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RESEARCH ARTICLE

SELECTION AND CULTIVATION OF A HIGH-YIELDING STRAIN OF SPIRULINA PLATENSIS

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Abstract

Spirulina platensis**,**a filamentous cyanobacterium,is globally recognized for its high protein content,bioactive compounds, and health-promoting properties. Enhancing biomass productivity through strain selection and optimized cultivation is crucial for meeting commercial demands in nutraceutical and pharmaceutical industries. This study aimed to identify and cultivate a high-yielding S. platensis strain with superior growth performance and nutritional quality. Three strains (SP1, SP2, SP3) were grown in BG11, Zarrouk's, and Modified Zarrouk's media under controlled laboratory conditions for 30 days. Growth was assessed via optical density at 680 nm (OD_{680}), biomass yield (g L^{-1} day^{-1}), and protein content using the Lowry method. SP2 achieved the highest biomass productivity (0.08 g L^{-1} day^{-1}) and protein content (62.5 ± 2.9%) in Modified Zarrouk's medium, outperforming SP1 and SP3. These results indicate that SP2 is a promising candidate for large-scale cultivation due to its yield potential and nutritional profile, supporting applications in sustainable protein production, nutraceuticals , and pharmaceuticals.

Introduction:-

Spirulina platensis is a filamentous, photosynthetic cyanobacterium widely used as a nutritional supplement and functional food ingredient due to its high protein content (55–70%), essential amino acids, vitamins, minerals, and antioxidant pigments like C-phycocyanin. Its applications span nutraceuticals, pharmaceuticals, cosmetics, and aquaculture feed.

With the growing global demand for sustainable protein sources, optimizing Spirulina cultivation for higher yield and nutritional value has become a priority. Biomass productivity is influenced by multiple factors, including strain genetic potential, medium composition, light intensity, pH, and temperature. Strain selection plays a pivotal role, as different isolates exhibit varied growth rates, nutrient utilization efficiencies, and biochemical profiles.

This study focuses on selecting a high-yielding **S. platensis** strain through comparative growth assessment in three commonly used culture media—BG11, Zarrouk's, and Modified Zarrouk's—under controlled laboratory conditions.

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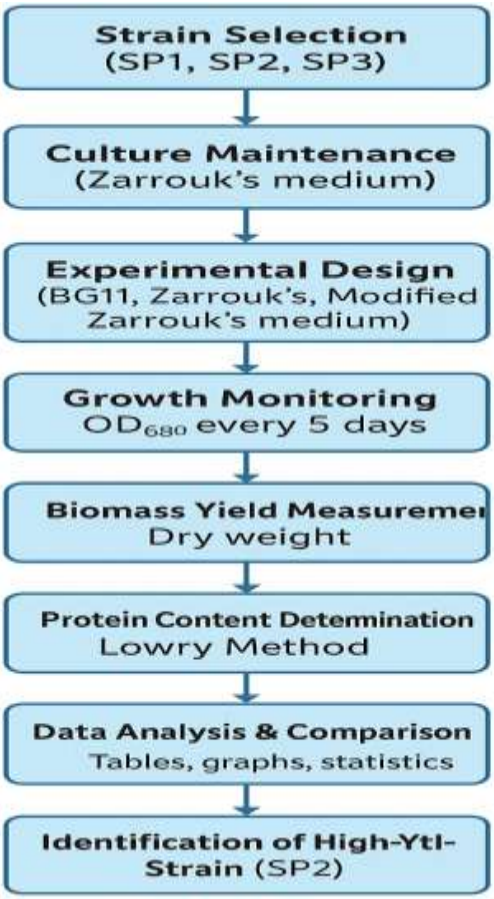
The findings aim to provide a basis for cost-effective, large-scale production of nutrient-rich Spirulina for commercial applications.

Figure 1. Flow chart of study methodology and significant points



Materials and Methodology:-

Strain Selection and Maintenance:
Three strains of **S. platensis** (SP1, SP2, SP3) were obtained from a culture collection and maintained in Zarrouk's medium under laboratory conditions (28 ± 2°C, pH 9.0, continuous aeration, and light intensity of 2,500 lux).

Experimental Design:
Each strain was cultivated in triplicate in BG11, Zarrouk's, and Modified Zarrouk's media (500 mL working volume in 1 L Erlenmeyer flasks). The initial inoculum was standardized to an OD_{680} of 0.2.

Growth Monitoring:
Optical density (OD_{680}) was recorded at 5-day intervals for 30 days using a UV–Vis spectrophotometer. Biomass yield was determined by filtering culture samples through pre-weighed Whatman GF/C filters, drying at 60°C until constant weight, and calculating g L^{-1} day^{-1} productivity.

Protein Content Determination:
Protein content was measured by the Lowry method using bovine serum albumin (BSA) as the standard, with results expressed as percentage of dry biomass.

Results:-

Growth Performance (OD_{680} Values):

SP2 demonstrated the highest OD_{680} values in all media, with Modified Zarrouk's medium showing the most pronounced growth (OD_{680} = 1.92 ± 0.04 at day 30).

Table 1. OD_{680} of SP1 in different media over 30 days

Day	BG11	Zarrouk's	Modified Zarrouk's
0	0.20	0.20	0.20
5	0.35	0.39	0.41
10	0.48	0.53	0.58
15	0.62	0.68	0.74
20	0.76	0.85	0.93
25	0.88	1.01	1.10
30	0.95	1.12	1.25

Table 2. OD_{680} of SP2 in different media over 30 days

Day	**BG11**	**Zarrouk's**	**Modified Zarrouk's**
0	0.20	0.20	0.20
5	0.39	0.43	0.46
10	0.55	0.61	0.68
15	0.73	0.80	0.90
20	0.91	1.02	1.15
25	1.05	1.21	1.36
30	1.14	1.35	1.55

Table 3. OD_{680} of SP3 in different media over 30 days

Day	BG11	Zarrouk's	Modified Zarrouk's
0	0.20	0.20	0.20
5	0.37	0.41	0.44
10	0.51	0.57	0.62
15	0.68	0.74	0.81
20	0.85	0.93	1.02
25	0.98	1.10	1.20
30	1.07	1.23	1.38

Protein Content:-

Protein content was significantly higher in SP2 (62.5 ± 2.9%) compared to SP1 (58.4 ± 2.7%) and SP3 (59.6 ± 2.5%).

Table 4. Biomass yield and protein content of S. platensis **strains**

Strain	Medium	Biomass Productivity (g L^{-1} day^{-1})	Protein Content (%)
SP1	BG11	0.06 ± 0.002	58.2 ± 2.1
SP1	Zarrouk's	0.07 ± 0.003	59.8 ± 1.9
SP1	Modified Zarrouk's	0.075 ± 0.003	60.4 ± 2.0
SP2	BG11	0.07 ± 0.002	60.5 ± 2.4
SP2	Zarrouk's	0.075 ± 0.002	61.7 ± 2.6
SP2	Modified Zarrouk's	0.08 ± 0.002	**62.5 ± 2.9**
SP3	BG11	0.065 ± 0.002	59.0 ± 2.3
SP3	Zarrouk's	0.07 ± 0.002	60.1 ± 2.5
SP3	Modified Zarrouk's	0.075 ± 0.002	± 2.4**2.16**

Discussion:-

The present study demonstrated that strain selection and culture medium composition significantly influence the growth performance, biomass productivity, and protein content of S. platensis**.** Among the three tested strains, SP2 consistently showed superior growth, particularly when cultivated in Modified Zarrouk's medium, achieving the highest OD_{680} values, biomass productivity (0.08 g L^{-1} day^{-1}), and protein content (62.5 ± 2.9%).

The enhanced performance of SP2 in Modified Zarrouk's medium can be attributed to several factors. Firstly, genetic variation among S. platensis strains may lead to differences in nutrient uptake efficiency, photosynthetic capacity, and tolerance to pH and light fluctuations. Previous studies have reported that strain-specific adaptation plays a critical role in determining biomass yield and biochemical composition (Habib et al., 2008; Richmond, 2004).

Secondly, the nutrient-rich and bicarbonate-optimized formulation of Modified Zarrouk's medium likely provided improved carbon availability and ionic balance, supporting robust growth and protein synthesis. Sodium bicarbonate serves as the primary inorganic carbon source for Spirulina**,** and its optimal concentration is essential for maintaining high photosynthetic activity and pH stability during cultivation (Zarrouk, 1966).

The observed protein contents across all strains (55–62%) align with the typical protein range for S. platensis reported in literature, further confirming the high nutritional quality of the cultivated biomass. Notably, SP2's protein content in Modified Zarrouk's medium was at the upper range of reported values, indicating potential for use in nutraceutical formulations, functional foods, and as a sustainable protein source for aquaculture and livestock feeds.

Comparative analysis also revealed that BG11 medium supported slower growth compared to Zarrouk's and Modified Zarrouk's media. This difference may be due to the lower bicarbonate and nitrate content in BG11, which can limit carbon assimilation and nitrogen metabolism in Spirulina**.** The results are consistent with earlier findings that bicarbonate-rich media enhance Spirulina biomass productivity (Belay et al., 1994).

While the current study was conducted under controlled laboratory conditions, scalability to outdoor or photobioreactor-based cultivation will require further optimization to account for environmental variables such as fluctuating temperature, light intensity, and potential contamination. Additionally, future work could investigate the biochemical composition beyond protein—such as phycocyanin, carotenoids, and essential fatty acids—to fully characterize the commercial value of SP2.

Overall, the findings underscore the importance of integrating strain selection with medium optimization to maximize yield and nutritional quality in Spirulina cultivation. The superior performance of SP2 in Modified Zarrouk's medium positions it as a promising candidate for large-scale, cost-effective biomass production for the nutraceutical and pharmaceutical industries

Conclusion:-

This study highlights the critical role of strain selection and medium optimization in maximizing Spirulina platensis biomass productivity and nutritional quality. Among the tested strains, SP2 exhibited the highest growth rate, biomass yield, and protein content when cultivated in Modified Zarrouk's medium under controlled laboratory conditions. The enhanced performance is attributed to both the inherent genetic potential of SP2 and the optimized

nutrient composition of the medium, particularly its bicarbonate content, which supports efficient carbon assimilation and protein synthesis.

These results establish SP2 as a promising candidate for large-scale commercial cultivation, with significant potential applications in nutraceuticals, pharmaceuticals, and sustainable protein production. Future studies should focus on outdoor cultivation trials, large-scale photobioreactor optimization, and comprehensive biochemical profiling to further enhance its industrial value.

Summary Points:
• Strain SP2 showed the highest growth and protein content.
• Modified Zarrouk's medium was most effective for cultivation.
• Biomass productivity and protein levels were within reported ranges.
• SP2 is a promising strain for commercial-scale production.

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