Research Article

Evaluation of Rice Bran Extract as a Low-Cost Medium for the Culture of Spirulina *Arthrospira platensis*

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Abstract | Spirulina (*Arthrospira platensis*) is a photosynthetic cyanobacterium widely recognized for its exceptional nutritional profile, making it suitable for both animal feed supplements and human consumption. Due to its high biomass yield, Kosaric medium (KM) is frequently used for *A. platensis* cultivation; however, its production costs are high because of the ingredient costs. To address this limitation, the present study evaluated rice bran extract (RBE) as a cost-effective alternative nutrient source for *A. platensis* culture. The growth performance and pigmentations of *A. platensis* was studied in KM (control medium) and four different concentrations of RBE media, viz., 10% (RBE10), 20% (RBE20), 30% (RBE30), and 40% (RBE40), supplemented with 3.0 g/L $NaHCO_3$ and 1.25 g/L $NaNO_3$ with three replications for a culture duration of 24 days. Maximum cell weight (45.9 ± 0.6 mg/L), optical density (1.28 ± 0.06), specific growth rate (0.50± 0.02 µ/day), chlorophyll *a* (0.78 ± 0.17 µg/mL), phycocyanin (1.70 ± 0.07 µg/mL), and β-carotene (1.48 ± 0.10 µg/mL) of *A. platensis* were observed in KM. Similar results were also obtained at RBE10 (cell weight: 45.3 ± 1.4 mg/L; optical density 1.19 ± 0.26, specific growth rate: 0.48 ± 0.03 µ/day; chlorophyll *a*: 0.74 ± 0.20 µg/mL; phycocyanin: 1.68 ± 0.07 µg/mL, β-carotene: 1.24 ± 0.28 µg/mL). The findings of this study revealed that all growth parameters and pigmentations decreased gradually with increasing RBE medium concentration. Therefore, these results suggest that 10% RBE can serve as a viable, cost-effective alternative to KM for *A. platensis* cultivation.

Received | January 27, 2026; **Accepted** | April 28, 2026; **Published** | July 06, 2026
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Citation | Sultana, Z., T. Gias, M. Das, U.K. Fatema, M.A. Hossain. 2026. Evaluation of rice bran extract as a low-cost medium for the culture of spirulina *Arthrospira platensis*. *Sarhad Journal of Agriculture,* 42(3): 1236-1245.
DOI | https://dx.doi.org/10.17582/journal.sja/2026/42.3.1236.1245
Keywords | *Arthrospira platensis*, Rice bran extract medium, Microalgal growth, Pigment content

Introduction

Microalgae are unicellular, photosynthetic microorganisms found in freshwater, marine, and brackish ecosystems. They play a crucial role in aquatic ecosystems by contributing significantly to global oxygen production and forming the base of the aquatic food web. Microalgae thrive in a liquid, aerated environment when provided with the right amount of light, carbon dioxide, and other nutrients (Rosenberg *et al*., 2008). According to Rizwan *et al*. (2018), microalgae have a higher net biomass productivity than any other terrestrial plant or animal. Microalgae do not require fertile land to thrive, unlike land-based plants, and they may be grown with wastewater or even seawater (Nagappan

et al., 2021). Although microalgae have simple growth requirements, they can accumulate large amounts of lipids, proteins, and carbohydrates, yielding biomass that is rich in nutrients that promote growth. Lipid, protein, carbohydrates, and numerous pigments are among the essential biochemical components found in microalgal biomass (Apandi *et al.*, 2019). The primary natural food sources for zooplankton in aquatic systems are microalgae, which offer significant nutritional value and provide pigments, antioxidants, and other bioactive compounds (Tibaldi *et al.*, 2015). Since they serve as an important food source for fish in their natural environment, they are suitable ingredients for the manufacture of aquaculture feed. Polyunsaturated fatty acids (PUFAs), amino acids, vitamins, minerals, and nearly all other essential nutrients are found in algae (Carneiro *et al.*, 2020). Microalgae are emerging as a promising sustainable alternative to traditional fishmeal in aquaculture due to their high protein content and balanced amino acid profiles. Studies have demonstrated that incorporating microalgae into fish diets can support growth performance and enhance the nutritional quality of fish fillets. Incorporating microalgae to feed enhances weight gain, increases the amount of lipids and protein in fish muscles, increases the ability of fish to withstand stress and diseases, and improves the texture and flavor of fish fillet (Nagappan *et al.*, 2021).

Spirulina *(Arthrospira platensis)* is a multicellular, free-floating, filamentous cyanobacterium or photosynthetic blue-green algae characterized by its spiral or helical trichomes. They are microscopic and range in size from 300 to 500 µm. They thrive in saline, alkaline environments with a pH of 9-11, which is too high for most other species to survive. (Khatun *et al.*, 2019). According to Usharani *et al.* (2012), spirulina have a simple prokaryotic cell structure, a glycogen-containing cellular membrane, photosynthetic capabilities, and no plant cell wall, which are characteristics of bacteria, plants, and animals, respectively. Both macro and micronutrients are present in very high concentrations. Minerals like iron, calcium, chromium, copper, magnesium, manganese, phosphorus, potassium, sodium, and zinc, as well as proteins and carbohydrates, account for 60–70% of its dry weight chemical composition. G-linolenic acid (GLA), an essential fatty acid, and pigments such as carotenes, phycocyanin, and chlorophyll *a* are also found (Soni *et al.*, 2017). It can play an important role in human and animal nutrition, environmental protection through wastewater recycling, and energy conservation (Grewe and Pulz, 2012). *A. platensis* is one of the most promising microalgae for culture due to its high nutritional value. Nowadays, spirulina is gaining significant interest for its cellular contents, including vitamins, minerals, polyunsaturated fatty acids, carotenoids, and other pigments that have antioxidant activity (Wang *et al.*, 2007). According to Matos *et al.* (2017), spirulina can enhance an organism's immune function, promote calcium absorption, and delay the aging process. The use of spirulina expanded from human consumption to medical, agricultural, industrial, and commercial applications as our knowledge of its biological systems and processes increased. Because of its bioactive properties, which can improve the health, quality, and stress tolerance of cultured fish, spirulina also serves as a functional feed supplement (Kim *et al.*, 2013; Ragaza *et al.*, 2020).

Despite its high nutritional and commercial value, large-scale production of *A. platensis* is constrained by the high cost of conventional culture media. Kosaric medium, a nutrient solution containing several costly chemical ingredients to support spirulina growth, is widely used for its effectiveness; however, its high price has prompted research into alternatives (Kanok *et al.*, 2023). Nutrient costs are the second-largest expense in spirulina production after labor and make cultivation economically challenging, especially in developing countries (Ghofar *et al.*, 2019). Thus, reducing culture medium costs while maintaining biomass quality is a critical challenge for sustainable spirulina production. Spirulina growth and nutritional composition depend heavily on the culture medium. Rice bran, a byproduct of rice milling, is nutrient-rich and contains proteins, carbohydrates, lipids, minerals, antioxidants, and bioactive compounds (Sukma *et al.*, 2018). It supplies essential minerals such as calcium, phosphorus, iron, zinc, and magnesium to support microalgal growth (Raghavendra and Ramachandra, 2005). It is also rich in glucose, serving as an effective external carbon source for microbial photosynthesis and promoting biomass accumulation (Hong and Wang, 2017; Zhao *et al.*, 2018). These properties suggest that rice bran has potential as an alternative culture medium for microalgae. Although rice bran is recognized for its nutritional value and availability, few studies have examined its direct use as a cost-effective culture medium for *A. platensis*. Furthermore, comparisons between rice bran-based media and the

standard Kosaric medium are insufficient, especially regarding growth performance and feasibility. This research gap restricts the adoption of low-cost, sustainable spirulina production systems.

The primary purpose of this study is to develop and test a cost-effective culture medium using rice bran as a nutrient source for cultivating *A. platensis*. The study also assesses rice bran's suitability for supporting *A. platensis* growth as an alternative to conventional, high-cost media. Creating a low-cost medium could reduce *A. platensis* production costs and make large-scale cultivation accessible, especially in resource-limited regions. Using rice bran, an agricultural byproduct, promotes waste valorization and environmental sustainability. The results may help increase the availability of nutritionally rich *A. platensis* for aquaculture, human nutrition, and industrial use.

Materials and Methods

Preparation of rice bran extract

Rice bran extract was selected as a cost-effective nutrient source for the cultivation of *A. platensis*, which was obtained from a local rice mill in the Gazipur district near Gazipur Agricultural University, Bangladesh. The collected rice bran was first sieved to remove rice husk and other contaminants. The bran was then oven-dried at 80 °C for 24 h to ensure sterilization. For the preparation of rice bran extract, 50 g of dried rice bran powder was added to 1.0 L of distilled water in a 1.0 L conical flask, and the mixture was mixed thoroughly. The suspension was allowed to stand at room temperature for 24 h. After incubation, the mixture was filtered through a 0.45 µm Whatman filter paper to obtain a clear extract, removing suspended solids and other contaminants. The resulting filtrate was stored and used to prepare *A. platensis* culture media.

Preparation of Kosaric Medium (KM)

KM is widely used as a standard medium for *A. platensis* culture. The composition of KM is shown in Table 1. For the preparation of KM, the ingredients from no. 1 to 8 mentioned in Table 1 were weighed using an electric balance and then transferred into a 1.0 L conical flask. Micronutrient solution was prepared by adding the ingredients to 1 L of distilled water. Subsequently, 0.5 mL of micronutrient solution was pipetted into the flask, followed by the addition of distilled water to achieve a final volume of 1.0 L. The medium was then thoroughly mixed and sterilized by moist heat at 121 °C for 15 minutes, followed by cooling for 24 hours.

Table 1: *Composition of KM for A. platensis culture.*

Serial No.	Chemicals/compounds	Concentration in stock solution
1	$NaHCO_3$	9.00 g/L
2	K_2HPO_4	0.25 g/L
3	$NaNO_3$	1.25 g/L
4	K_2SO_4	0.50 g/L
5	NaCl	0.50 g/L
6	$MgSO_4.7H_2O$	0.10 g/L
7	$CaCl_2$	0.02 g/L
8	$FeSO_4.2H_2O$	0.005 g/L
9	Micronutrient solution	0.5 ml/L
	Composition of micronutrient solution	
	i) H_3BO_3	2.86 g/L
	ii) $MnCl_2.4H_2O$	1.81 g/L
	iii) $ZnSO_4.7H_2O$	0.22 g/L
	iv) $CuSO_4.5H_2O$	0.08 g/L
	v) MoO_3	0.01 g/L
	vi) $CoCl_2.6H_2O$	0.01 g/L

Preparation of rice bran extract media

The prepared rice bran extract was diluted to 10, 20, 30, and 40% and designated RBE10, RBE20, RBE30, and RBE40, respectively. All the RBE media were added with 3 g/L $NaHCO_3$ and 1.25 g/L $NaNO_3$ as carbon and nitrogen sources, respectively. Then the media were mixed well, sterilized at 121 °C for 15 minutes with moist heat, and cooled for 24 hours.

Experimental culture of A. platensis

The pure stock sample of *A. platensis* was collected from the Microalgae Culture Unit of the Department of Aquaculture, Faculty of Fisheries, GAU, Bangladesh. The experiment was conducted in a completely randomized design (CRD) with five treatments (KM as control, RBE10, RBE20, RBE30, and RBE40), each with three replications for a culture duration of 24 days. Before the culture initiation of *A. platensis*, the pH of all media was adjusted to 9.5 by incorporating 0.1 N NaOH, depending on the pH condition of the selected medium. *A. platensis* was cultured in 1000 mL Erlenmeyer flasks and inoculated into each culture flask to produce a culture containing 10% suspension. The flasks were kept under LED lights

in the growth chamber. The aeration was provided by the pump aerator (Sobo pump, Aquarium pump SB-348A). The light-to-dark time ratio was maintained at 16h: 8h throughout the culture period. Sampling was performed at 6-day intervals to monitor physicochemical properties, cell dry weight, optical density, specific growth rate, and pigment contents (chlorophyll *a*, phycocyanin, and β-carotene). The optimum pH was maintained from 9.0 to 9.7 and the temperature was regulated 30 to 31°C.

Estimation of cell weight (Dry basis)

A sample containing 20 mL of algal *A. platensis* suspension was filtered through a filter paper (Whatman GF/C filter paper of 0.45 µm mesh size and 47 mm diameter). The filter paper was weighed prior to filtration. When the sample was being filtered to remove insoluble salts, it was washed with 10 mL of acidified water (pH = 4). After that, the filter papers were placed in a glass Petri dish and heated in the oven at 70 °C overnight. For cooling, Petri dishes were placed in a desiccator for 20 minutes, and then the filter papers were weighed. Cell dry weight was calculated according to Clesceri *et al.* (1989).

$$W = \frac{FFW - IFW}{Amount\ of\ sample\ taken\ filtration\ (mL)} \times 100$$

Where W= Cell dry weight in g/L; FFW= Final filter weight in g; and IFW= Initial filter weight in g.

Measurement of optical density

Optical density (OD) of samples collected at different sampling dates was measured at 680 nm using a UV-Vis spectrophotometer (BK-UV1800, Biobase, China). A sample of *A. platensis* grown under different treatments was placed in a cuvette and scanned in a spectrophotometer. The OD of the samples was then recorded at 680 nm.

Estimation of Chlorophyll a, Phycocyanin, and β-carotene

Chlorophyll *a* was estimated according to the method of Fathi *et al.* (2013). *A. platensis* samples were collected at 6-day intervals to estimate chlorophyll *a*, phycocyanin, and β-carotene content. *A. platensis* sample (5 mL) from each treatment (Control, RBE10, RBE20, RBE30, and RBE40) was pipetted from the culture flask and taken into a test tube. Each sample was then centrifuged at 4000 rpm for 10 minutes, and the supernatant was discarded. Due to the presence of salts, the sediment was centrifuged again. After centrifugation, the resulting sediment was dissolved in 5 mL of acetone (80%). The solution was again centrifuged at 4000 rpm for 10 minutes. Then it was placed in a spectrophotometer to measure the light absorbance at 412, 431, 460, and 480 nm. A blank with 100% distilled water was run simultaneously. Beta-carotene, chlorophyll *a*, and phycocyanin were calculated according to Eijckelhoff and Dekker (1997) by the following formulae-

Chlorophyll *a* (µg/ mL) = -1.709 A412 + 11.970 A431 - 2.998 A460 - 5.708 A480

Phycocyanin (µg/ mL) = [A615-0.474(A652)]/5.34

β-carotene (µg/ mL) = -0.430 A412 + 0.251 A431 - 4.376 A460 +13.216 A480

Specific growth rate (SGR)

The specific growth rate (SGR, µ/day) of cultured microalgae was calculated by the following equation (Clesceri *et al.*, 1989):

$$SGR\ (\mu/day) = \ln (X_1 - X_2)/ T_2 - T_1$$

Where,

X_1 = Biomass concentration at the end of the selected time interval, X_2 = Biomass concentration at the beginning of the selected time interval, and $T_2 - T_1$ = Elapsed time between selected time in days.

Determination of the physicochemical properties of the culture media

The physicochemical parameters, such as temperature, pH, and light intensity of the culture media, were measured at 6-day intervals up to the end of the experiment using the following procedures, as described by Clesceri *et al.* (1989).

Statistical analysis

All data were collected and recorded in a computer spreadsheet and analyzed using one-way ANOVA with Statistix 10. Mean comparisons were performed using the least significant difference (LSD) test at the $p < 0.05$ significance level.

Results and Discussion

Cell dry weight

The mean cell dry weight of *A. platensis* across treatments during the experimental period is shown in Figure 1. The initial inoculum rate in all the treatments was 0.10 ± 0.01 mg/L in the present

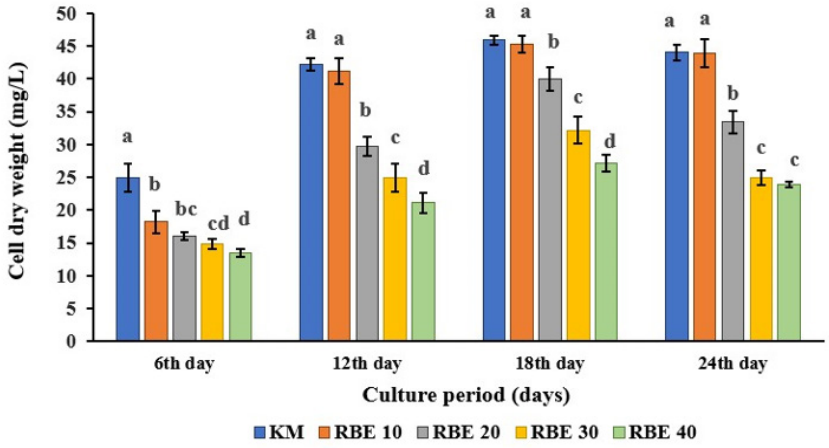

Figure 1: *Cell dry weight (mg/L) of A. platensis under different treaments during the experimental period. Means with different letters are significantly different (p< 0.05)*

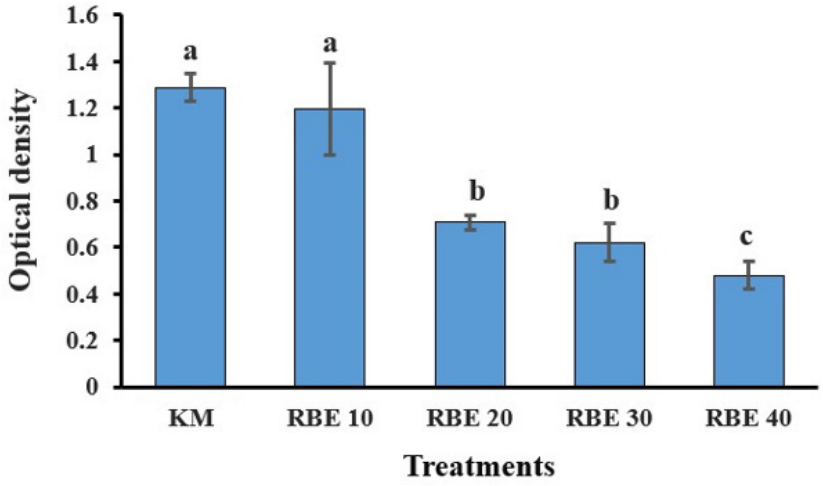

Figure 2: *Means optical density of A. platensis under different treaments on the 18th day of culture. Different latter at the end of trends line represent significant (p< 0.05) different among the treament.*

experiment. After 6 days of incubation, there was a significant increase in dry weight and greater variation among treatments. The growth of *A. platensis* reached the 18th day of culture, at which point it entered the exponential growth phase. During the exponential phase (day 18), the maximum cell dry weight in the KM medium (control) reached 45.9 ± 0.6 mg/L, while RBE10 achieved 45.30 ± 1.4 mg/L, where no significant difference was observed between RBE10 and KM ($p > 0.05$). However, when the RBE concentration was increased from 20% to 40%, cell dry weight gradually decreased. The mean cell dry weight of *A. platensis* in RBE20, RBE30, and RBE40 was 40.06 ± 1.8 mg/L, 32.2 ± 1.7 mg/L, and 27.23 ± 1.3 mg/L, respectively, and a significant difference was observed among the treatments.

On the 18th day of culture, KM medium exhibited a steady increase in cell dry weight, likely due to the presence of all essential nutrients required for optimal *A. platensis* growth. In this study, cell dry weight in RBE10 medium was comparable to that in KM, indicating that both media provide optimal nutrient conditions for enhanced *A. platensis* growth. Nutrient concentration in the culture medium is a key factor regulating microalgal growth and biomass accumulation (Nurjannah *et al.*, 2025). However, higher RBE concentrations (RBE20, RBE30, and RBE40) resulted in a gradual reduction in cell dry weight. According to Yeesang and Cheirsilp (2014), this decline may be attributed to the darker coloration of RBE at higher concentrations, which limits light penetration and, consequently, reduces photosynthetic activity and microalgal growth.

Optical density

The mean optical density (OD) in different treatments on the 18th day is shown in Figure 2. OD of *A.*

platensis was found to increase until the stationary phase (18th day). The mean values of OD ranged from 0.29 ± 0.06 to 1.28 ± 0.6 over the experimental period. During the exponential phase (day 18), the mean optical density (OD_{680}) of *A. platensis* cultures in KM, RBE10, RBE20, RBE30, and RBE40 was recorded as 1.28 ± 0.06, 1.19 ± 0.26, 0.708 ± 0.03, 0.62 ± 0.08, and 0.48 ± 0.06 g/L, respectively; however, a decline in optical density was observed beyond this period. The highest optical density (1.28 g/L) was recorded in KM, followed by 1.19 g/L in RBE10, and the lowest (0.29 g/L) was found in RBE40.

In this study, several factors may contribute to the higher optical density (1.28 ± 0.06 g/L) in KM, likely due to optimal nutrient levels. RBE10 showed an optical density (1.19 ± 0.26 g/L) that was not significantly different from that of the control media. Baidya *et al.* (2021) found a positive correlation between the microalgal cell dry weight and optical density. Since the mean cell weight of *A. platensis* was higher in the KM and RBE10, an increase in OD was also found in this study. The lowest optical density in RBE40 may be due to the high nutrient concentration in the medium. The findings from Bualuang *et al.* (2022) revealed that the growth of *A. platensis* increased at 0.1% and 0.2% of small fish bone meal (SFBM) supplementation, while decreasing at a relatively higher level (1.0%) of SFBM supplementation. Therefore, the inhibition of photosynthesis at higher concentrations (20-40%) of RBE media could be another reason for the reduced optical density compared to KM and RBE10.

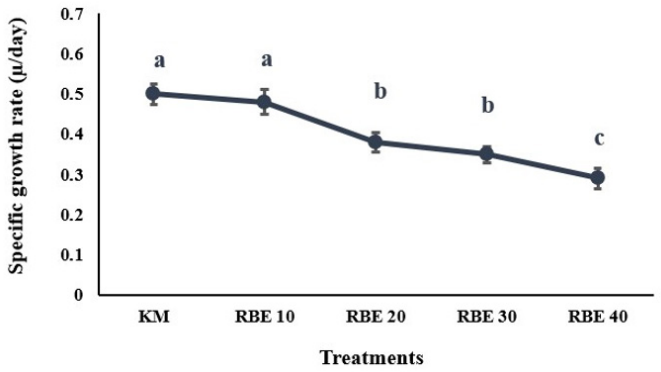

Figure 3: *SGR (μ/day) of A. platensis under different treaments on the 18th day of culture. Means with different letters on the 18th day of culture are significantly different (p<0.05).*

Specific growth rate

The specific growth rate (SGR) of *A. platensis* in different treatments on the 18th day is presented in Figure 3. An upward trend in SGR was observed up to the exponential phase (day 18). During this phase, the SGR of *A. platensis* in KM was 0.50 ± 0.02 μ/day, while RBE10 recorded 0.48 ± 0.03 μ/day, showing no significant difference from the KM control ($p > 0.05$). In contrast, SGR values in RBE20, RBE30, and RBE40 were 0.38 ± 0.02, 0.35 ± 0.02, and 0.29 ± 0.02 μ/day, respectively, and all were significantly lower than KM and RBE10. The similarity in the SGR values of RBE10 (0.48 μ/day) and KM (0.50 μ/day) indicates that RBE10 medium provides a nutrient environment comparable to that of the standard KM medium, making it a potentially suitable alternative for spirulina cultivation. Islam *et al.* (2022) observed SGR values ranging from 0.23 to 0.52 μ/day when *A. platensis* was cultured in different concentrations of digested rotten guava extract, with higher nutrient availability supporting higher SGR. Similarly, Delrue *et al.* (2017) reported that *A. platensis* exhibits SGR values of 0.45-0.55 μ/day under optimized laboratory conditions, underscoring the importance of a balanced nutrient composition for sustaining exponential growth. Nutrient concentration is therefore a key factor regulating SGR, and the comparable performance of RBE10 and KM suggests that RBE10 provides sufficient nutrient availability for robust growth. However, the reduced SGR values observed at higher RBE concentrations (20-40%) may be due to impurities or increased medium turbidity, which can limit light penetration and reduce photosynthetic efficiency. According to Ndjouondo *et al.* (2017), excessive nutrient loading or medium coloration can negatively affect the growth of *A. platensis* by altering light availability and medium quality. This supports the present findings, which show that higher RBE concentrations were associated with gradually lower SGR values.

Chlorophyll a

The mean chlorophyll *a* content of *A. platensis* in different treatments on the 18th day is presented in Figure 4. An upward trend in chlorophyll *a* content of *A. platensis* was observed up to the stationary phase (18th day), after which it began to decrease. The mean chlorophyll *a* content of *A. platensis* ranged from 0.17 ± 0.03 μg/mL to 0.78 ± 0.17 μg/mL during the culture period. The control media (KM) had the maximum chlorophyll *a* content (0.78 ± 0.17 μg/mL). Similar results were observed for chlorophyll *a* of the *A. platensis* in RBE10 (0.74 ± 0.20μg/mL); however,

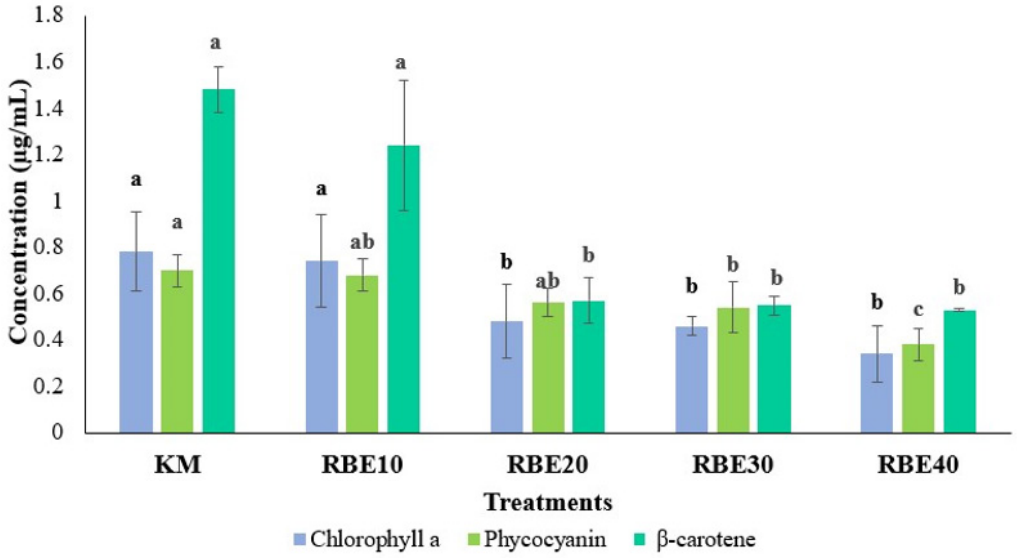

Figure 4: *Chlorophyll a, phycocyanin (ug/mL) of A. platensis under differnet treatments on the 18th day of culture. Means with different letters on the 18th day of culture are significantiy different (p<0.05).*

no statistical significance (p > 0.05) was observed between control and RBE10. On the other hand, higher concentrations of rice bran extract as RBE20 (0.48 ± 0.16 µg/mL), RBE30 (0.46 ± 0.04µg/mL), and RBE40 (0.34 ± 0.12 µg/mL) showed decreased amount of chlorophyll *a* content.

In the present study, the highest chlorophyll *a* content was observed in KM and RBE10, and several factors may have contributed to these results. Physical factors such as temperature, aeration, and light intensity, as well as chemical factors such as nutrient availability, may all affect chlorophyll levels. The biomass concentration can be indirectly determined by measuring chlorophyll *a* concentration. Chlorophyll concentration typically increases with biomass concentration. Given the direct relationship between the cell weight and optical density, the chlorophyll *a* content was also observed to increase in KM and RBE10. Conversely, the higher RBE concentrations, specifically RBE20, RBE30, and RBE40, showed markedly reduced chlorophyll *a* levels, likely attributable to diminished pigmentation that limited light penetration within the culture medium. In mixotrophic conditions, light availability and an organic carbon source are the two primary factors influencing pigment production in *A. platensis*. However, at high to medium concentrations, light penetration becomes severely limited, thereby constraining pigment synthesis (Mirhosseini *et al.*, 2022). The findings of Chainapong *et al.* (2012) showed that moderate nutrient enrichment can enhance pigment production by maintaining a balance between nutrient availability and sufficient light exposure. In this experiment, RBE10 supported higher chlorophyll *a* accumulation, indicating that the physiological activity of *A. platensis* is strongly influenced by both nutrient concentration and the optimal properties of the culture medium.

Phycocyanin

The mean phycocyanin content of *A. platensis* in different treatments on the 18th day is presented in Figure 4. An upward trend in the phycocyanin content of *A. platensis* was observed up to the exponential phase (18th day); thereafter, it began to decline. The KM (control) had the highest phycocyanin content (1.70 ± 0.07 µg/mL). Similar results were observed for phycocyanin of the *A. platensis* in RBE10 (1.68 ± 0.07 µg/mL). However, the higher rice bran extract concentrations (RBE20, RBE30, and RBE40) showed reduced phycocyanin content of 1.56 ± 0.06 µg/mL, 1.54 ± 0.11 µg/mL, and 1.38 ± 0.07 µg/mL, respectively, compared with KM and RBE10. There was a significant difference (p < 0.05) among the treatments of RBE20, RBE30, and RBE40.

β-carotene

The mean β-carotene content of *A. platensis* across different treatments on the 18th day is shown in Figure 4. Up to the exponential phase (18th day), β-carotene in *A. platensis* showed an increasing trend, after which it began to decline. The KM (control) had the highest β-carotene content (1.48 ± 0.10 µg/mL). Similar findings were observed for β-carotene in *A. platensis* in RBE10 (1.24 ± 0.28 µg/mL), which were not significantly (p > 0.05) different from the control.

However, the higher rice bran extract concentrations (RBE20, RBE30, and RBE40) showed reduced β-carotene content (0.57 ± 0.10 µg/mL, 0.55 ± 0.04 µg/mL, and 0.53 ± 0.007 µg/mL, respectively) compared with KM and RBE10. There was a significant difference ($p < 0.05$) among the treatments of RBE20, RBE30, and RBE40 compared with KM and RBE10. The reason for such variation may be differences in coloration, nutrient composition, and light penetration into the culture media.

The study found that RBE10 exhibited the highest β-carotene levels, comparable to those of chlorophyll *a*. Carotenoids and chlorophyll concentrations are related; a similar trend of their enhancement is also observed in this study. Moreover, factors that enhance chlorophyll *a* synthesis, such as carbon (C), nitrogen (N), phosphorus (P), potassium (K), and zinc (Zn), also contributed to increased β-carotene accumulation.

Conclusions and Recommendations

The present study demonstrates that rice bran extract (RBE) can be a viable and cost-effective alternative to the conventional Kosaric medium (KM) for cultivating *Arthrospira platensis*. Among the various concentrations, RBE10 consistently supported growth performance, pigment synthesis, and physiological activity comparable to KM, as evidenced by similar cell dry weight, optical density, specific growth rate, and pigment content. In contrast, higher RBE concentrations (20-40%) led to gradually lower biomass and pigment levels, likely due to increased RBE in the medium, which reduces light penetration and consequently limits photosynthetic efficiency. Using 10% RBE not only reduces reliance on costly chemical media but also promotes the productive use of rice bran, an abundant agricultural byproduct. This approach offers a sustainable, low-cost strategy for *A. platensis* cultivation, particularly beneficial for small-scale producers and resource-limited settings. Future research should focus on optimizing RBE preparation methods, evaluating large-scale cultivation performance, and assessing the biochemical composition of *A. platensis* grown in RBE-based media to further validate its commercial potential.

Acknowledgments

The authors are grateful to the Research Management Wing of Gazipur Agricultural University for funding the research and for providing this opportunity to conduct the study.

Novelty Statement

The study is significant for its findings that rice bran extract (RBE) can be used as an alternative medium for *A. platensis* culture. Moreover, 10% RBE provides comparable growth performance and pigment content with Kosaric media. Overall, the study findings suggest the adoption of agro-residue-derived rice bran extract media for *A. platensis* culture to reduce cost and dependency on expensive synthetic media.

Author's contribution

Zakia Sultana and Md. Amzad Hossain: Planning, designing the research, and writing the original manuscript.
Zakia Sultana and Tanzila Gias: Conducting fieldwork, collecting and visualizing data, and editing the manuscript.
Md. Amzad Hossain, Mousumi Das and Umme Kaniz Fatema: Supervision, guidance, suggestions throughout the research process and reviewing the manuscript.

Generative AI or AI-assisted technology statement.
No AI technology has been used in this whole experimental research trial.

Conflict of interest
The authors have declared that there is no conflict of interest exists.

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