VOLUME 9 ISSUE 1 2023

ISSN 2454 – 3055

INTERNATIONAL JOURNAL OF ZOOLOGICAL INVESTIGATIONS

Forum for Biological and Environmental Sciences

Published by Saran Publications, India

International Journal of Zoological Investigations Vol. 9, No. 1, 464-470 (2023)

International Journal of Zoological Investigations
Contents available at Journals Home Page: www.ijzi.net
Editor-in-Chief: Prof. Ajai Kumar Srivastav
Published by: Saran Publications, Gorakhpur, India

ISSN: 2454-3055

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

Jesuvadiyal Rajula S. and Martin P.*

Department of Zoology, Government Arts College for Men, Nandanam, Chennai, Tamil Nadu 600035, India

**Corresponding Author*

Received: 8th January, 2023; **Accepted:** 21st February, 2023; **Published online:** 19th March, 2023

https://doi.org/10.33745/ijzi.2023.v09i01.051

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 consists 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 (1408.987±7.505), potassium (796.2533±6.35), magnesium (796.2533±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

Citation: Jesuvadiyal Rajula S. and Martin P.: Effects of different organic vermicomposts media as alternative growth media for the culture of *Spirulina*. Intern. J. Zool. Invest. 9(1): 464-470, 2023.

https://doi.org/10.33745/ijzi.2023.v09i01.051

Introduction

Photosynthetic microorganisms are one of the most promising sources of energy as they are renewable and CO_2 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.

Table 1: Experimental design for the culture of *S. platensis*

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

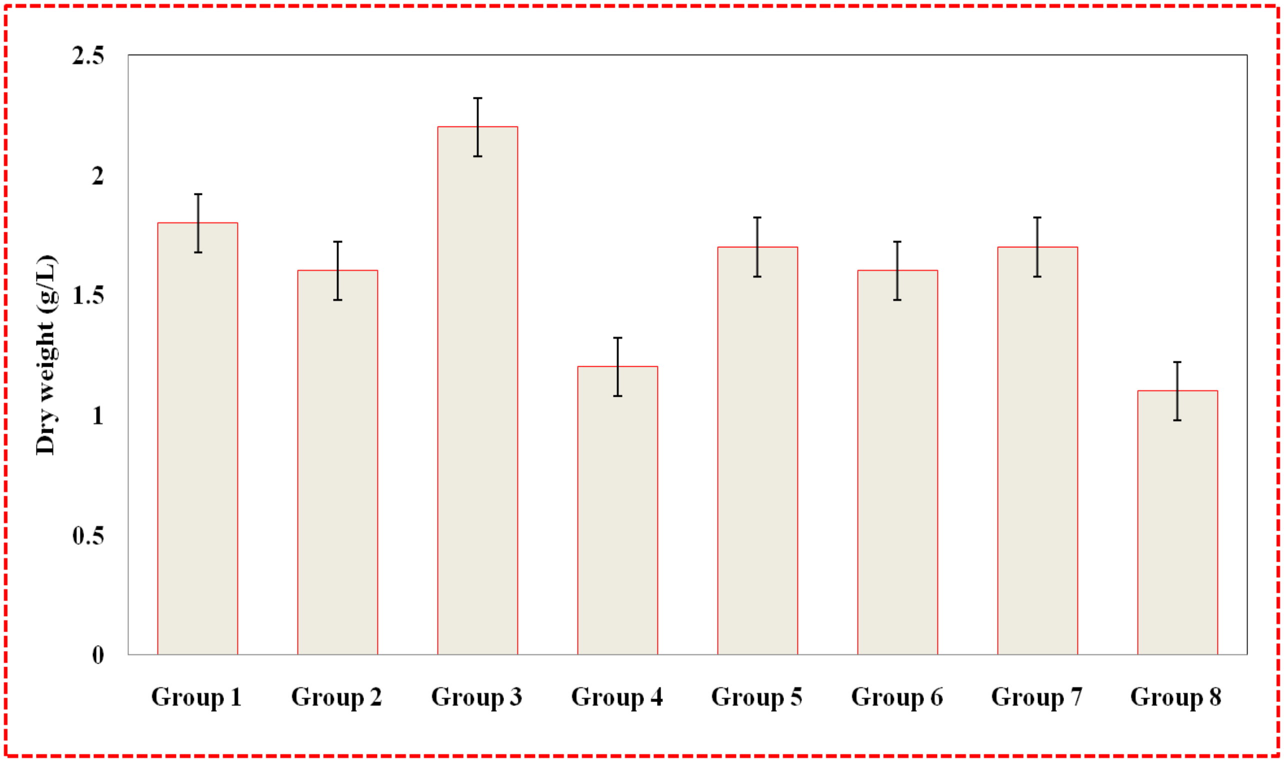

Fig. 1: Dry weight of *S. platensis* cultivated from different VM incorporated with ZM.

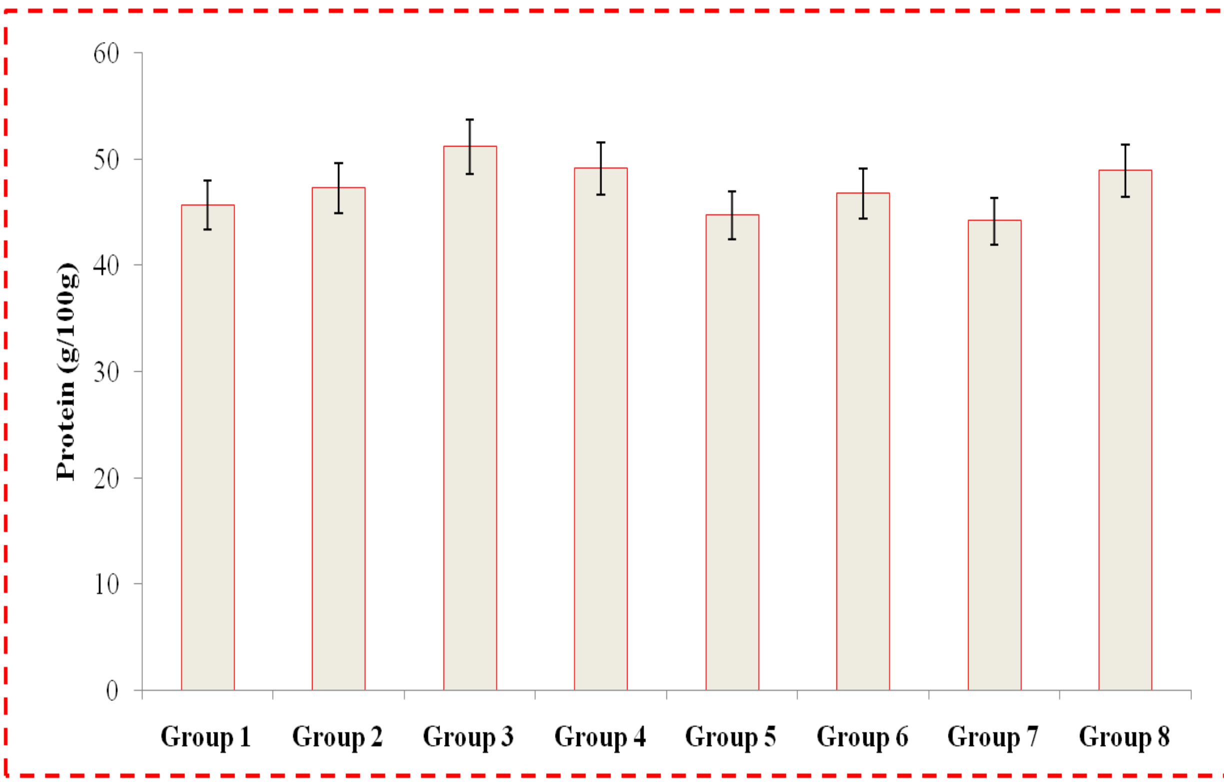

Fig. 2: Total protein content in S. platensis cultivated from different VM incorporated with ZM.

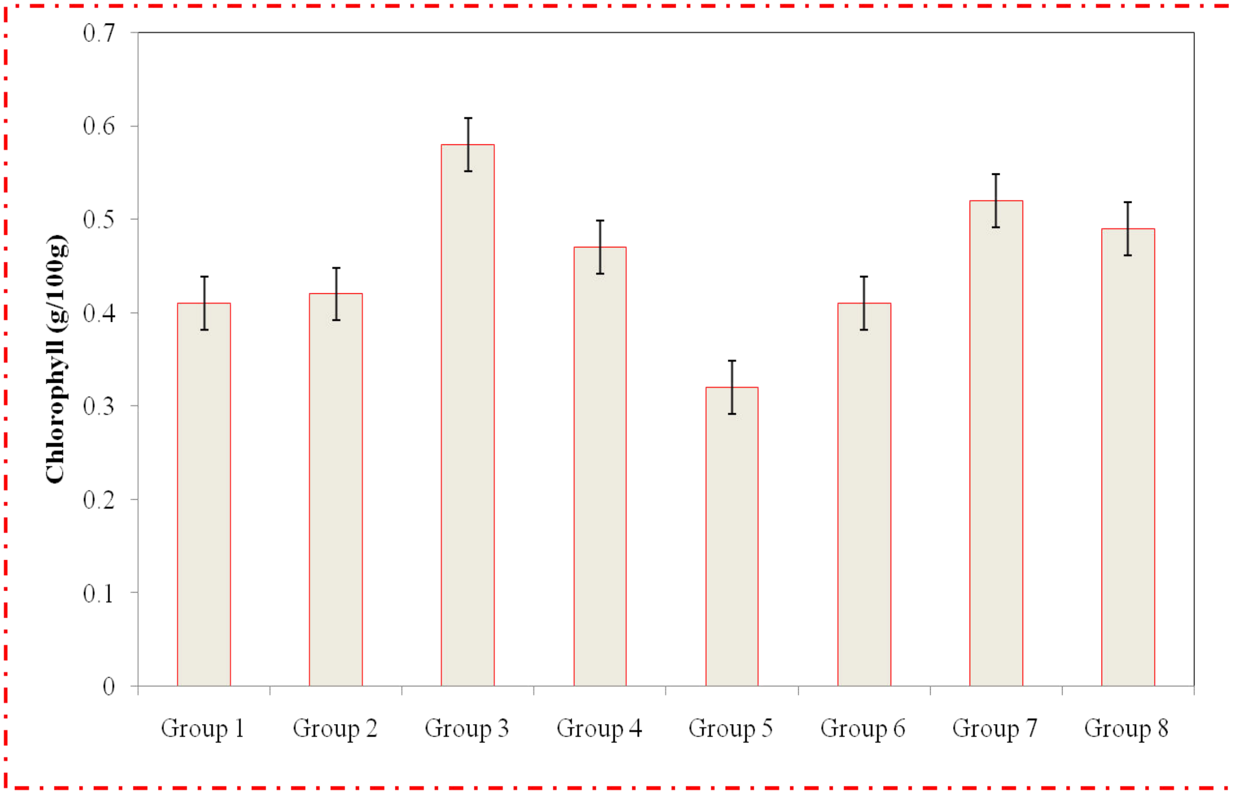

Fig. 3: Total chlorophyll content in S. platensis cultivated from different VM incorporated with ZM.

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

Biochemical parameter	Group 1	Group 2	Group 3	Group 4
Nitrogen (g/100g)	7.12±0.17	7.3±0.32	7.58667±0.57	7.53±0.53
Calcium (mg/100g)	316.60±36.97	295.24±55.47	365.9667±5.77	362.54±5.85
Potassium (mg/100g)	1338.16±53.83	85811.44±73102.17	1408.987±7.505	1416.18±17.46
Magnesium (mg/100g)	1024.047±203.62	967.32±154.5047	796.2533±6.35	784.86±17.43
Iron (g/100g)	24.66±5.22	19.51±0.76	20.63±1.7	20.16±1.50
Total Organic Carbon (g/100g)	25.88±1.529	20.06±3.51	28.12±3.46	26.75±3.06

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*

Biochemical parameter	Group 5	Group 6	Group 7	Group 8
Nitrogen (g/100g)	7.84±0.13	7.83±0.29	7.02±0.17	7.48±0.48
Calcium (mg/100g)	377.75±32.42	364.53±87.75	337.95±36.97	359.12±0.15

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.

Acknowledgements

The authors express their gratitude to the authorities of PG and Research Department of Zoology, Government Arts College for Men, Nandanam, Chennai, Tamil Nadu, India. The authors are also thankful to the Dr. R. Vijayaraj, Department of Marine Biotechnology, AMET University for his valuable suggestion and guidance during this research work.

References

Abdelhay R, Moustafa Y and EL-Metwaly Ess E. (2019) The use of vermicompost in cultivation and production of *Spirulina* platensis. Egyptian J Aquacult. 9(3): 1-11.

Abed E, Ihab AN, Suliman E and Mahmoud A. (2016) Impact of *Spirulina* on nutritional status, haematological profile and anaemia status in malnourished children in the Gaza Strip: randomized clinical trial. Matern Pediatr Nutr. 110: 2.

Altaff K and Vijayaraj R. (2021a) Micro-algal diet for copepod culture with reference to their nutritive value–a review. Int J Cur Res Rev. 13(7): 86.

Altaff K and Vijayaraj R. (2021b) Influence of heat shock protein (hsp-70) enhancing compound from red alga (*Porphyridium cruentum*) for augmenting egg production in copepod culture–a new *in silico* report. Marine Sci Technol Bull. 10(2): 186-192.

Bari E, Cascino FC, Foglio L, Proietti L, Perteghella S, Torre ML and Parati K. (2021) Alternative culture media and cold-drying for obtaining high biological value *Arthrospira platensis* (Cyanobacteria). Phycologia 60(3): 237-246.

Bensehaila S, Doumandji A, Boutekrabt L, Manafikhi H, Peluso I, Bensehaila K, Kouache A and Bensehaila A. (2015) The nutritional quality of *Spirulina platensis* of Tamenrasset, Algeria. African J Biotechnol. 14(19): 1649-1654.

Delrue F, Alaux E, Moudjaoui L, Gaignard C, Fleury G, Perilhou A, Richaud P,Petitjean M and Sassi JF. (2017) Optimization of *Arthrospira platensis* (*Spirulina*) growth: from laboratory scale to pilot scale. Fermentation 3(4): 59.

Ghaeni M and Roomiani L. (2016) Review for application and medicine effects of *Spirulina*, microalgae. J Adv Agricult Technol. 3(2): 114-117.

Jain S and Singh SG. (2013) Low cost medium formulation using cow dung ash for the cultivation of Cyanobacterium: *Spirulina* (*Arthrospira*) *platensis*. Emir J Food Agricult. 25(9): 682-691.

Koru E. (2012) Earth food *Spirulina* (*Arthrospira*): Production and quality standards. In: Food Additive, (ed.) El-Samragy Yehia, IntechOpen, pp. 191-202.

Markou G and Georgakakis D. (2011) Cultivation of filamentous cyanobacteria (blue-green algae) in agro-industrial wastes and wastewaters: a review. Appl Energy 88(10): 3389-3401.

Maurya PK, Mondal S, Kumar V and Singh SP. (2021) Roadmap to sustainable carbon-neutral energy and environment: can we cross the barrier of biomass productivity?. Environ Sci Pollut Res. 28(36): 49327-49342.

Mobin SM, Chowdhury H and Alam F. (2019) Commercially important bioproducts from microalgae and their current applications–A review. Energy Procedia 160: 752-760.

Piorreck M, Baasch KH and Pohl P. (1984) Biomass production, total protein, chlorophylls, lipids and fatty acids of freshwater green and blue-green algae under different nitrogen regimes. Phytochem. 23(2): 207.

Radha V, Jayaprakashvel M and Altaff K. (2022) Role of heat shock protein influencing bioactive compounds from mangrove tropical estuarine microalgae for enhancement of copepod egg production in culture system. Mar Sci Technol Bull. 11: 280-287.

Ragaza JA, Hossain MS, Meiler KA, Velasquez SF and Kumar V. (2020) A review on *Spirulina*: alternative media for cultivation and nutritive value as an aquafeed. Rev Aquacult. 12(4): 2371-2395.

Richmond A. (2017) Microalgae of economic potential. In CRC Handbook of microalgal mass culture, CRC Press, pp. 199-244.

Rittmann BE. (2008) Opportunities for renewable bioenergy using microorganisms. Biotechnol Bioengineer. 100(2): 203-212.

Soni RA, Sudhakar K and Rana RS. (2017) *Spirulina*– From growth to nutritional product: A review. Trends Food Sci Technol. 69: 157-171.

Soni RA, Sudhakar K, Rana RS and Baredar P. (2021) Food supplements formulated with *Spirulina*. In: Algae, Springer, Singapore, pp. 201-226.

Teklić T, Parađiković N, Špoljarević M, Zeljković S, Lončarić Z and Lisjak M. (2021) Linking abiotic stress, plant metabolites, biostimulants and functional food. Annals Appl Biol. 178(2): 169-191.

Theodorou ME, Elrifi IR, Turpin DH and Plaxton WC. (1991) Effects of phosphorus limitation on respiratory metabolism in the green alga Selenastrum minutum. Plant Physiol. 95(4): 1089-1095.

Trabelsi L, Ben Ouada H, Bacha H and Ghoul M. (2009) Combined effect of temperature and light intensity on growth and extracellular polymeric substance production by the cyanobacterium *Arthrospira platensis.* J Appl Phycology 21(4): 405-412.

Usharani G, Saranraj P and Kanchana D. (2012) *Spirulina* cultivation: a review. Int J Pharm Biol Arch. 3(6): 1327-1341.

Zhai J, Li X, Li W, Rahaman MH, Zhao Y, Wei B and Wei H. (2017) Optimization of biomass production and nutrients removal by *Spirulina* platensis from municipal wastewater. Ecol Engineer. 108: 83-92.

Zhang L, Chen L, Wang J, Chen Y, Gao X, Zhang Z and Liu T. (2015) Attached cultivation for improving the biomass productivity of *Spirulina* platensis. Bioresource Technol. 181: 136-142.