pgs20032_mba.anil@cbit.c   | online       | Deloitte-USI         | Tax intern                | Finance        |
| 32 | 1601-20-672-033 | AVINASH BIRADAR                                | avinashbiradar23@gmail.co  | om           | growth arrow         | equity research ana       | finance        |
| 33 | 1601-20-672-034 | BHARATH KUMAR<br>ALLADI                        | kumar74469@gmail.com       | online       | NVR consultancy      | hr                        | hr and analyt  |
| 34 | 1601-20-672-035 | CHANDU NARAPARAJU                              |                            |              |                      |                           |                |
| 35 | 1601-20-672-036 | ESHWAR KIRAN ARPULA                            | eshwarkiran04@gmail.com    | Online       | Prudhviraj&associ    | Financial Trainee         | Finance        |
| 36 | 1601-20-672-037 | FAYAZ SK                                       | pgs20037_mba.fayaz@cbit    | Offline      | Diagnostic BioSyst   | Finance                   | Finance        |
| 37 | 1601-20-672-038 | GANESH KUMAR G                                 | pgs20038_ganesh@cbit.org   | Offline      | CBIT                 | Recruitment               | HR             |
| 38 | 1601-20-672-039 | HEMANTH SALPRASAD<br>RAJU PORANKI              | hemanth.poranki546@gma     | Part time    | Times of India       | Business developmen       | marketing      |
| 39 | 1601-20-672-040 | JAGADISH LAVUDYA                               |                            |              |                      |                           |                |
| 40 | 1601-20-672-041 | KODANDA SAI NIKHIL<br>PADAM                    | sainikhilpadam7@gmail.co   | HR           | Gao Tek Inc          | Human Resource Inte       | HR & Logistic: |
| 41 | 1601-20-672-042 | MOHAN S  |                            |              |                      |                           |                |
| 42 | 0               | NAVEEN KUMAR<br>MANTHRI<br>PAAVANA VENKATA SAI | 7780510001                 | Recruitment  | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 43 | 1601-20-672-044 | PAAVANA VENKATA SAI<br>MANIKONDA               | pgs20044_mba.paavana@o     | Offline      | R Krishna & Ass      | Auditing and Taxation     | Finance        |
| 44 | 1601-20-672-045 | PRASHANTH DAPPU                                |                            |              |                      |                           |                |
| 45 | 1601-20-672-046 | PRUDHVI ANUGULA                                | pgs20046_mba.prudhvi@c     | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 46 | 1601-20-672-047 | PRUDHVI RAJ MIRYALA                            | miryalaprudhviraj@gmail.c  | Summer Inte  | Learnovate ecomr     | Finance Intern            | Finance        |
| 47 | 1601-20-672-048 | PRUDHVI RAJ<br>PILLI ALAMARRI                  | pillalamarriprudhviraj@gm  | online       | Learnovate ecomr     | Finance intern            | Finance        |
| 48 | 1601-20-672-049 | RAJARAM BHUKYA                                 | pgs20049_mba.rajaram@c     | Offline      | Star Fitness Studio  | <b>Operations</b> Manager | Finance        |
| 49 | 1601-20-672-050 | RAMESH JAKKULA                                 | pgs20050_mba.ramesh@cl     | oit.org.in   | Sids farm private li | Sales and Marketing       | Marketing      |
| 50 | 1601-20-672-051 | SAI KIRAN VEMULA                               | pgs20051_mba.sai@cbit.or   | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 51 | 1601-20-672-052 |  | pgs20052_mba.samara@ct     | Offline      | Dhanavanthari Pvt    | Accounts Intern           | Finance        |
| 52 | 1601-20-672-053 | SRAVAN KUMAR<br>RENUKUNTI A                    | pgs20053_mba.sravan@cb     | part time    | Ifortis              | corporate ambassado       | marketing      |
| 53 | 1601-20-672-054 | SRI DATTA CHARAN K                             |                            |              |                      |                           |                |
| 54 | 1601-20-672-055 | SRINIVAS POSHETTI                              | poshettisrinivas5@gmail.co | Finance      | Suman chemical ir    | Financial Analyst and     | FINANCE        |
| 55 | 1601-20-672-056 | SUMANTH GORULA                                 | pgs20056_mba.sumanth@      |              | -                    | Marketing & Sales I       | -              |
| 56 | 1601-20-672-057 | VAMSHI SHIV VENAKATA<br>RAMESH TOOPATI         | pgs20057_mba.vamshi@cb     | Human Resou  | Oil and Natural Ga   | Human Resource Proc       | HR             |
| 57 | 1601-20-672-058 | VINAY KRISHNA KONJETI                          | pgs20058_mba.vinay@cbit    | Online       | Deloitte             | Tax Intern                | Finance        |
| 58 | 1601-20-672-059 | YASHWANTH GADDAM                               | pgs20059_mba.yashwanth     | offline      | Dhanavanthari P      | Accounts Intern           | Finance        |

| 59 | 1601-20-672-060 | YASHWANTH REDDY B                                  |                            | Online        | finaltics         | Investment Banking A   | finance      |
|----|-----------------|--|----------------------------|---------------|-------------------|------------------------|--------------|
| 60 | 1601-20-672-061 | ANUSHA REDDY M                                     |                            |               |                   |                        |              |
| 61 | 1601-20-672-062 | BRUNDAVANI HINDU S                                 | pgs20062_mba.brundavani    | online        | Times of India    | sales and marketing    | marketing ar |
| 62 | 1601-20-672-063 | CHAITANYA CHIRRA                                   | chirra.chaitanya1998@gma   | Summer Inte   | Times Of India    | Marketing Intern       | Finance & Bu |
| 63 | 1601-20-672-064 | CHANDANA PUNNA                                     | chandupunna2000@gmail.     | social media  | IMUN Campus Am    | Matketing              | Finance and  |
| 64 | 1601-20-672-065 | KEERTHANA MADGULA                                  | 6303692849                 | Sales and Ma  | TIMES OF INDIA    | Sales and Marketing    | Fin & Market |
| 65 | 1601-20-672-066 | LAKSHMI PRIYA K                                    |                            |               |                   |                        |              |
| 66 | 1601-20-672-067 | NAGA KEERTHI MAKAM                                 |                            |               |                   |                        |              |
| 67 | 1601-20-672-068 | NEEHARIKA DESETTI                                  | pgs20068_mba.neeharika@    | online        | ICICI bank        | counselor              | marketing    |
| 68 | 1601-20-672-069 | NIHARIKA M   | pgs20069_mba.niharika@c    | Online        | Times of India    | sales and Marketing    | Marketing    |
| 69 | 1601-20-672-070 | NIKITHA TELUGU                                     | pgs20070_mba.nikitha@cb    | Online        | shubham naari sha | Human resource         | HR           |
| 70 | 1601-20-672-071 | PRAVALLIKA REDDY<br>TRAIMELA<br>PREM KUMAR KEERTHI | pgs20071_mba.pravallika@   | Online        | iFortis Corporate | Marketing              | Marketing    |
| 71 | 1601-20-672-072 | PREM KUMAR KEERTHI<br>BAMAGALLA<br>PRIYALEKHA      | pgs20072_mba.prem@cbit     | part time     | Youth Empowerm    | HR                     | Human Reso   |
| 72 | 1601-20-672-073 | PRIYALEKHA<br>LINGAPLIRAM<br>SATYA SAI GOVERDHANI  | pgs20073_mba.priyalekha    | online        | TIMES OF INDIA    | Sales and marketing    | Marketing    |
| 73 | 1601-20-672-074 | SATYA SAI GOVERDHANI<br>VINEELA AINAPURAPU         | pgs20074_mba.satya@cbit    | offline       | AFCONS INFRASTR   | Accounts & Finance     | Finance      |
| 74 | 1601-20-672-075 | SHAIK NOOREAFSHA                                   | Pgs20075_mba.shaik@cbit    | Online        | Shubham Naari Sh  | HR intern              | HR           |
| 75 | 1601-20-672-076 | SHIRISHA GOVULA                                    |                            |               |                   |                        |              |
| 76 | 1601-20-672-077 | SRAVYA BOINDALA                                    | pgs20077_mba.sravya@cb     | online        | Times Of India    | sales and marketing    | Finance and  |
| 77 | 1601-20-672-078 | SWARNALIKA<br>VARUKOLU                             | pgs20078_mba.swarnalika    | Online        | Shine projects    | Human Resource inter   | Human Reso   |
| 78 | 1601-20-672-079 | SWATHI BUCHANPALLI                                 | Pgs20079_mba.swathi@cb     | Sales and ma  | Times of india    | Sales and marketing    | Fin& HR      |
| 79 | 1601-20-672-081 | VARA LAKSHMI PETERU                                | pgs20081_mba.varalakshm    | online        | Exposys Data Labs | Data Science           | Finance & BA |
| 80 | 1601-20-672-082 | VIJAYA LAKSHMI NALLAB                              | nvlakshminirula@gmail.cor  | HR            | shubham nari mah  | nila kaylan samiti NGO | HR and Busin |
| 81 | 1601-20-672-083 | VIJETHA KURUVA                                     |                            |               |                   |                        |              |
| 82 | 1601-20-672-084 | VINEETHA EEGA                                      | pgs20084_mba.vineetha@     | online        | Bajaj             | Recruitment and seled  | HR           |
| 83 | 1601-20-672-085 | ARUN KUMAR MATTAM                                  | 9398132821                 | Digital Marke | Exposys Data Labs | Digital Marketing      | Finance & LS |
| 84 | 1601-20-672-086 | BHANU PRAKASH<br>RAGAM<br>CHAITANYA JWALA          |                            |               |                   |                        |              |
| 85 | 1601-20-672-087 | CHAITANYA JWALA<br>MIDASALA                        | chaitanyajwala.cj.6@gmail. | Sales and Ma  | Times Of India    | Sales and Marketing    | Marketing    |
| 86 | 1601-20-672-088 | GANGADHAR ORAGANTI                                 | pgs20088_mba.ganmgadha     | Summer Inte   | Shubham Naari Sh  | Marketing Intern       | Finance and  |
| 87 | 1601-20-672-089 | HRUSHIKESH KANDALA                                 |                            |               |                   |                        |              |
| 88 | 1601-20-672-090 | KALYAN BANDI                                       | pgs20090_mba.kalyan@cb     | Teli marketin | g                 |                        |              |
| 89 | 1601-20-672-091 | KISHORE KUMAR D                                    |                            |               |                   |                        |              |
| 90 | 1601-20-672-093 | MAHENDER KORRA                                     | korramahender.1803@gma     | USER ENGAG    | WHITEHATJR        | USER ENGAGEMENT I      | MARKETING    |
| 91 | 1601-20-672-095 | MOHAMMED RASHAD ALI                                | pgs20095_mba.mohamme       | online        | Shubham Nari Sha  | Supply chain and Mar   | Supply chain |

| 92  | 1601-20-672-096 | MOHAN SWARGAM                           |                          |               |                     |                       |               |
|-----|-----------------|---|--------------------------|---------------|---------------------|-----------------------|---------------|
| 93  | 1601-20-672-097 | PAVAN KUMAR<br>SUDDALA                  | pavansuddala01@gmail.co  | Online        | Times of India      | Sales and Marketing i | Marketing     |
| 94  | 1601-20-672-098 | SUDDALA<br>RAJASHEKAR REDDY<br>VUDTHURU | pgs20098_mba.rajashekar( | Online        | Shubham Nari Sha    | Human Resources       | HR            |
| 95  | 1601-20-672-099 | RAVI SALCHINNI<br>PRAKASH               |                          |               |                     |                       |               |
| 96  | 1601-20-672-100 | RAVI TEJA KANUGANTI                     | 8686665939               | A Report on S | Sumega Technolog    | A Report on Social Me | Marketing     |
| 97  | 1601-20-672-101 | RISHI SAI VIGNESH G S                   |                          |               |                     |                       |               |
| 98  | 1601-20-672-102 | ROCHAN KOTA                             | pgs200102_mba.rochan@c   | Online        | Shriman Shares Ar   | Finance Intern        | Finance       |
| 99  | 1601-20-672-103 | ROHITH T                                | rohitht23@gmail.com, 837 | Summer Inte   | Times Of India      | Marketing Intern      | Finance & M   |
| 100 | 1601-20-672-104 | SAHADEVUDU<br>UNGARALA                  | pgs20104_mba.sahadevud   | Online        | AVISHKAR TECH SO    | DATA SCIENCE          | Business Ana  |
| 101 | 1601-20-672-105 | SAI KUMAR TALARI                        | pgs20105_mba.saikumar@   | Online        | TATA MOTORS         | Marketing Intern      | Marketing     |
| 102 | 1601-20-672-106 | SAI RAM NALLOLLA                        | pgs20106_mba.sai@cbit.or | Online        | TOI                 | Tele Marketing        | Marketing     |
| 103 | 1601-20-672-107 | SAI TEJA SAMALA                         | pgs20107_mba.sai@cbit.or | Online        | IfortisTimes of ind | Sales and Marketing   | Sales         |
| 104 | 1601-20-672-108 | SAI VARUN REDDY<br>DOMA                 |                          |               |                     |                       |               |
| 105 | 1601-20-672-109 | SAM SOURABH KINNERA                     | pgs20109_mba.sam@cbit.o  | Offline       | Oriental Insurance  | Marketing             | Marketing     |
| 106 | 1601-20-672-110 | SHAIK LATHEEF SAHEB                     | pgs20110_mba.shaik@cbit  | Summer Inte   | VIBGYOR             | Finance& Hr Intern    | Finance & HF  |
| 107 | 1601-20-672-111 | SHARATH KUMAR REDDY                     | bollaramsharathreddy22@  | gmail.com     |                     |                       |               |
| 108 | 1601-20-672-112 | SHIVA KUMAR NIMMA                       |                          |               |                     |                       |               |
| 109 | 1601-20-672-113 | SHIVA SANTHOSH<br>CHOLLETI              | pgs20113_mba.shiva@c     | Online        | Exposys data labsL  | Digital Marketing     | Marketing     |
| 110 | 1601-20-672-114 | SRICHARAN VELETI                        |                          |               |                     |                       |               |
| 111 | 1601-20-672-115 | SRIKANTH NAYAK                          | pgs200115_mba.srikanth@  | Offline       | Divya Textiles      | Supervisor for Produc | Finance       |
| 112 | 1601-20-672-116 | TRISHUL KOTAM                           | pgs20116_mba.trishul@cbi | offline       | Lexiko Infra Syster | HR co-ordinator       | HR            |
| 113 | 1601-20-672-117 | VENKATAKRISHNA REDDY ANNAPUREDDY        | pgs20117_mba.venkatakris | online        | Times Of India      | Sales and Marketing   | Marketing ar  |
| 114 | 1601-20-672-118 | VINAY PRAKASH<br>MADDIPATI              | pgs20118_mba.vinay@cbit  | Online        | Deloitte USI        | Tax intern            | Finance       |
| 115 | 1601-20-672-119 | VISHAL GOULIKAR                         | gowlikarvishal@gmail.com | Finance       | Shubham nari mal    | BDM                   | Finance and I |
| 116 | 1601-20-672-120 | VISHAL NAYANA                           |                          |               |                     |                       |               |

| Topic on<br>Internship<br>done(ex:<br>recuitment) | Duration of<br>internship<br>(start and End<br>dates) | Stipend      | Name of the<br>External<br>Guide | External guide Email address      | External guide Contact Number |
|---|---|--------------|----------------------------------|-----------------------------------|-------------------------------|
| 9   | 10  | 11           | 12                               | 13                                |                               |
| recruitment                                       | 2months(29/<br>06/2021 to<br>29/08/2021)              | nil          | sandhya                          | aims@buzibrains.com               |                               |
| recruiting, sales                                 | 45 days, 2 mor  | nths, 1 mont | h, 1 month                       |                                   |                               |
| Taxation, Bank F                                  |   |              |                                  | pgs20008_mba.harshita@cbit.org.in |                               |
| Sales   | 45 days   | No           |                                  |                                   |                               |
| recruitment                                       | 2 months  | 0            |                                  |                                   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20007_mba.monica@cbit.org.in   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20008_mba.mounika@cbit.org.in  |                               |
| Digital Marketin                                  |   |              | Mrs.Deepa                        | pgs20009_mba.nandini@cbit.org.in  |                               |
|   |   | nil          |                                  | 7337595637                        |                               |
| Recruitment                                       | 6th August 202  | nil          |                                  | pgs20011_mba.nazneen@cbit.org.in  |                               |
| HR  | 2 months  |              |                                  | 9111122118                        |                               |
| Recruitment                                       | 45 days(25/05,  |              | Nikhat                           |                                   |                               |
| Recruitment                                       | 16th May 2021   |              |                                  | aims@buzibrains.com               |                               |
| Recruitment                                       | 45days  | 21k          |                                  | hr@cbit.ac.in, 77022 18313        |                               |
| Recruitment                                       | 2 months  |              | shraddha                         | 7839517264                        |                               |
| Recruitment                                       | 45 days   | 21000        | Anne Voilet                      | hr@cbit.ac.in, 77022 18313        |                               |
| recruitment                                       | 45 days(25/05,  | nil          | Nikhat                           |                                   |                               |
| NA  | 2 Months  | NA           | Siddharth                        | sidddharth@havoctherapy.com       |                               |
| Accountant  | 2 Months  | 10,000       | Sravani                          | 7981340263                        |                               |
| Accountant  | 2&1/2 months  | 10,000       | Swetha Gauta                     | 9966933908                        |                               |
| Teaching about                                    | 1 July to 1 Sept                                      | Nil          |                                  | hr@gtmandsons.com                 | 8825335493                    |
| Sales and Marke                                   | 17-06-2021 to   | Nil          |                                  | pgs20025_mba.swetha@cbit.org.in   |                               |
| Recruitment                                       | 2 months  | Nil          |                                  |                                   |                               |

| Accounting, Dra       | 16th june to 1 | Nil     |               | ca.prudhviraj009@gmail.com        |            |
|-----------------------|----------------|---------|---------------|-----------------------------------|------------|
| Learning and De       |                | Nil     | G Satish Kum  | guntur.satishkumar@ranegroup.com, | 8688692815 |
| HR Associate          | 15th June to 1 | Nil     |               | pgs20030_mba.vihari@cbit.org.in   |            |
| Recruitment           | 06-07-2021 to  | 21000/- | Anne Violet   | hr@cbit.ac.in                     |            |
| UK Tax reporting      | 1st June 2021  | 25000   | Prateek Kulka | arni                              |            |
|                       | 2 Months       |         |               |                                   | 7799891255 |
| recruitment           |                |         | raghu         |                                   | 6302860884 |
| Accounting, Dra       | 8 months(16th  | Nil     | Prudhviraj    | ca.prudhviraj009@gmail.com        | 8639630059 |
| Basic Finance & A     | 16th August to | Nil     |               |                                   |            |
| Recruitment           | 45 days        | 21000   | Anne Voilet   | hr@cbit.ac.in, 77022 18313        |            |
| sales                 | 2 months       | nil     | najesh        | 9677141888                        |            |
| HR Management         | 3 Months       |         | Aparna Nallur | aparnanalluri@yahoo               |            |
| HR Associate          | 17-08-2021-17  | Nil     |               | pgs20043_mba.naveen@cbit.org.in   |            |
| Finance Executiv      | 28th June 20   | 5000    | Prashanth     | prashanth@rkrishna.in             | 7995589596 |
| Finance Executiv      | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |
| NA                    | 2 Months       | NA      | Ravi Singh    |                                   |            |
|                       | 45 days        | NA      |               |                                   |            |
| <b>Operations</b> Man | 90 Days(12.07  | 20000   | Mr. Mohd. Ja  | 8883244445                        |            |
| Lead generation       | , Branding,    | 45 Days |               | 5K stipend                        |            |
| Finance Executiv      | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |
| Accounting Mar        | 45 days        | Nil     | Mr. Ramacha   | ndra Raju                         |            |
| sales funnel          | 2 months       | nil     | Architha      | 9.18247E+11                       |            |
| Indepth researc       | 2 months       |         | Sumeet maar   | 7434074794                        |            |
| sales and marl        | 45 Days        | nil     |               |                                   |            |
| Employees Perc        | 45days         | nil     | Rajesh Kaleku | 9490168003                        |            |
| UK Taxation           | 39 days        | 25000   | Mr. Amit Kun  | 9844178229                        |            |
| Accounting Mar        | 45 days        | nil     | Mr. Ramacha   | ndra Raju                         |            |

408 / 426

| Investment ban  | 2 months        | nil       | Nishika Sharn | 7208112389                          |
|-----------------|-----------------|-----------|---------------|-------------------------------------|
|                 |                 |           |               |                                     |
| sales and marke |                 | nill      | nagesh        |                                     |
| NA              | 2 Months        | NA        | Nagesh        | 9677141888                          |
| Marketing       | 5 weeks         | Nil       |               | pgs20064_mba.chandana@cbit.org.in   |
| Sales and Marke | 17-06-2021 to   | Nil       |               | pgs20065_mba.keerthana@cbit.org.in  |
|                 |                 |           |               |                                     |
| marketing       | 1-7-2021 to 1-9 |           | Dilip Kumar   | dilip17893@gmail.com                |
| sales           | 2 Months        | nil       | Nagesh        | 9.19677E+11                         |
| Recruitment     | 45Days          | Nil       |               |                                     |
| sales and marl  | 45 Days         | Nil       |               |                                     |
| Recruiting      |                 | nil       | Tapashya      | 9618267848                          |
| Sales and marke |                 | nill      | Nagesh        |                                     |
| Accounts & Fina | 12.08.2021 to   | nil       | Vaithy Krishn | vaithy@afcons.com                   |
| Recruiting      | 06.07.2021 to   | Nil       | Archie        |                                     |
| Sales and Marke | 2 months        |           | Nagesh        | 9677141888                          |
| Recruitment     | 22-06-2021 to   | NIL       | Sriharsha     | sriharsha@shineprojects.in          |
| Marketing       | 2months         | Nil       | Ravi          | Pgs20078_mba.swathi@cbit.org.in     |
| Data Science    | 1month          | nil       |               |                                     |
| ess analytics   | 2 months        |           |               |                                     |
| recruitment     | 6 weeks         | nill      |               |                                     |
| Marketing       | 1 month         | nil       | Vishnuvardha  | pgs20085_mba.arun@cbit.org.in       |
| Marketing       | 2 months        | Nil       | Ravi          | RaviKumar.Pasupuleti@timesgroup.cor |
| NA              | 45 days         | Na        | Anushka Priya | priyaanushka2002@gmail.com          |
|                 |                 |           |               |                                     |
| Presales        | 3 Months        | 12000/ Pm | Rahul Swami   | 7738772969                          |
| Promotion       | 2 months        | Nil       |               |                                     |

| Sales             | 2 months       | Nill      | Nagesh                                   |                               |
|-------------------|----------------|-----------|--|-------------------------------|
| Recruitment       | 45 days(08-07- | Nil       |  |                               |
|                   |                |           |  |                               |
| A Report on Soc   | ial Media Mark | eting     |  | pgs20100_mba.ravi@cbit.org.in |
| Mutual Funds Po   | 4E days (02.08 | NII       | Mr.Raja Redo                             |                               |
|                   | 2 Months       |           | ,  | ,<br>T                        |
| NA                |                | NA        | Nagesh                                   | 9677141888                    |
| Data Science      | 45 days        | Nil       |  |                               |
| Customer Relati   |                | Nil       | Mr. Shashi                               |                               |
| Tele Marketing    | 8 weeks        | Nil       | Mr. Ravi                                 | 9963090279                    |
| Sales             | 45 Days2 mont  | hs2 month | s  |                               |
| Markating prost   | 4E dave        | Nil       | D.satish Babı                            | l                             |
| Marketing pract   |                |           |  |                               |
| NA                | 2 Months       | NA        | Eesh                                     | 9930238370                    |
|                   |                |           |  |                               |
| Digital Marketi   | 1 month1 mon   | Nil       |  |                               |
| Inventory Mana    | 70 days        | Nil       | Mr. Vijay                                | 7069890949                    |
| Recruitment       | 45 days        | Nil       |  |                               |
| Sales and marke   |                | Nil       | Ms. Bachu Radhika<br>Kiran Kumar 9885318 |                               |
|                   |                |           |  |                               |
| UK Tax reporting  |                |           | Akshay Rao                               | akshaymrao@gmail.com          |
| Business Analytic | Zmonths        | Nill      | Yashika                                  | 9642265734                    |
|                   |                |           |  |                               |

| S.No. | R.No.           | Name of the Student         | Student Email and<br>Contact Number | Internship    | Company in<br>which internship | Title of the<br>Internship given to<br>student(ex:seo<br>analyst) | Specializatio<br>n on<br>internship<br>done |
|-------|-----------------|-----------------------------|-------------------------------------|---------------|--------------------------------|---|---|
| 1     | 2               | 3                           | 4                                   | 5             | 6                              | 7   | 8   |
| 1     | 1601-20-672-001 | AKHILA ANNASARAM            | akhila2198@gmail.com,<br>9640614291 | online        | Buzibrains                     | online HR Co-ordinato   | HR  |
| 2     | 1601-20-672-002 | ASHFIYA NASEERUDDIN<br>SYED | Ashfiyasyed2000mj@gmail             | online        | IFORTIS WORLDW                 | HR, DIGITAL MARKET  | HR  |
| 3     | 1601-20-672-003 | BHAGYASREE<br>KADIMICHERLA  |                                     |               |                                |   |   |
| 4     | 1601-20-672-004 | HARSHITHA MUTHYALA          | 8008680589                          |               | Trivision integrate            | Taxation, Bank Recon  | Fin & Market                                |
| 5     | 1601-20-672-005 | LAHARI ANUMANDLA            | laharianumandla99@gmail             | online        | AIM India                      | Intern  | Finance and                                 |
| 6     | 1601-20-672-006 | MEGHANA REDDY SANVE         | meghana.sanvelli@gmail.co           | online        | FITIG Association              | HR  | HR and LOGI                                 |
| 7     | 1601-20-672-007 | MONICA AKUNOORI             | monica13.aku@gmail.com              | offline       | Gratisol Labs                  | Digital Marketing inte  | Finance and                                 |
| 8     | 1601-20-672-008 | MOUNIKA JARAPLA             | mounikareddy5589@gmail              | offline       | Gratisol Labs                  | Digital Marketing inte  | Finance and                                 |
| 9     | 1601-20-672-009 | NANDINI BADIKE              | nandinibadike4@gmail.con            | offline       | Chemtopes                      | Marketing and sales   | Marketing                                   |
| 10    | 1601-20-672-010 | NAVYA PRIYADARSHIINI        | navya0636@gmail.com                 | Part time     | Ifortis                        | Human Resources   | HR  |
| 11    | 1601-20-672-011 | NAZNEEN INTESHA             | inteshanazneen@gmail.cor            | online        | FITIG Association              | Human resource inter  | Finance and                                 |
| 12    | 1601-20-672-012 | NISMA                       | nisma206aijaz@gmail.com             | HR            | shubham nari mah               | nila kaylan samiti NGO  | Finance and I                               |
| 13    | 1601-20-672-013 | PRINCESS GADDAMEEDI         | princessg561@gmail.com,             | online        | ifortis world wide             | Hr trainee  | HR  |
| 14    | 1601-20-672-014 | REVATHI J                   | pgs20116_mba.trishul@cb             | online        | BuziBrAlns                     | online HR Co-ordinato   | HR  |
| 15    | 1601-20-672-015 | RINKU KUMARI                | rinkukumari3843@gmail.co            | HR internship | CBIT                           | Recruitment   | HR  |
| 16    | 1601-20-672-016 | RUCHITHA MUCHARLA           | reddy.ruchitha8@gmail.coi           | HR            | career dreams edu              | Human resource and a  | HR n marketi                                |
| 17    | 1601-20-672-017 | SAHADEV KANCHAN<br>SINGH    | pgs20017_mba.sahadev@c              | Offline       | CBIT                           | Recruitment   | HR  |
| 18    | 1601-20-672-018 | SAMYUKTHA<br>YADAVELLY      | samyukthayadavelly@gma              | online        | Ifortis world wide             | Hr trainee  | HR  |
| 19    | 1601-20-672-019 | SATYAVENI BODASINGU         | bodasingukanchan@gma                | Summer Inte   | Havoc Therapy p                | HR Intern   | Finance & H                                 |
| 20    | 1601-20-672-020 | SIREESHA N                  | shirishashirisha84932@gm            | Online        | Vasista Enterprise             | Account Manager   | Finance & Lo                                |
| 21    | 1601-20-672-021 | SOUMYA SRI BAGGAM           | s.sri.s.soumya@gmail.com            | Offline       | Studio Vriksh                  | On site finance manag   | Finance                                     |
| 22    | 1601-20-672-022 | SUPRIYA                     | 2022supriya@gmail.com               | online        | GTM & sons pvt. It             | Financial trainee   | Finance                                     |
| 23    | 1601-20-672-023 | SUPRIYA MANDADA             |                                     |               |                                |   |   |
| 24    | 1601-20-672-025 | SWETHA EMMIDI N S           | 9489729226                          | Sales and Ma  | TIMES OF INDIA                 | Sales and Marketing   | Fin & Analy                                 |
| 25    | 1601-20-672-026 | TANUJA GUDAPATI             | tanujagudapati99@gmail.c            |               |                                | HR  | ,<br>HR                                     |

| 26 | 1601-20-672-027 | TEJASWINI R                                    |                            |              |                      |                           |                |
|----|-----------------|--|----------------------------|--------------|----------------------|---------------------------|----------------|
| 27 | 1601-20-672-028 | VAISHNAVI BANDARU                              | Vaishnavibandaru02@gma     | Online       | Prudhviraj& assoc    | Financial Trainee         | Finance        |
| 28 | 1601-20-672-029 | VAISHNAVI REDDY MADI                           | Vaishnavireddy947@gmail.   | offline      | Rane Engine Valve    | HR                        | FInance and    |
| 29 | 1601-20-672-030 | VIHARI S                                       | 8096741467                 | HR Associate | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 30 | 1601-20-672-031 | ABHILASH MALYALA                               | pgs20031_mba.abhilash@o    | offline      | CBIT (A)             | HR Trainee                | HR             |
| 31 | 1601-20-672-032 | ANIL P   | pgs20032_mba.anil@cbit.c   | online       | Deloitte-USI         | Tax intern                | Finance        |
| 32 | 1601-20-672-033 | AVINASH BIRADAR                                | avinashbiradar23@gmail.co  | om           | growth arrow         | equity research ana       | finance        |
| 33 | 1601-20-672-034 | BHARATH KUMAR<br>ALLADI                        | kumar74469@gmail.com       | online       | NVR consultancy      | hr                        | hr and analyt  |
| 34 | 1601-20-672-035 | CHANDU NARAPARAJU                              |                            |              |                      |                           |                |
| 35 | 1601-20-672-036 | ESHWAR KIRAN ARPULA                            | eshwarkiran04@gmail.com    | Online       | Prudhviraj&associ    | Financial Trainee         | Finance        |
| 36 | 1601-20-672-037 | FAYAZ SK                                       | pgs20037_mba.fayaz@cbit    | Offline      | Diagnostic BioSyst   | Finance                   | Finance        |
| 37 | 1601-20-672-038 | GANESH KUMAR G                                 | pgs20038_ganesh@cbit.org   | Offline      | CBIT                 | Recruitment               | HR             |
| 38 | 1601-20-672-039 | HEMANTH SALPRASAD<br>RAJU PORANKI              | hemanth.poranki546@gma     | Part time    | Times of India       | Business developmen       | marketing      |
| 39 | 1601-20-672-040 | JAGADISH LAVUDYA                               |                            |              |                      |                           |                |
| 40 | 1601-20-672-041 | KODANDA SAI NIKHIL<br>PADAM                    | sainikhilpadam7@gmail.co   | HR           | Gao Tek Inc          | Human Resource Inte       | HR & Logistic: |
| 41 | 1601-20-672-042 | MOHAN S  |                            |              |                      |                           |                |
| 42 | 0               | NAVEEN KUMAR<br>MANTHRI<br>PAAVANA VENKATA SAI | 7780510001                 | Recruitment  | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 43 | 1601-20-672-044 | PAAVANA VENKATA SAI<br>MANIKONDA               | pgs20044_mba.paavana@o     | Offline      | R Krishna & Ass      | Auditing and Taxation     | Finance        |
| 44 | 1601-20-672-045 | PRASHANTH DAPPU                                |                            |              |                      |                           |                |
| 45 | 1601-20-672-046 | PRUDHVI ANUGULA                                | pgs20046_mba.prudhvi@c     | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 46 | 1601-20-672-047 | PRUDHVI RAJ MIRYALA                            | miryalaprudhviraj@gmail.c  | Summer Inte  | Learnovate ecomr     | Finance Intern            | Finance        |
| 47 | 1601-20-672-048 | PRUDHVI RAJ<br>PILLI ALAMARRI                  | pillalamarriprudhviraj@gm  | online       | Learnovate ecomr     | Finance intern            | Finance        |
| 48 | 1601-20-672-049 | RAJARAM BHUKYA                                 | pgs20049_mba.rajaram@c     | Offline      | Star Fitness Studio  | <b>Operations</b> Manager | Finance        |
| 49 | 1601-20-672-050 | RAMESH JAKKULA                                 | pgs20050_mba.ramesh@cl     | oit.org.in   | Sids farm private li | Sales and Marketing       | Marketing      |
| 50 | 1601-20-672-051 | SAI KIRAN VEMULA                               | pgs20051_mba.sai@cbit.or   | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 51 | 1601-20-672-052 |  | pgs20052_mba.samara@ct     | Offline      | Dhanavanthari Pvt    | Accounts Intern           | Finance        |
| 52 | 1601-20-672-053 | SRAVAN KUMAR<br>RENUKUNTI A                    | pgs20053_mba.sravan@cb     | part time    | Ifortis              | corporate ambassado       | marketing      |
| 53 | 1601-20-672-054 | SRI DATTA CHARAN K                             |                            |              |                      |                           |                |
| 54 | 1601-20-672-055 | SRINIVAS POSHETTI                              | poshettisrinivas5@gmail.co | Finance      | Suman chemical ir    | Financial Analyst and     | FINANCE        |
| 55 | 1601-20-672-056 | SUMANTH GORULA                                 | pgs20056_mba.sumanth@      |              | -                    | Marketing & Sales I       | -              |
| 56 | 1601-20-672-057 | VAMSHI SHIV VENAKATA<br>RAMESH TOOPATI         | pgs20057_mba.vamshi@cb     | Human Resou  | Oil and Natural Ga   | Human Resource Proc       | HR             |
| 57 | 1601-20-672-058 | VINAY KRISHNA KONJETI                          | pgs20058_mba.vinay@cbit    | Online       | Deloitte             | Tax Intern                | Finance        |
| 58 | 1601-20-672-059 | YASHWANTH GADDAM                               | pgs20059_mba.yashwanth     | offline      | Dhanavanthari P      | Accounts Intern           | Finance        |

| 59 | 1601-20-672-060 | YASHWANTH REDDY B                                  |                            | Online        | finaltics         | Investment Banking A  | finance      |
|----|-----------------|--|----------------------------|---------------|-------------------|-----------------------|--------------|
| 60 | 1601-20-672-061 | ANUSHA REDDY M                                     |                            |               |                   |                       |              |
| 61 | 1601-20-672-062 | BRUNDAVANI HINDU S                                 | pgs20062_mba.brundavani    | online        | Times of India    | sales and marketing   | marketing ar |
| 62 | 1601-20-672-063 | CHAITANYA CHIRRA                                   | chirra.chaitanya1998@gma   | Summer Inte   | Times Of India    | Marketing Intern      | Finance & Bu |
| 63 | 1601-20-672-064 | CHANDANA PUNNA                                     | chandupunna2000@gmail.     | social media  | IMUN Campus Am    | Matketing             | Finance and  |
| 64 | 1601-20-672-065 | KEERTHANA MADGULA                                  | 6303692849                 | Sales and Ma  | TIMES OF INDIA    | Sales and Marketing   | Fin & Market |
| 65 | 1601-20-672-066 | LAKSHMI PRIYA K                                    |                            |               |                   |                       |              |
| 66 | 1601-20-672-067 | NAGA KEERTHI MAKAM                                 |                            |               |                   |                       |              |
| 67 | 1601-20-672-068 | NEEHARIKA DESETTI                                  | pgs20068_mba.neeharika@    | online        | ICICI bank        | counselor             | marketing    |
| 68 | 1601-20-672-069 | NIHARIKA M   | pgs20069_mba.niharika@c    | Online        | Times of India    | sales and Marketing   | Marketing    |
| 69 | 1601-20-672-070 | NIKITHA TELUGU                                     | pgs20070_mba.nikitha@cb    | Online        | shubham naari sha | Human resource        | HR           |
| 70 | 1601-20-672-071 | PRAVALLIKA REDDY<br>TRAIMELA<br>PREM KUMAR KEERTHI | pgs20071_mba.pravallika@   | Online        | iFortis Corporate | Marketing             | Marketing    |
| 71 | 1601-20-672-072 | PREM KUMAR KEERTHI<br>BAMAGALLA<br>PRIYALEKHA      | pgs20072_mba.prem@cbit     | part time     | Youth Empowerm    | HR                    | Human Reso   |
| 72 | 1601-20-672-073 | PRIYALEKHA<br>LINGAPURAM<br>SATYA SATGOVERDHANI    | pgs20073_mba.priyalekha@   | online        | TIMES OF INDIA    | Sales and marketing   | Marketing    |
| 73 | 1601-20-672-074 | SATYA SALGOVERDHANI<br>VINEELA AINAPURAPU          | pgs20074_mba.satya@cbit    | offline       | AFCONS INFRASTR   | Accounts & Finance    | Finance      |
| 74 | 1601-20-672-075 | SHAIK NOOREAFSHA                                   | Pgs20075_mba.shaik@cbit    | Online        | Shubham Naari Sh  | HR intern             | HR           |
| 75 | 1601-20-672-076 | SHIRISHA GOVULA                                    |                            |               |                   |                       |              |
| 76 | 1601-20-672-077 | SRAVYA BOINDALA                                    | pgs20077_mba.sravya@cb     | online        | Times Of India    | sales and marketing   | Finance and  |
| 77 | 1601-20-672-078 | SWARNALIKA<br>VARUKOLU                             | pgs20078_mba.swarnalika    | Online        | Shine projects    | Human Resource inte   | Human Reso   |
| 78 | 1601-20-672-079 | SWATHI BUCHANPALLI                                 | Pgs20079_mba.swathi@cb     | Sales and ma  | Times of india    | Sales and marketing   | Fin& HR      |
| 79 | 1601-20-672-081 | VARA LAKSHMI PETERU                                | pgs20081_mba.varalakshm    | online        | Exposys Data Labs | Data Science          | Finance & BA |
| 80 | 1601-20-672-082 | VIJAYA LAKSHMI NALLAB                              | nvlakshminirula@gmail.cor  | HR            | shubham nari mah  | ila kaylan samiti NGO | HR and Busin |
| 81 | 1601-20-672-083 | VIJETHA KURUVA                                     |                            |               |                   |                       |              |
| 82 | 1601-20-672-084 | VINEETHA EEGA                                      | pgs20084_mba.vineetha@     | online        | Bajaj             | Recruitment and seled | HR           |
| 83 | 1601-20-672-085 | ARUN KUMAR MATTAM                                  | 9398132821                 | Digital Marke | Exposys Data Labs | Digital Marketing     | Finance & LS |
| 84 | 1601-20-672-086 | BHANU PRAKASH<br>RAGAM<br>CHAILANYA JWALA          |                            |               |                   |                       |              |
| 85 | 1601-20-672-087 | CHAITANYA JWALA<br>MIDASALA                        | chaitanyajwala.cj.6@gmail. | Sales and Ma  | Times Of India    | Sales and Marketing   | Marketing    |
| 86 | 1601-20-672-088 | GANGADHAR ORAGANTI                                 | pgs20088_mba.ganmgadha     | Summer Inte   | Shubham Naari Sh  | Marketing Intern      | Finance and  |
| 87 | 1601-20-672-089 | HRUSHIKESH KANDALA                                 |                            |               |                   |                       |              |
| 88 | 1601-20-672-090 | KALYAN BANDI                                       | pgs20090_mba.kalyan@cb     | Teli marketin | g                 |                       |              |
| 89 | 1601-20-672-091 | KISHORE KUMAR D                                    |                            |               |                   |                       |              |
| 90 | 1601-20-672-093 | MAHENDER KORRA                                     | korramahender.1803@gma     | USER ENGAG    | WHITEHATJR        | USER ENGAGEMENT I     | MARKETING    |
| 91 | 1601-20-672-095 | MOHAMMED RASHAD ALI                                | pgs20095_mba.mohamme       | online        | Shubham Nari Sha  | Supply chain and Mar  | Supply chain |

| 92  | 1601-20-672-096 | MOHAN SWARGAM                           |                          |               |                     |                       |               |
|-----|-----------------|---|--------------------------|---------------|---------------------|-----------------------|---------------|
| 93  | 1601-20-672-097 | PAVAN KUMAR<br>SUDDALA                  | pavansuddala01@gmail.co  | Online        | Times of India      | Sales and Marketing i | Marketing     |
| 94  | 1601-20-672-098 | SUDDALA<br>RAJASHEKAR REDDY<br>VUDTHURU | pgs20098_mba.rajashekar( | Online        | Shubham Nari Sha    | Human Resources       | HR            |
| 95  | 1601-20-672-099 | RAVI SALCHINNI<br>PRAKASH               |                          |               |                     |                       |               |
| 96  | 1601-20-672-100 | RAVI TEJA KANUGANTI                     | 8686665939               | A Report on S | Sumega Technolog    | A Report on Social Me | Marketing     |
| 97  | 1601-20-672-101 | RISHI SAI VIGNESH G S                   |                          |               |                     |                       |               |
| 98  | 1601-20-672-102 | ROCHAN KOTA                             | pgs200102_mba.rochan@c   | Online        | Shriman Shares Ar   | Finance Intern        | Finance       |
| 99  | 1601-20-672-103 | ROHITH T                                | rohitht23@gmail.com, 837 | Summer Inte   | Times Of India      | Marketing Intern      | Finance & M   |
| 100 | 1601-20-672-104 | SAHADEVUDU<br>UNGARALA                  | pgs20104_mba.sahadevud   | Online        | AVISHKAR TECH SO    | DATA SCIENCE          | Business Ana  |
| 101 | 1601-20-672-105 | SAI KUMAR TALARI                        | pgs20105_mba.saikumar@   | Online        | TATA MOTORS         | Marketing Intern      | Marketing     |
| 102 | 1601-20-672-106 | SAI RAM NALLOLLA                        | pgs20106_mba.sai@cbit.or | Online        | ΤΟΙ                 | Tele Marketing        | Marketing     |
| 103 | 1601-20-672-107 | SAI TEJA SAMALA                         | pgs20107_mba.sai@cbit.or | Online        | IfortisTimes of ind | Sales and Marketing   | Sales         |
| 104 | 1601-20-672-108 | SAI VARUN REDDY<br>DOMA                 |                          |               |                     |                       |               |
| 105 | 1601-20-672-109 | SAM SOURABH KINNERA                     | pgs20109_mba.sam@cbit.o  | Offline       | Oriental Insurance  | Marketing             | Marketing     |
| 106 | 1601-20-672-110 | SHAIK LATHEEF SAHEB                     | pgs20110_mba.shaik@cbit  | Summer Inte   | VIBGYOR             | Finance& Hr Intern    | Finance & HF  |
| 107 | 1601-20-672-111 | SHARATH KUMAR REDDY                     | bollaramsharathreddy22@  | gmail.com     |                     |                       |               |
| 108 | 1601-20-672-112 | SHIVA KUMAR NIMMA                       |                          |               |                     |                       |               |
| 109 | 1601-20-672-113 | SHIVA SANTHOSH<br>CHOLLETI              | pgs20113_mba.shiva@c     | Online        | Exposys data labsL  | Digital Marketing     | Marketing     |
| 110 | 1601-20-672-114 | SRICHARAN VELETI                        |                          |               |                     |                       |               |
| 111 | 1601-20-672-115 | SRIKANTH NAYAK                          | pgs200115_mba.srikanth@  | Offline       | Divya Textiles      | Supervisor for Produc | Finance       |
| 112 | 1601-20-672-116 | TRISHUL KOTAM                           | pgs20116_mba.trishul@cbi | offline       | Lexiko Infra Syster | HR co-ordinator       | HR            |
| 113 | 1601-20-672-117 | VENKATAKRISHNA REDDY ANNAPUREDDY        | pgs20117_mba.venkatakris | online        | Times Of India      | Sales and Marketing   | Marketing ar  |
| 114 | 1601-20-672-118 | VINAY PRAKASH<br>MADDIPATI              | pgs20118_mba.vinay@cbit  | Online        | Deloitte USI        | Tax intern            | Finance       |
| 115 | 1601-20-672-119 | VISHAL GOULIKAR                         | gowlikarvishal@gmail.com | Finance       | Shubham nari mal    | BDM                   | Finance and I |
| 116 | 1601-20-672-120 | VISHAL NAYANA                           |                          |               |                     |                       |               |

| Topic on<br>Internship<br>done(ex:<br>recuitment) | Duration of<br>internship<br>(start and End<br>dates) | Stipend      | Name of the<br>External<br>Guide | External guide Email address      | External guide Contact Number |
|---|---|--------------|----------------------------------|-----------------------------------|-------------------------------|
| 9   | 10  | 11           | 12                               | 13                                |                               |
| recruitment                                       | 2months(29/<br>06/2021 to<br>29/08/2021)              | nil          | sandhya                          | aims@buzibrains.com               |                               |
| recruiting, sales                                 | 45 days, 2 mor  | nths, 1 mont | h, 1 month                       |                                   |                               |
| Taxation, Bank F                                  |   |              |                                  | pgs20008_mba.harshita@cbit.org.in |                               |
| Sales   | 45 days   | No           |                                  |                                   |                               |
| recruitment                                       | 2 months  | 0            |                                  |                                   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20007_mba.monica@cbit.org.in   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20008_mba.mounika@cbit.org.in  |                               |
| Digital Marketin                                  |   |              | Mrs.Deepa                        | pgs20009_mba.nandini@cbit.org.in  |                               |
| Recruiting  |   | nil          |                                  | 7337595637                        |                               |
| Recruitment                                       | 6th August 202  | nil          |                                  | pgs20011_mba.nazneen@cbit.org.in  |                               |
| HR  | 2 months  |              |                                  | 9111122118                        |                               |
| Recruitment                                       | 45 days(25/05,  | nil          | Nikhat                           |                                   |                               |
| Recruitment                                       | 16th May 2021   | nill         | Sandhya, Ank                     | aims@buzibrains.com               |                               |
| Recruitment                                       | 45days  | 21k          |                                  | hr@cbit.ac.in, 77022 18313        |                               |
| Recruitment                                       | 2 months  |              | shraddha                         | 7839517264                        |                               |
| Recruitment                                       | 45 days   | 21000        | Anne Voilet                      | hr@cbit.ac.in, 77022 18313        |                               |
| recruitment                                       | 45 days(25/05,  | nil          | Nikhat                           |                                   |                               |
| NA  | 2 Months  | NA           | Siddharth                        | sidddharth@havoctherapy.com       |                               |
| Accountant  | 2 Months  | 10,000       | Sravani                          | 7981340263                        |                               |
| Accountant  | 2&1/2 months  | 10,000       | Swetha Gauta                     | 9966933908                        |                               |
| Teaching about                                    | 1 July to 1 Sept                                      | Nil          |                                  | hr@gtmandsons.com                 | 8825335493                    |
| Sales and Marke                                   | 17-06-2021 to   | Nil          |                                  | pgs20025_mba.swetha@cbit.org.in   |                               |
| Recruitment                                       | 2 months  | Nil          |                                  |                                   |                               |

| Accounting, Dra       | 16th june to 1 | Nil     |               | ca.prudhviraj009@gmail.com        |            |
|-----------------------|----------------|---------|---------------|-----------------------------------|------------|
| Learning and De       |                | Nil     | G Satish Kum  | guntur.satishkumar@ranegroup.com, | 8688692815 |
| HR Associate          | 15th June to 1 | Nil     |               | pgs20030_mba.vihari@cbit.org.in   |            |
| Recruitment           | 06-07-2021 to  | 21000/- | Anne Violet   | hr@cbit.ac.in                     |            |
| UK Tax reporting      | 1st June 2021  | 25000   | Prateek Kulka | arni                              |            |
|                       | 2 Months       |         |               |                                   | 7799891255 |
| recruitment           |                |         | raghu         |                                   | 6302860884 |
| Accounting, Dra       | 8 months(16th  | Nil     | Prudhviraj    | ca.prudhviraj009@gmail.com        | 8639630059 |
| Basic Finance & A     | 16th August to | Nil     |               |                                   |            |
| Recruitment           | 45 days        | 21000   | Anne Voilet   | hr@cbit.ac.in, 77022 18313        |            |
| sales                 | 2 months       | nil     | najesh        | 9677141888                        |            |
| HR Management         | 3 Months       |         | Aparna Nallur | aparnanalluri@yahoo               |            |
| HR Associate          | 17-08-2021-17  | Nil     |               | pgs20043_mba.naveen@cbit.org.in   |            |
| Finance Executiv      | 28th June 20   | 5000    | Prashanth     | prashanth@rkrishna.in             | 7995589596 |
| Finance Executiv      | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |
| NA                    | 2 Months       | NA      | Ravi Singh    |                                   |            |
|                       | 45 days        | NA      |               |                                   |            |
| <b>Operations</b> Man | 90 Days(12.07  | 20000   | Mr. Mohd. Ja  | 8883244445                        |            |
| Lead generation       | , Branding,    | 45 Days |               | 5K stipend                        |            |
| Finance Executiv      | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |
| Accounting Mar        | 45 days        | Nil     | Mr. Ramacha   | ndra Raju                         |            |
| sales funnel          | 2 months       | nil     | Architha      | 9.18247E+11                       |            |
| Indepth researc       | 2 months       |         | Sumeet maar   | 7434074794                        |            |
| sales and marl        | 45 Days        | nil     |               |                                   |            |
| Employees Perc        | 45days         | nil     | Rajesh Kaleku | 9490168003                        |            |
| UK Taxation           | 39 days        | 25000   | Mr. Amit Kun  | 9844178229                        |            |
| Accounting Mar        | 45 days        | nil     | Mr. Ramacha   | ndra Raju                         |            |

416 / 426

| Investment ban  | 2 months       | nil       | Nishika Sharn | 7208112389                          |
|-----------------|----------------|-----------|---------------|-------------------------------------|
|                 |                |           |               |                                     |
| sales and marke |                | nill      | nagesh        |                                     |
| NA              | 2 Months       | NA        | Nagesh        | 9677141888                          |
| Marketing       | 5 weeks        | Nil       |               | pgs20064_mba.chandana@cbit.org.in   |
| Sales and Marke | ≘17-06-2021 to | Nil       |               | pgs20065_mba.keerthana@cbit.org.in  |
|                 |                |           |               |                                     |
| marketing       | 1-7-2021 to 1- |           | Dilip Kumar   | dilip17893@gmail.com                |
| sales           | 2 Months       | nil       | Nagesh        | 9.19677E+11                         |
| Recruitment     | 45Days         | Nil       |               |                                     |
| sales and mar   | 45 Days        | Nil       |               |                                     |
| Recruiting      |                | nil       | Tapashya      | 9618267848                          |
| Sales and marke |                | nill      | Nagesh        |                                     |
| Accounts & Fina |                |           | -             | vaithy@afcons.com                   |
| Recruiting      | 06.07.2021 to  | Nil       | Archie        |                                     |
| Sales and Marke | 2 months       |           | Nagesh        | 9677141888                          |
| Recruitment     | 22-06-2021 to  | NIL       | Sriharsha     | sriharsha@shineprojects.in          |
| Marketing       | 2months        | Nil       | Ravi          | Pgs20078_mba.swathi@cbit.org.in     |
| Data Science    | 1month         | nil       |               |                                     |
| ess analytics   | 2 months       |           |               |                                     |
| recruitment     | 6 weeks        | nill      |               |                                     |
| Marketing       | 1 month        | nil       | Vishnuvardha  | pgs20085_mba.arun@cbit.org.in       |
| Marketing       | 2 months       | Nil       | Ravi          | RaviKumar.Pasupuleti@timesgroup.con |
| NA              | 45 days        | Na        | Anushka Priya | priyaanushka2002@gmail.com          |
|                 |                |           |               |                                     |
| Presales        | 3 Months       | 12000/ Pm | Rahul Swami   | 7738772969                          |
| Promotion       | 2 months       | Nil       |               |                                     |

| Sales             | 2 months       | Nill      | Nagesh                                   |                               |
|-------------------|----------------|-----------|--|-------------------------------|
| Recruitment       | 45 days(08-07- | Nil       |  |                               |
|                   |                |           |  |                               |
| A Report on Soc   | ial Media Mark | eting     |  | pgs20100_mba.ravi@cbit.org.in |
| Mutual Funds Po   | 4E days (02.08 | NII       | Mr.Raja Redo                             |                               |
|                   | 2 Months       |           | · · · ·                                  | ,<br>T                        |
| NA                |                | NA        | Nagesh                                   | 9677141888                    |
| Data Science      | 45 days        | Nil       |  |                               |
| Customer Relati   |                | Nil       | Mr. Shashi                               |                               |
| Tele Marketing    | 8 weeks        | Nil       | Mr. Ravi                                 | 9963090279                    |
| Sales             | 45 Days2 mont  | hs2 month | s  |                               |
| Markating prost   | 4E dave        | Nil       | D.satish Babı                            | l                             |
| Marketing pract   |                |           |  |                               |
| NA                | 2 Months       | NA        | Eesh                                     | 9930238370                    |
|                   |                |           |  |                               |
| Digital Marketi   | 1 month1 mon   | Nil       |  |                               |
| Inventory Mana    | 70 days        | Nil       | Mr. Vijay                                | 7069890949                    |
| Recruitment       | 45 days        | Nil       |  |                               |
| Sales and marke   |                | Nil       | Ms. Bachu Radhika<br>Kiran Kumar 9885318 |                               |
|                   |                |           |  |                               |
| UK Tax reporting  |                |           | Akshay Rao                               | akshaymrao@gmail.com          |
| Business Analytic | Zmonths        | Nill      | Yashika                                  | 9642265734                    |
|                   |                |           |  |                               |

| S.No. | R.No.           | Name of the Student         | Student Email and<br>Contact Number | Internship    | Company in<br>which internship | Title of the<br>Internship given to<br>student(ex:seo<br>analyst) | Specializatio<br>n on<br>internship<br>done |
|-------|-----------------|-----------------------------|-------------------------------------|---------------|--------------------------------|---|---|
| 1     | 2               | 3                           | 4                                   | 5             | 6                              | 7   | 8   |
| 1     | 1601-20-672-001 | AKHILA ANNASARAM            | akhila2198@gmail.com,<br>9640614291 | online        | Buzibrains                     | online HR Co-ordinato   | HR  |
| 2     | 1601-20-672-002 | ASHFIYA NASEERUDDIN<br>SYED | Ashfiyasyed2000mj@gmail             | online        | IFORTIS WORLDW                 | HR, DIGITAL MARKET  | HR  |
| 3     | 1601-20-672-003 | BHAGYASREE<br>KADIMICHERLA  |                                     |               |                                |   |   |
| 4     | 1601-20-672-004 | HARSHITHA MUTHYALA          | 8008680589                          |               | Trivision integrate            | Taxation, Bank Recon  | Fin & Market                                |
| 5     | 1601-20-672-005 | LAHARI ANUMANDLA            | laharianumandla99@gmail             | online        | AIM India                      | Intern  | Finance and                                 |
| 6     | 1601-20-672-006 | MEGHANA REDDY SANVE         | meghana.sanvelli@gmail.co           | online        | FITIG Association              | HR  | HR and LOGI                                 |
| 7     | 1601-20-672-007 | MONICA AKUNOORI             | monica13.aku@gmail.com              | offline       | Gratisol Labs                  | Digital Marketing inte  | Finance and                                 |
| 8     | 1601-20-672-008 | MOUNIKA JARAPLA             | mounikareddy5589@gmail              | offline       | Gratisol Labs                  | Digital Marketing inte  | Finance and                                 |
| 9     | 1601-20-672-009 | NANDINI BADIKE              | nandinibadike4@gmail.con            | offline       | Chemtopes                      | Marketing and sales   | Marketing                                   |
| 10    | 1601-20-672-010 | NAVYA PRIYADARSHIINI        | navya0636@gmail.com                 | Part time     | Ifortis                        | Human Resources   | HR  |
| 11    | 1601-20-672-011 | NAZNEEN INTESHA             | inteshanazneen@gmail.cor            | online        | FITIG Association              | Human resource inter  | Finance and                                 |
| 12    | 1601-20-672-012 | NISMA                       | nisma206aijaz@gmail.com             | HR            | shubham nari mah               | nila kaylan samiti NGO  | Finance and I                               |
| 13    | 1601-20-672-013 | PRINCESS GADDAMEEDI         | princessg561@gmail.com,             | online        | ifortis world wide             | Hr trainee  | HR  |
| 14    | 1601-20-672-014 | REVATHI J                   | pgs20116_mba.trishul@cb             | online        | BuziBrAlns                     | online HR Co-ordinato   | HR  |
| 15    | 1601-20-672-015 | RINKU KUMARI                | rinkukumari3843@gmail.co            | HR internship | CBIT                           | Recruitment   | HR  |
| 16    | 1601-20-672-016 | RUCHITHA MUCHARLA           | reddy.ruchitha8@gmail.coi           | HR            | career dreams edu              | Human resource and a  | HR n marketi                                |
| 17    | 1601-20-672-017 | SAHADEV KANCHAN<br>SINGH    | pgs20017_mba.sahadev@c              | Offline       | CBIT                           | Recruitment   | HR  |
| 18    | 1601-20-672-018 | SAMYUKTHA<br>YADAVELLY      | samyukthayadavelly@gma              | online        | Ifortis world wide             | Hr trainee  | HR  |
| 19    | 1601-20-672-019 | SATYAVENI BODASINGU         | bodasingukanchan@gma                | Summer Inte   | Havoc Therapy p                | HR Intern   | Finance & H                                 |
| 20    | 1601-20-672-020 | SIREESHA N                  | shirishashirisha84932@gm            | Online        | Vasista Enterprise             | Account Manager   | Finance & Lo                                |
| 21    | 1601-20-672-021 | SOUMYA SRI BAGGAM           | s.sri.s.soumya@gmail.com            | Offline       | Studio Vriksh                  | On site finance manag   | Finance                                     |
| 22    | 1601-20-672-022 | SUPRIYA                     | 2022supriya@gmail.com               | online        | GTM & sons pvt. It             | Financial trainee   | Finance                                     |
| 23    | 1601-20-672-023 | SUPRIYA MANDADA             |                                     |               |                                |   |   |
| 24    | 1601-20-672-025 | SWETHA EMMIDI N S           | 9489729226                          | Sales and Ma  | TIMES OF INDIA                 | Sales and Marketing   | Fin & Analy                                 |
| 25    | 1601-20-672-026 | TANUJA GUDAPATI             | tanujagudapati99@gmail.c            |               |                                | HR  | ,<br>HR                                     |

| 26 | 1601-20-672-027 | TEJASWINI R                                    |                            |              |                      |                           |                |
|----|-----------------|--|----------------------------|--------------|----------------------|---------------------------|----------------|
| 27 | 1601-20-672-028 | VAISHNAVI BANDARU                              | Vaishnavibandaru02@gma     | Online       | Prudhviraj& assoc    | Financial Trainee         | Finance        |
| 28 | 1601-20-672-029 | VAISHNAVI REDDY MADI                           | Vaishnavireddy947@gmail.   | offline      | Rane Engine Valve    | HR                        | FInance and    |
| 29 | 1601-20-672-030 | VIHARI S                                       | 8096741467                 | HR Associate | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 30 | 1601-20-672-031 | ABHILASH MALYALA                               | pgs20031_mba.abhilash@o    | offline      | CBIT (A)             | HR Trainee                | HR             |
| 31 | 1601-20-672-032 | ANIL P   | pgs20032_mba.anil@cbit.c   | online       | Deloitte-USI         | Tax intern                | Finance        |
| 32 | 1601-20-672-033 | AVINASH BIRADAR                                | avinashbiradar23@gmail.co  | om           | growth arrow         | equity research ana       | finance        |
| 33 | 1601-20-672-034 | BHARATH KUMAR<br>ALLADI                        | kumar74469@gmail.com       | online       | NVR consultancy      | hr                        | hr and analyt  |
| 34 | 1601-20-672-035 | CHANDU NARAPARAJU                              |                            |              |                      |                           |                |
| 35 | 1601-20-672-036 | ESHWAR KIRAN ARPULA                            | eshwarkiran04@gmail.com    | Online       | Prudhviraj&associ    | Financial Trainee         | Finance        |
| 36 | 1601-20-672-037 | FAYAZ SK                                       | pgs20037_mba.fayaz@cbit    | Offline      | Diagnostic BioSyst   | Finance                   | Finance        |
| 37 | 1601-20-672-038 | GANESH KUMAR G                                 | pgs20038_ganesh@cbit.org   | Offline      | CBIT                 | Recruitment               | HR             |
| 38 | 1601-20-672-039 | HEMANTH SALPRASAD<br>RAJU PORANKI              | hemanth.poranki546@gma     | Part time    | Times of India       | Business developmen       | marketing      |
| 39 | 1601-20-672-040 | JAGADISH LAVUDYA                               |                            |              |                      |                           |                |
| 40 | 1601-20-672-041 | KODANDA SAI NIKHIL<br>PADAM                    | sainikhilpadam7@gmail.co   | HR           | Gao Tek Inc          | Human Resource Inte       | HR & Logistic: |
| 41 | 1601-20-672-042 | MOHAN S  |                            |              |                      |                           |                |
| 42 | 0               | NAVEEN KUMAR<br>MANTHRI<br>PAAVANA VENKATA SAI | 7780510001                 | Recruitment  | GAO Tek Inc          | HR Associate              | HR & Fin       |
| 43 | 1601-20-672-044 | PAAVANA VENKATA SAI<br>MANIKONDA               | pgs20044_mba.paavana@o     | Offline      | R Krishna & Ass      | Auditing and Taxation     | Finance        |
| 44 | 1601-20-672-045 | PRASHANTH DAPPU                                |                            |              |                      |                           |                |
| 45 | 1601-20-672-046 | PRUDHVI ANUGULA                                | pgs20046_mba.prudhvi@c     | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 46 | 1601-20-672-047 | PRUDHVI RAJ MIRYALA                            | miryalaprudhviraj@gmail.c  | Summer Inte  | Learnovate ecomr     | Finance Intern            | Finance        |
| 47 | 1601-20-672-048 | PRUDHVI RAJ<br>PILLI ALAMARRI                  | pillalamarriprudhviraj@gm  | online       | Learnovate ecomr     | Finance intern            | Finance        |
| 48 | 1601-20-672-049 | RAJARAM BHUKYA                                 | pgs20049_mba.rajaram@c     | Offline      | Star Fitness Studio  | <b>Operations</b> Manager | Finance        |
| 49 | 1601-20-672-050 | RAMESH JAKKULA                                 | pgs20050_mba.ramesh@cl     | oit.org.in   | Sids farm private li | Sales and Marketing       | Marketing      |
| 50 | 1601-20-672-051 | SAI KIRAN VEMULA                               | pgs20051_mba.sai@cbit.or   | Offline      | R Krishna & Associ   | Finance Internship        | Finance        |
| 51 | 1601-20-672-052 |  | pgs20052_mba.samara@ct     | Offline      | Dhanavanthari Pvt    | Accounts Intern           | Finance        |
| 52 | 1601-20-672-053 | SRAVAN KUMAR<br>RENUKUNTI A                    | pgs20053_mba.sravan@cb     | part time    | Ifortis              | corporate ambassado       | marketing      |
| 53 | 1601-20-672-054 | SRI DATTA CHARAN K                             |                            |              |                      |                           |                |
| 54 | 1601-20-672-055 | SRINIVAS POSHETTI                              | poshettisrinivas5@gmail.co | Finance      | Suman chemical ir    | Financial Analyst and     | FINANCE        |
| 55 | 1601-20-672-056 | SUMANTH GORULA                                 | pgs20056_mba.sumanth@      |              | -                    | Marketing & Sales I       | -              |
| 56 | 1601-20-672-057 | VAMSHI SHIV VENAKATA<br>RAMESH TOOPATI         | pgs20057_mba.vamshi@cb     | Human Resou  | Oil and Natural Ga   | Human Resource Proc       | HR             |
| 57 | 1601-20-672-058 | VINAY KRISHNA KONJETI                          | pgs20058_mba.vinay@cbit    | Online       | Deloitte             | Tax Intern                | Finance        |
| 58 | 1601-20-672-059 | YASHWANTH GADDAM                               | pgs20059_mba.yashwanth     | offline      | Dhanavanthari P      | Accounts Intern           | Finance        |

| 59 | 1601-20-672-060 | YASHWANTH REDDY B                                  |                            | Online                      | finaltics         | Investment Banking A  | finance      |
|----|-----------------|--|----------------------------|-----------------------------|-------------------|-----------------------|--------------|
| 60 | 1601-20-672-061 | ANUSHA REDDY M                                     |                            |                             |                   |                       |              |
| 61 | 1601-20-672-062 | BRUNDAVANI HINDU S                                 | pgs20062_mba.brundavani    | online                      | Times of India    | sales and marketing   | marketing ar |
| 62 | 1601-20-672-063 | CHAITANYA CHIRRA                                   | chirra.chaitanya1998@gma   | Summer Inte                 | Times Of India    | Marketing Intern      | Finance & Bu |
| 63 | 1601-20-672-064 | CHANDANA PUNNA                                     | chandupunna2000@gmail.     | social media                | IMUN Campus Am    | Matketing             | Finance and  |
| 64 | 1601-20-672-065 | KEERTHANA MADGULA                                  | 6303692849                 | Sales and Ma TIMES OF INDIA |                   | Sales and Marketing   | Fin & Market |
| 65 | 1601-20-672-066 | LAKSHMI PRIYA K                                    |                            |                             |                   |                       |              |
| 66 | 1601-20-672-067 | NAGA KEERTHI MAKAM                                 |                            |                             |                   |                       |              |
| 67 | 1601-20-672-068 | NEEHARIKA DESETTI                                  | pgs20068_mba.neeharika@    | online                      | ICICI bank        | counselor             | marketing    |
| 68 | 1601-20-672-069 | NIHARIKA M   | pgs20069_mba.niharika@c    | Online                      | Times of India    | sales and Marketing   | Marketing    |
| 69 | 1601-20-672-070 | NIKITHA TELUGU                                     | pgs20070_mba.nikitha@cb    | Online                      | shubham naari sha | Human resource        | HR           |
| 70 | 1601-20-672-071 | PRAVALLIKA REDDY<br>TRAIMELA<br>PREM KUMAR KEERTHI | pgs20071_mba.pravallika@   | Online                      | iFortis Corporate | Marketing             | Marketing    |
| 71 | 1601-20-672-072 | PREM KUMAR KEERTHI<br>BAMAGALLA<br>PRIYALEKHA      | pgs20072_mba.prem@cbit     | part time                   | Youth Empowerm    | HR                    | Human Reso   |
| 72 | 1601-20-672-073 | PRIYALEKHA<br>LINGAPURAM<br>SATYA SATGOVERDHANI    | pgs20073_mba.priyalekha@   | online                      | TIMES OF INDIA    | Sales and marketing   | Marketing    |
| 73 | 1601-20-672-074 | SATYA SALGOVERDHANI<br>VINEELA AINAPURAPU          | pgs20074_mba.satya@cbit    | offline                     | AFCONS INFRASTR   | Accounts & Finance    | Finance      |
| 74 | 1601-20-672-075 | SHAIK NOOREAFSHA                                   | Pgs20075_mba.shaik@cbit    | Online                      | Shubham Naari Sh  | HR intern             | HR           |
| 75 | 1601-20-672-076 | SHIRISHA GOVULA                                    |                            |                             |                   |                       |              |
| 76 | 1601-20-672-077 | SRAVYA BOINDALA                                    | pgs20077_mba.sravya@cb     | online                      | Times Of India    | sales and marketing   | Finance and  |
| 77 | 1601-20-672-078 | SWARNALIKA<br>VARUKOLU                             | pgs20078_mba.swarnalika    | Online                      | Shine projects    | Human Resource inte   | Human Reso   |
| 78 | 1601-20-672-079 | SWATHI BUCHANPALLI                                 | Pgs20079_mba.swathi@cb     | Sales and ma                | Times of india    | Sales and marketing   | Fin& HR      |
| 79 | 1601-20-672-081 | VARA LAKSHMI PETERU                                | pgs20081_mba.varalakshm    | online                      | Exposys Data Labs | Data Science          | Finance & BA |
| 80 | 1601-20-672-082 | VIJAYA LAKSHMI NALLAB                              | nvlakshminirula@gmail.cor  | HR                          | shubham nari mah  | ila kaylan samiti NGO | HR and Busin |
| 81 | 1601-20-672-083 | VIJETHA KURUVA                                     |                            |                             |                   |                       |              |
| 82 | 1601-20-672-084 | VINEETHA EEGA                                      | pgs20084_mba.vineetha@     | online                      | Bajaj             | Recruitment and seled | HR           |
| 83 | 1601-20-672-085 | ARUN KUMAR MATTAM                                  | 9398132821                 | Digital Marke               | Exposys Data Labs | Digital Marketing     | Finance & LS |
| 84 | 1601-20-672-086 | BHANU PRAKASH<br>RAGAM<br>CHAILANYA JWALA          |                            |                             |                   |                       |              |
| 85 | 1601-20-672-087 | CHAITANYA JWALA<br>MIDASALA                        | chaitanyajwala.cj.6@gmail. | Sales and Ma                | Times Of India    | Sales and Marketing   | Marketing    |
| 86 | 1601-20-672-088 | GANGADHAR ORAGANTI                                 | pgs20088_mba.ganmgadha     | Summer Inte                 | Shubham Naari Sh  | Marketing Intern      | Finance and  |
| 87 | 1601-20-672-089 | HRUSHIKESH KANDALA                                 |                            |                             |                   |                       |              |
| 88 | 1601-20-672-090 | KALYAN BANDI                                       | pgs20090_mba.kalyan@cb     | Teli marketin               | g                 |                       |              |
| 89 | 1601-20-672-091 | KISHORE KUMAR D                                    |                            |                             |                   |                       |              |
| 90 | 1601-20-672-093 | MAHENDER KORRA                                     | korramahender.1803@gma     | USER ENGAG                  | WHITEHATJR        | USER ENGAGEMENT I     | MARKETING    |
| 91 | 1601-20-672-095 | MOHAMMED RASHAD ALI                                | pgs20095_mba.mohamme       | online                      | Shubham Nari Sha  | Supply chain and Mar  | Supply chain |

| 92  | 1601-20-672-096 | MOHAN SWARGAM                           |                          |               |                     |                       |               |
|-----|-----------------|---|--------------------------|---------------|---------------------|-----------------------|---------------|
| 93  | 1601-20-672-097 | PAVAN KUMAR<br>SUDDALA                  | pavansuddala01@gmail.co  | Online        | Times of India      | Sales and Marketing i | Marketing     |
| 94  | 1601-20-672-098 | SUDDALA<br>RAJASHEKAR REDDY<br>VUDTHURU | pgs20098_mba.rajashekar( | Online        | Shubham Nari Sha    | Human Resources       | HR            |
| 95  | 1601-20-672-099 | RAVI SAI CHINNI<br>PRAKASH              |                          |               |                     |                       |               |
| 96  | 1601-20-672-100 | RAVI TEJA KANUGANTI                     | 8686665939               | A Report on S | Sumega Technolog    | A Report on Social Me | Marketing     |
| 97  | 1601-20-672-101 | RISHI SAI VIGNESH G S                   |                          |               |                     |                       |               |
| 98  | 1601-20-672-102 | ROCHAN KOTA                             | pgs200102_mba.rochan@c   | Online        | Shriman Shares Ar   | Finance Intern        | Finance       |
| 99  | 1601-20-672-103 | ROHITH T                                | rohitht23@gmail.com, 837 | Summer Inte   | Times Of India      | Marketing Intern      | Finance & M   |
| 100 | 1601-20-672-104 | SAHADEVUDU<br>UNGARALA                  | pgs20104_mba.sahadevud   | Online        | AVISHKAR TECH SO    | DATA SCIENCE          | Business Ana  |
| 101 | 1601-20-672-105 | SAI KUMAR TALARI                        | pgs20105_mba.saikumar@   | Online        | TATA MOTORS         | Marketing Intern      | Marketing     |
| 102 | 1601-20-672-106 | SAI RAM NALLOLLA                        | pgs20106_mba.sai@cbit.or | Online        | ΤΟΙ                 | Tele Marketing        | Marketing     |
| 103 | 1601-20-672-107 | SAI TEJA SAMALA                         | pgs20107_mba.sai@cbit.or | Online        | IfortisTimes of ind | Sales and Marketing   | Sales         |
| 104 | 1601-20-672-108 | SAI VARUN REDDY<br>DOMA                 |                          |               |                     |                       |               |
| 105 | 1601-20-672-109 | SAM SOURABH KINNERA                     | pgs20109_mba.sam@cbit.c  | Offline       | Oriental Insurance  | Marketing             | Marketing     |
| 106 | 1601-20-672-110 | SHAIK LATHEEF SAHEB                     | pgs20110_mba.shaik@cbit  | Summer Inte   | VIBGYOR             | Finance& Hr Intern    | Finance & HF  |
| 107 | 1601-20-672-111 | SHARATH KUMAR REDDY                     | bollaramsharathreddy22@  | gmail.com     |                     |                       |               |
| 108 | 1601-20-672-112 | SHIVA KUMAR NIMMA                       |                          |               |                     |                       |               |
| 109 | 1601-20-672-113 | SHIVA SANTHOSH<br>CHOLLETI              | pgs20113_mba.shiva@c     | Online        | Exposys data labsL  | Digital Marketing     | Marketing     |
| 110 | 1601-20-672-114 | SRICHARAN VELETI                        |                          |               |                     |                       |               |
| 111 | 1601-20-672-115 | SRIKANTH NAYAK                          | pgs200115_mba.srikanth@  | Offline       | Divya Textiles      | Supervisor for Produc | Finance       |
| 112 | 1601-20-672-116 | TRISHUL KOTAM                           | pgs20116_mba.trishul@cbi | offline       | Lexiko Infra Syster | HR co-ordinator       | HR            |
| 113 | 1601-20-672-117 | VENKATAKRISHNA REDDY ANNAPUREDDY        | pgs20117_mba.venkatakris | online        | Times Of India      | Sales and Marketing   | Marketing ar  |
| 114 | 1601-20-672-118 | VINAY PRAKASH<br>MADDIPATI              | pgs20118_mba.vinay@cbit  | Online        | Deloitte USI        | Tax intern            | Finance       |
| 115 | 1601-20-672-119 | VISHAL GOULIKAR                         | gowlikarvishal@gmail.com | Finance       | Shubham nari mał    | BDM                   | Finance and I |
| 116 | 1601-20-672-120 | VISHAL NAYANA                           |                          |               |                     |                       |               |

| Topic on<br>Internship<br>done(ex:<br>recuitment) | Duration of<br>internship<br>(start and End<br>dates) | Stipend      | Name of the<br>External<br>Guide | External guide Email address      | External guide Contact Number |
|---|---|--------------|----------------------------------|-----------------------------------|-------------------------------|
| 9   | 10  | 11           | 12                               | 13                                |                               |
| recruitment                                       | 2months(29/<br>06/2021 to<br>29/08/2021)              | nil          | sandhya                          | aims@buzibrains.com               |                               |
| recruiting, sales                                 | 45 days, 2 mor  | nths, 1 mont | h, 1 month                       |                                   |                               |
| Taxation, Bank F                                  |   |              |                                  | pgs20008_mba.harshita@cbit.org.in |                               |
| Sales   | 45 days   | No           |                                  |                                   |                               |
| recruitment                                       | 2 months  | 0            |                                  |                                   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20007_mba.monica@cbit.org.in   |                               |
| Marketing,Web                                     |   |              |                                  | pgs20008_mba.mounika@cbit.org.in  |                               |
| Digital Marketin                                  |   |              | Mrs.Deepa                        | pgs20009_mba.nandini@cbit.org.in  |                               |
| Recruiting  |   | nil          |                                  | 7337595637                        |                               |
| Recruitment                                       | 6th August 202  | nil          |                                  | pgs20011_mba.nazneen@cbit.org.in  |                               |
| HR  | 2 months  |              |                                  | 9111122118                        |                               |
| Recruitment                                       | 45 days(25/05,  | nil          | Nikhat                           |                                   |                               |
| Recruitment                                       | 16th May 2021   | nill         | Sandhya, Ank                     | aims@buzibrains.com               |                               |
| Recruitment                                       | 45days  | 21k          |                                  | hr@cbit.ac.in, 77022 18313        |                               |
| Recruitment                                       | 2 months  |              | shraddha                         | 7839517264                        |                               |
| Recruitment                                       | 45 days   | 21000        | Anne Voilet                      | hr@cbit.ac.in, 77022 18313        |                               |
| recruitment                                       | 45 days(25/05,  | nil          | Nikhat                           |                                   |                               |
| NA  | 2 Months  | NA           | Siddharth                        | sidddharth@havoctherapy.com       |                               |
| Accountant  | 2 Months  | 10,000       | Sravani                          | 7981340263                        |                               |
| Accountant  | 2&1/2 months  | 10,000       | Swetha Gauta                     | 9966933908                        |                               |
| Teaching about                                    | 1 July to 1 Sept                                      | Nil          |                                  | hr@gtmandsons.com                 | 8825335493                    |
| Sales and Marke                                   | Sales and Marke 17-06-2021 to                         |              |                                  | pgs20025_mba.swetha@cbit.org.in   |                               |
| Recruitment                                       | 2 months  | Nil          |                                  |                                   |                               |

| Accounting, Dra     | 16th june to 1 | Nil     |               | ca.prudhviraj009@gmail.com        |            |  |
|---------------------|----------------|---------|---------------|-----------------------------------|------------|--|
|                     |                | Nil     | G Satish Kum  | guntur.satishkumar@ranegroup.com, | 8688692815 |  |
| HR Associate        | 15th June to 1 | Nil     |               | pgs20030_mba.vihari@cbit.org.in   |            |  |
| Recruitment         | 06-07-2021 to  | 21000/- | Anne Violet   | hr@cbit.ac.in                     |            |  |
| UK Tax reporting    | 1st June 2021  | 25000   | Prateek Kulka | Prateek Kulkarni                  |            |  |
|                     | 2 Months       |         |               |                                   | 7799891255 |  |
| recruitment         |                |         | raghu         |                                   | 6302860884 |  |
| Accounting, Dra     | 8 months(16th  | Nil     | Prudhviraj    | ca.prudhviraj009@gmail.com        | 8639630059 |  |
| Basic Finance & A   | 16th August to | Nil     |               |                                   |            |  |
| Recruitment         | 45 days        | 21000   | Anne Voilet   | hr@cbit.ac.in, 77022 18313        |            |  |
| sales               | 2 months       | nil     | najesh        | 9677141888                        |            |  |
| HR Management       | 3 Months       |         | Aparna Nallur | aparnanalluri@yahoo               |            |  |
| HR Associate        | 17-08-2021-17  | Nil     |               | pgs20043_mba.naveen@cbit.org.in   |            |  |
| Finance Executiv    | 28th June 202  | 5000    | Prashanth     | prashanth@rkrishna.in             | 7995589596 |  |
| Finance Executiv    | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |  |
| NA                  | 2 Months       | NA      | Ravi Singh    |                                   |            |  |
|                     | 45 days        | NA      |               |                                   |            |  |
| Operations Man      | 90 Days(12.07  | 20000   | Mr. Mohd. Ja  | 8883244445                        |            |  |
| Lead generation     | n ,Branding ,p | 45 Days |               | 5K stipend                        |            |  |
| Finance Executiv    | 28/06/2021 - 1 | 5000    | Prashanth     | prashanth@rkrishna.in             |            |  |
| Accounting Mar      | 45 days        | Nil     | Mr. Ramacha   | ndra Raju                         |            |  |
| sales funnel        | 2 months       | nil     | Architha      | 9.18247E+11                       |            |  |
| Indepth researc     | 2 months       |         | Sumeet maar   | 7434074794                        |            |  |
| sales and marl      | 45 Days        | nil     |               |                                   |            |  |
| Employees Perc      | 45days         | nil     | Rajesh Kaleku | 9490168003                        |            |  |
| UK Taxation 39 days |                | 25000   | Mr. Amit Kun  | 9844178229                        |            |  |
| Accounting Mar      | 45 days        | nil     | Mr. Ramacha   | ndra Raju                         |            |  |

| Investment ban  | 2 months        | nil       | Nishika Sharn | 7208112389                          |
|-----------------|-----------------|-----------|---------------|-------------------------------------|
|                 |                 |           |               |                                     |
| sales and marke |                 | nill      | nagesh        |                                     |
| NA              | 2 Months        | NA        | Nagesh        | 9677141888                          |
| Marketing       | 5 weeks         | Nil       |               | pgs20064_mba.chandana@cbit.org.in   |
| Sales and Marke | 17-06-2021 to   | Nil       |               | pgs20065_mba.keerthana@cbit.org.in  |
|                 |                 |           |               |                                     |
| marketing       | 1-7-2021 to 1-9 |           | Dilip Kumar   | dilip17893@gmail.com                |
| sales           | 2 Months        | nil       | Nagesh        | 9.19677E+11                         |
| Recruitment     | 45Days          | Nil       |               |                                     |
| sales and marl  | 45 Days         | Nil       |               |                                     |
| Recruiting      |                 | nil       | Tapashya      | 9618267848                          |
| Sales and marke |                 | nill      | Nagesh        |                                     |
| Accounts & Fina | 12.08.2021 to   | nil       | Vaithy Krishn | vaithy@afcons.com                   |
| Recruiting      | 06.07.2021 to   | Nil       | Archie        |                                     |
| Sales and Marke | 2 months        |           | Nagesh        | 9677141888                          |
| Recruitment     | 22-06-2021 to   | NIL       | Sriharsha     | sriharsha@shineprojects.in          |
| Marketing       | 2months         | Nil       | Ravi          | Pgs20078_mba.swathi@cbit.org.in     |
| Data Science    | 1month          | nil       |               |                                     |
| ess analytics   | 2 months        |           |               |                                     |
| recruitment     | 6 weeks         | nill      |               |                                     |
| Marketing       | 1 month         | nil       | Vishnuvardha  | pgs20085_mba.arun@cbit.org.in       |
| Marketing       | 2 months        | Nil       | Ravi          | RaviKumar.Pasupuleti@timesgroup.cor |
| NA              | 45 days         | Na        | Anushka Priya | priyaanushka2002@gmail.com          |
|                 |                 |           |               |                                     |
| Presales        | 3 Months        | 12000/ Pm | Rahul Swami   | 7738772969                          |
| Promotion       | 2 months        | Nil       |               |                                     |

| Sales             | 2 months                | Nill  | Nagesh            |                               |
|-------------------|-------------------------|-------|-------------------|-------------------------------|
| Recruitment       | 45 days(08-07-          | Nil   |                   |                               |
|                   |                         |       |                   |                               |
| A Report on Soc   | ial Media Mark          | eting |                   | pgs20100_mba.ravi@cbit.org.in |
|                   |                         |       |                   |                               |
| Mutual Funds Po   | 45 days (02.08          | Nil   | Mr.Raja Redo      | yk yk                         |
| NA                | 2 Months                | NA    | Nagesh            | 9677141888                    |
| Data Science      | 45 days                 | Nil   |                   |                               |
| Customer Relati   | 45 days                 | Nil   | Mr. Shashi        |                               |
| Tele Marketing    | 8 weeks                 | Nil   | Mr. Ravi          | 9963090279                    |
| Sales             | 45 Days2 months2 month  |       | S                 |                               |
|                   |                         |       |                   |                               |
| Marketing pract   | eting pract 45 days Nil |       | D.satish Babu     | L                             |
| NA                | 2 Months                | NA    | Eesh              | 9930238370                    |
|                   |                         |       |                   |                               |
|                   |                         |       |                   |                               |
| Digital Marketin  | 1 month1 mon            | Nil   |                   |                               |
|                   |                         |       |                   |                               |
| Inventory Mana    | 70 days                 | Nil   | Mr. Vijay         | 7069890949                    |
| Recruitment       | 45 days                 | Nil   | Ms. Bachu Radhika |                               |
| Sales and marke   | 2 months                | Nil   | Kiran Kumar       | 9885318862                    |
| UK Tax reporting  | 1st June 2021           | 25000 | ) Akshay Rao      | akshaymrao@gmail.com          |
| Business Analytic | 2months                 | Nill  | Yashika           | 9642265734                    |
|                   |                         |       |                   |                               |