Effects of Different Organic Vermicomposts Media as Alternative Growth Media for the Culture of *Spirulina*

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**Abstract:** Nowadays, operational costs of culturing *Spirulina*, notably the costs of the culture media and the regulation of inhibitors in the medium, are the main barriers for scaling up this bioprocess. Hence, the present study was aimed to investigate the effect of different vermicomposts incorporated with Zarrouk Medium (ZM) for the cultivation of *Spirulina*. In this study, experiments consisted of 8 groups. Group 1 is vermimedia (VM) prepared from vermicompost using *Eudrilus eugeniae* with ZM (10 ml/l); group 2 is VM prepared from decomposed materials of *Jasminum sambac* using *E. eugeniae* worms with ZM (10 ml/l); group 3 is VM prepared from decomposed materials of *Celosia argentea* using *E. eugeniae* worms with ZM (10 ml/l); group 4 is VM prepared from decomposed materials of *Penaeus indicus* compost using *E. eugeniae* worms with ZM (10 ml/l); group 5 is VM prepared from vermicompost using *Eisenia fetida* with ZM (10 ml/l); group 6 is VM prepared from decomposed materials of *J. sambac* using *E. fetida* worms with ZM (10 ml/l); group 7 is VM prepared from decomposed materials of *C. argentea* using *E. fetida* worms with ZM (10 ml/l); and group 8 is VM prepared from decomposed materials of *P. indicus* compost using *E. fetida* worms with ZM (10 ml/l). The total biomass, chlorophyll and major biochemical profile contents were estimated using standard methods. For this study, the *P. indicus* compost using *E. eugeniae* worms with ZM has resulted in highest biomass concentration when compared to other VM materials (2.2±0.3 g/l) and the highest protein and chlorophyll content was also recorded in group 3. The biochemical profiles such as nitrogen (7.3±0.32), calcium (316.60±36.97), chlorophyll (1408.98±7.505), potassium (796.25±6.35), magnesium (796.25±6.35), iron (20.63±1.7) and total organic carbon (28.12±3.46) were also significantly higher in the group 3 when compared to other VM. Based on our experimental results, it is concluded that modified organic media could be used for better biomass yield.

**Keywords:** *Spirulina platensis*, Organic vermicompost, Biomass production, Vermimedia, Zarrouk medium


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**Introduction**

Photosynthetic microorganisms are one of the most promising sources of energy as they are renewable and CO₂ neutral (Rittmann, 2008; Maurya *et al.*, 2021). Species belonging to the
genus *Spirulina* are among the photosynthetic microorganisms of commercial importance (Richmond, 2017; Soni et al., 2021). *Spirulina* is a multicellular and filamentous blue green alga which has gained considerable attention in the health care and food sector as a protein and vitamin supplement (Usharani et al., 2012; Soni et al., 2017; Altaff and Vijayaraj, 2021a). It grows in water, can be harvested and processed easily (Soni et al., 2017). It also contains very high amount of micro- and macronutrients (Usharani et al., 2012; Soni et al., 2017; Altaff and Vijayaraj, 2021a, b; Radha et al., 2022). Cyanobacteria have been commercially explored owing to its capacity to generate great amount of important products, such as phycocyanin (Koru, 2012; Mobin et al., 2019). It is also being used for the production of food supplements, animal feed, and pharmaceutical products (Usharani et al., 2012; Soni et al., 2017; Altaff and Vijayaraj, 2021a, b; Radha et al., 2022). The mass cultivation of *Spirulina* depends on a number of factors, including the availability of nutrients, temperature, and light (Soni et al., 2017). *Spirulina* also requires a relatively high pH, which inhibits the growth of other algae in the system (Soni et al., 2017). In order to maintain high pH and avoid fluctuations, high amounts of sodium bicarbonate must always be there in the culture medium (Soni et al., 2017). *Spirulina* cultivation can be improved though three criteria such as productivity, quality, and cost (Zhang et al., 2015; Delrue et al., 2017). *Spirulina* biomass productivity can be significantly improved by using the appropriate medium (Zhai et al., 2017). Indeed, modified Zarrouk Medium (ZM) was found to provide higher biomass productivity than the two other media tested (Ragaza et al., 2020). To reduce *Spirulina* production cost, dilutions of the modified ZM were tested and it was shown that modified ZM could be diluted up to five times without impacting the biomass productivity (Delrue et al., 2017). Furthermore, decomposed organic and inorganic nutrients media have been proven to be a good source of culture medium for *Spirulina* by many researchers (Markou and Georgakakis, 2011; Jain and Singh, 2013; Abdelhay et al., 2019). Hence, in the present study was aimed to investigate the effect of different vermicomposts incorporated with Zarrouk Medium (ZM) for the cultivation of *Spirulina platensis*.

**Materials and Methods**

For this study *Spirulina platensis* culture was obtained from Oferr Nallayan Spirulina Research Centre, Natham village, Chennai, India. The obtained *S. platensis* seed culture was sub-cultured in Zarrouk’s medium which was prepared as per composition of Zarrouk's medium and inoculated with *S. platensis* for further analysis. For this study, the *S. platensis* was cultivated in the different vermimedia (VM) incorporated with Zarrouk Medium and used for culturing *S. platensis*. The experiments were divided into 8 groups and the detailed experimental setup is given Table 1.

| Group 1 | The VM was prepared from vermicompost using *Eudrilus eugeniae* with ZM (10 ml/l) |
| Group 2 | The VM was prepared from decomposed materials of *Jasminum sambac* using *E. eugeniae* worms with ZM (10 ml/l) |
| Group 3 | The VM was prepared from decomposed materials of *Celosia argentea* using *E. eugeniae* worms with ZM (10 ml/l) |
| Group 4 | The VM was prepared from decomposed materials of *Penaeus indicus* compost using *E. eugeniae* worms with ZM (10 ml/l) |
| Group 5 | The VM was prepared from vermicompost using *Eisenia fetida* with ZM (10 ml/l) |
| Group 6 | The VM was prepared from decomposed materials of *J. sambac* using *E. fetida* worms with ZM (10 ml/l) |
| Group 7 | The VM was prepared from decomposed materials of *C. argentea* using *E. fetida* worms with ZM (10 ml/l) |
| Group 8 | The VM was prepared from decomposed materials of *P. indicus* compost using *E. fetida* worms with ZM (10 ml/l) |

Total experimental period was 10 days. After 10 days the media along with culture was filtered using a Whatman No. 1 filter paper. The culture thus obtained as a residue on the filter paper, was
sun dried for two days and weighed. The dried *S. platensis* was used for further biochemical profile analysis. The protein (IS 7219), nitrogen (IS 7219), calcium (CVR/INS/SOP ICPMS/003), chlorophyll (CVR/FD/COP/018), potassium (CVR/INS/SOP ICPMS/003), magnesium (CVR/INS/SOP ICPMS/003), iron (CVR/INS/SOP ICPMS/003) and total organic carbon (IS 2720) contents were estimated using standard methods.

The triplicate samples were analyzed and results are expressed as mean ± SD. All the data were statistically analyzed using One-way ANOVA test (Analysis of Variance) and GraphPad Prism 8 Software. A value of 0.05 was considered statistically significant.

**Results and Discussion**

In this study, different organic vermicompost from *Jasminum sambac*, *Celosia argentea* and Prawn shell of *Penaeus indicus* were used as culture medium for *S. platensis*. In this study, the *P. indicus* compost using *E. eugeniae* worms with ZM has resulted in highest biomass concentration when compared to other VM materials (2.2±0.3 g/l). Similarly, the decomposed materials of *C. argentea* using *E. fetida* worms with ZM also showed higher amount of yield when compared to other VM (Fig. 1).

The *S. platensis* has gained considerable popularity in the health food industry and increasingly as a protein supplement to aquaculture diets, human consumption, complementary dietary ingredient of feed for fish, shrimp and poultry, and increasingly as a protein supplement to aqua feeds (Usharani *et al.*, 2012; Soni *et al.*, 2017; Altaff and Vijayaraj, 2021a, b; Radha *et al.*, 2022). As shown in Figure 2, the significantly highest protein content was reported. The increased protein content was apparently due to the increased nitrogen level in the medium as the total nitrogen in vermicompost. The present results derive support from observations of Piorreck *et al.* (1984) who reported that increasing the nitrogen level in the nutrient medium leads to a corresponding increase in the biomass and protein content of *S. platensis*. Theodorou *et al.* (1991) reported that soluble protein content in the Green Alga *Selenastrum minutum* was decreased under phosphorus limitation, which explains the lower protein content in *S. platensis* cultivated in Vermicompost. Chlorophyll is one of the most dominant pigments that can be isolated from *S. platensis* biomass. This bioactive pigment is used as natural food coloring and has antioxidant and anti-mutagenetic activities as well. This effect implies another value of using natural pigment. In this study, the higher amount of chlorophyll contents were reported in the *P. indicus* compost using *E. eugeniae* worms with ZM when compared to other VM (Fig. 3).

*Spirulina* also contains high level of biochemical profile especially minerals including calcium, iron, magnesium, manganese, potassium and zinc (Bensehaila *et al.*, 2015; Abed *et al.*, 2016; Ghaeni and Roomiani, 2016). It is accepted as functional food, which are defined as products derived from natural sources, whose consumption is likely to benefit human health and enhance performance (Bensehaila *et al.*, 2015; Abed *et al.*, 2016; Ghaeni and Roomiani, 2016; Teklić *et al.*, 2021). In the present study, the biochemical compositions were also found significantly (P<0.05) higher in VM that was prepared from decomposed material *P. indicus* when compared to other vermicompost. Based on the biochemical profile, the *S. platensis* production has proved the use of vermicompost from *P. indicus* using *E. eugeniae* as significant contribution to the growth and productivity of biomass and biochemical profiles such as nitrogen (7.3±0.32), calcium (316.60±36.97), potassium (796.2533±6.35), magnesium (796.2533±6.35), iron (20.63±1.7) and total organic carbon (28.12±3.46) when compared to other VM (Tables 2, 3).

Based on our observation, *S. platensis* can be cultivated on vermicompost prepared from *P. indicus* shell using *E. eugeniae* during all the seasons and biomass produced can be safely used. This alternative VM can also be used for the high biomass productivity, significantly reducing
Fig. 1: Dry weight of *S. platensis* cultivated from different VM incorporated with ZM.

Fig. 2: Total protein content in *S. platensis* cultivated from different VM incorporated with ZM.
Fig. 3: Total chlorophyll content in *S. platensis* cultivated from different VM incorporated with ZM.

**Table 2:** Effects of different biochemical profile in *S. platensis* using different organic VM from *E. eugeniae*

<table>
<thead>
<tr>
<th>Biochemical parameter</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (g/100g)</td>
<td>7.12±0.17</td>
<td>7.3±0.32</td>
<td>7.58667±0.57</td>
<td>7.53±0.53</td>
</tr>
<tr>
<td>Calcium (mg/100g)</td>
<td>316.60±36.97</td>
<td>295.24±55.47</td>
<td>365.9667±5.77</td>
<td>362.54±5.85</td>
</tr>
<tr>
<td>Potassium (mg/100g)</td>
<td>1338.16±53.83</td>
<td>85811.44±73102.17</td>
<td>1408.987±7.505</td>
<td>1416.18±17.46</td>
</tr>
<tr>
<td>Magnesium (mg/100g)</td>
<td>1024.047±203.62</td>
<td>967.32±154.5047</td>
<td>796.2533±7.505</td>
<td>784.86±17.43</td>
</tr>
<tr>
<td>Iron (g/100g)</td>
<td>24.66±5.22</td>
<td>19.51±0.76</td>
<td>20.63±1.7</td>
<td>20.16±1.50</td>
</tr>
<tr>
<td>Total Organic Carbon (g/100g)</td>
<td>25.88±1.529</td>
<td>20.06±3.51</td>
<td>28.12±3.46</td>
<td>26.75±3.06</td>
</tr>
</tbody>
</table>

The values are represented as Mean ± SD. All the results are statically not significant at p 0.05; F. value = 0.40; p-value = 0.84.

**Table 3:** Effects of different biochemical profile in *S. platensis* using different organic VM from *E. fetida*

<table>
<thead>
<tr>
<th>Biochemical parameter</th>
<th>Group 5</th>
<th>Group 6</th>
<th>Group 7</th>
<th>Group 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (g/100g)</td>
<td>7.84±0.13</td>
<td>7.83±0.29</td>
<td>7.02±0.17</td>
<td>7.48±0.48</td>
</tr>
<tr>
<td>Calcium (mg/100g)</td>
<td>377.75±32.42</td>
<td>364.53±87.75</td>
<td>337.95±36.97</td>
<td>359.12±0.15</td>
</tr>
</tbody>
</table>
Potassium (mg/100g) 1434.47±0.73 43628.09±73.08 1369.24±53.83 1423.37±19.96
Magnesium (mg/100g) 749.41±28.30 829.99±196.18 906.48±203.62 773.48±13.37
Iron (g/100g) 21.94±2.99 23.58±3.14 21.64±5.22 19.69±0.91
Total Organic Carbon (g/100g) 27.22±2.10 25.78±6.71 25.003±1.52 25.38±1.09

The values are represented as Mean ± SD. All the results are statically not significant at p 0.05; F. value= 0.88; p-value = 0.54

productions costs and therefore increasing the feasibility of the process.

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References


