International Journal on Emerging Technologies **10**(2): 19-22(2019)

**ISSN No. (Print) : 0975-8364**
**ISSN No. (Online) : 2249-3255**

# Influence of Temperature and Light Intensity on the Growth Performance of *Spirulina platensis*

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*(Received 09 April 2019, Revised 01 July 2019 Accepted 03 July 2019)*
*(Published by Research Trend, Website: www.researchtrend.net)*

**ABSTRACT: Influence of light intensity, temperature and pond depth during different seasons and climatic conditions on *Spirulina platensis* was studied. Biomass productivity was calculated as cell dry weight. Biomass productivity and chlorophyll was maximum during summers when temperature was optimum with little humid climate and also the light intensity was maximum. *Spirulina* Biomass obtained in monsoon was least and in summers was maximum as the conditions were favourable, biomass was about 12.56g/m$^2$/d. Maximum protein content obtained was about 53.17%. This form of *Spirulina* can easily be accepted and adopted by rural women and children for maximum protein content in the form of food, feed and a good health supplements also this can lead to a bigger contribution in eradication of malnutrition.**

**Keywords:** *Spirulina*, Microalgae, harvesting, Productivity, Chlorophyll, Protein content

## I. INTRODUCTION

Microalgae were the planet's primary plants to appear. Billions of years ago, they transformed the carbon-dioxide-based climate into an oxygen-rich environment where other life forms could develop [1]. Biotechnological forms reliant on blue green algae became increasingly enthusiastic due to their ability to deliver an assorted range of synthetic concoctions and organically dynamic mixtures, such as vitamins, carotenoid pigments, proteins, etc. [2-5]. *Spirulina* is multi-cell and filamentous blue-green algae, as seen in (Fig.1), which has expanded widespread notoriety in the wellness nutrition industry and is gradually consuming less calories as a protein and vitamin supplement to aquaculture. It develops in water, is easy to collect and prepare, and has a high-scale and small-scale supplement. Because of its ability to deliver large amounts of profitable items, such as phycocyanin [6-8], the cyanobacteria *Spirulina platensis* was economically misused for the generation of human sustenance supplements, animal feed and pharmaceuticals. The vast-scale generation of *Spirulina* biomass is based on multiple components, most vital of those are the availability of nutrients, temperature and light. These elements can affect the development of *Spirulina* and the arrangement of biomass created by causing changes in metabolism that significantly adjust the time span of the collection of the main segments of biomass.

The optimum temperature for the growth of *Spirulina platensis* is 27°C-35°C. *Spirulina* also requires fairly high pH, which in the culture medium successfully suppresses the development of other algae. To support the high pH and light intensity, high sodium bicarbonate measures should be available reliably in the culture medium.

**Fig. 1.** Microscopic view of *Spirulina.*

*Spirulina platensis* is a multicellular, filamentous cyanobacteria consisting of blue-green cylindrical cell filaments (1 to 12 µm broad) in unbranched helicoidal trichomes, fibers being mobile, coasting along their pivot and without heterocysts. Carbon is the essential supplement desired by *Spirulina* and this form of life in antacid lakes is the overwhelming species in view of the proximity of high sodium carbonate convergences [1, 8-10].

The author examined that the second major expense in the production of *Spirulina* microalgal biomass is the expense of supplements, primarily the source of carbon. [3].

Major Objectives of this research work:

-To calculate maximum biomass content during various climatic conditions as summer, winters and monsoon

-To calculate maximum protein content in cultivated *Spirulina*

-To study elemental, nutritional and proximate analysis of *Spirulina* species.

## II. MATERIALS AND METHODS

In this study, *Spirulina platensis* mother culture for small-scale cultivation as given in fig. 2, was obtained from Gerophyta Nutraceuticals, illupur, Tamil Nadu and cultivated at the Energy Center, MANIT, Bhopal shown in figure 4, which was originally maintained at ambient temperature in Zarrouk's medium. Flow chart for *Spirulina* cultivation system is given in Fig. 3.

**Fig. 2.** *Spirulina* cultivation system at MANIT, Bhopal.

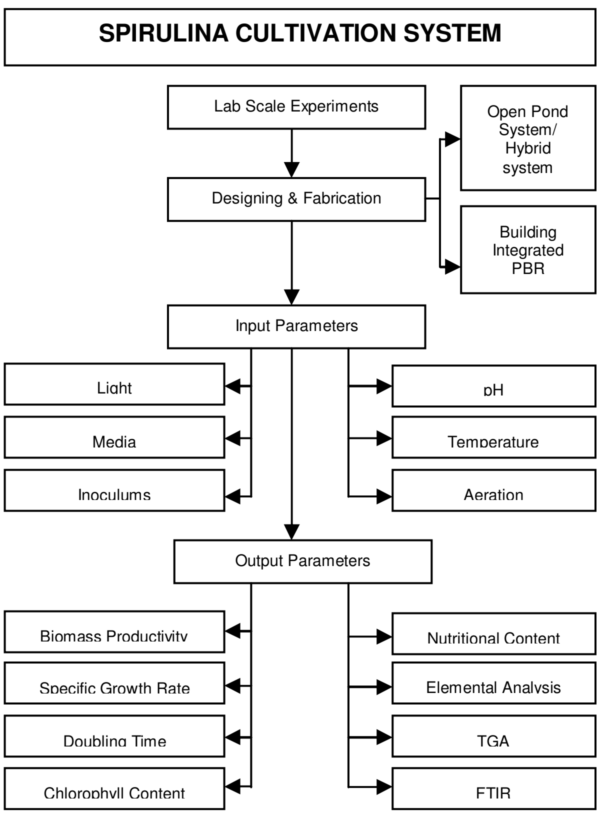


**Fig. 3.** *Spirulina* cultivation system at MANIT, Bhopal.

Production of algae involves basically three important steps:

- Cultivation using different types of media
- Harvesting using different sizes mesh cloth
- Processing to consumable forms


**Fig. 4.** Location for *Spirulina* cultivation at Energy Centre, MANIT, Bhopal.

Step wise experimental procedure-

- In a glass tank of 20litres RO water, zarrouk media was added.
- To this media solution 200ml inoculums was added early morning
- Manually aerated every hour
- Optical density was measured at 450nm and 630nm
- pH was measured and checked regularly
- when pH reached 11 , harvesting of *Spirulina* cells was done.
- Harvesting was done through 300micron mesh cloth
- Drying can be done in many ways, we opted for oven drying.
- Dried algal biomass was then grounded for further elemental, proximate and nutritional analysis.

## III. RESULT AND DISCUSSION

Lab scale experiments for *Spirulina* were carried out for getting the maximum protein content. Cultivation of microalgae was done in different seasons. First batch cultivation was done in rainy season July – August and biomass obtained was about 4.56 g/m$^2$/d. These months have been cloudy and the mean light intensity has been lower. While light intensity and temperature have been found to be adequate in this season, the rainy season is drizzly, humid and wet and it encourages contamination as cultivation becomes diluted and temperature remains 5-8$^{\circ}$C higher than normal. Atmospheric temperature fluctuation is the major factor affecting the higher production rates of biomass in *Spirulina*'s outdoor open cultivation. The culture may become contaminated during the rainy season due to rain drops resulting in the lowest level of dried mass. Thus the physical considerations that were not advantageous in monsoon were relatively controlled by using the appliances available locally and effortlessly without escalating production expenses. During this season, the warm humid environment encourages the contamination of bacteria [11-12]. The *Spirulina* culture's major contaminants were mostly protozoans such as Amoebae and Paramecium, which eventually ruined the cultures. Insects also appeared in the culture during the season, making it unfit for human consumption. Variation with number of days of specific growth rate is shown in (Fig.5).

Second batch cultivation was carried out in January and the obtained biomass was approximately 11.45 g / $m^2$/d (Table 1). *Spirulina* cultures were kept in the green house to reduce the effect of the low winter season temperature. The concentration of salinity or nutrients affects the growth rate of microalgae. Specific growth rates of *Spirulina platensis* in increased salinity concentrations were reported to be lower. Cultural depth often played a significant role in the yield of biomass. This was noted that when the culture depth was less than 20 cm, higher solar radiation was experienced by the superficial layer of the culture, when it was more than 25 cm deep, lower layer of culture could not get enough solar radiation. The depth of 20 cm was found to be optimal for *Spirulina* mass cultivation. Maintaining the pH level also played a major role in algae production. Mother culture was maintained at high pH (9-11) due to *Spirulina platensis* being grown in alkaline media. Also found helpful in controlling the photo inhibition was the proper agitation of cultures and it enhances the algae's productivity. Agitation helps in the algae's uniform exposure to Sunlight, consistent nutrient distribution [5]. *Spirulina* reproduces by fragmentation and continuous agitation, enhancing filament breakdown that helps to multiply and produce biomass [13-14].

Third batch cultivation was done in March-April when the temperature and light intensity was high and also the biomass obtained was a good yield i.e 12.56 g/$m^2$/d (Table 1). During summers, temperature was very high i.e about 45-500C maximum. For maintaining temperature difference exhaust fan was used. *Spirulina* gave maximum biomass content during optimum temperature 25-34°C. The incident solar radiations was very high in Bhopal during summers. Due to the high temperature range that does not allow any growth of the microorganism, no contamination was recorded in the summer season

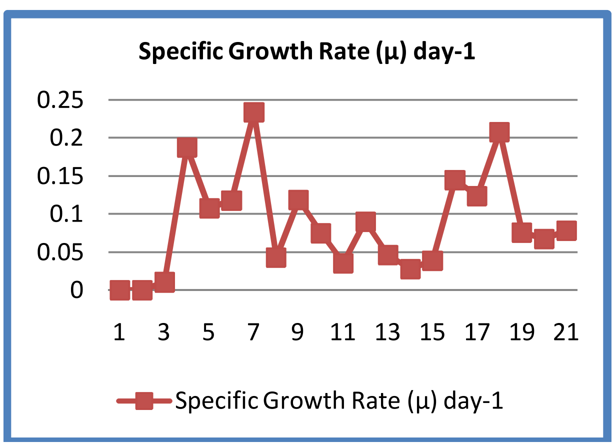


**Fig. 5.** Variation of Specific growth rate with Number of days for open pond.

When pH reached 11, harvesting was done using mesh cloth of 300micron size. Further, it as washed with fresh water for about 4-5 times to remove the excess salts and then dewatering id done to remove the excess water by pressing it gently. After this *Spirulina* is dried in oven or by keeping in sunlight for 7-8 hrs, and then this dried powder is subjected to elemental, proximate and nutritional analysis (Table 2).

**Table 1: Effect of temperature and light intensity on biomass of *Spirulina* in different climatic conditions.**

| Seasons | Light Intensity | Temp. Range | Biomass productivity | Chlorophyll |
|---|---|---|---|---|
| Monsoon (Jul-aug) | 3500 lux | 23 – 39°C | 4.56g/l/d | 1.24% |
| Winters (Jan) | 4100 lux | 9-30°C | 11.45 g/l/d | 1.31% |
| Summers (Mar-apr) | 4300 lux | 24-47°C | 12.56 g/l/d | 1.43% |

**Table 2: Elemental, Proximate and nutritional analysis of *Spirulina* sp.**

| Elemental Analysis | | | | |
|---|---|---|---|---|
| C% | H% | N% | O% | H/C% |
| 20.36 | 5.35 | 18.32 | 21.47 | 0.26 |
| **Proximate Analysis** | | | | |
| Moisture content | Volatile matter | Ash content | Fixed carbon | |
| 7.13% | 57.12% | 16.62% | 19.13% | |
| **Nutritional composition** | | | | |
| | Proteins | Carbohydrates | Lipids | Fats |
| | 60-70% | 23-28% | 6-7% | 7-8.5% |
| Sample | 53.17% | 23.25% | 4.9% | 6.05% |

## IV. DISCUSSION

In the near future, the world will face the test of century to create sufficient nutrition to support an extra 90 million people each year just as it will meet the various variety of sustenance requirements due to rising living standards and changing lifestyles. Today, 800 million individuals are confronting sustenance uncertainty in which 200 million are in India [15-19].

*Spirulina platensis* was cultivated in Bhopal under different climatic conditions to obtain maximum biomass productivity.

- ✓ Maximum biomass productivity was obtained during summers which also had maximum chlorophyll content.
- ✓ Nutritional analysis showed it also had maximum protein content. This is because of the optimum light intensity and proper temperature range.
- ✓ Maximum protein content was 53.17% and lipid was about 4.9%.

## V. CONCLUSIONS

After 1977 the investigation and formative work on *Spirulina* began in India in 1990, various government, non-governmental and private associations showed their enthusiasm for *Spirulina* in view of its multifunctional potentials which include remedial and pharmaceutical. Subsequently, it is widely developed to be used regularly as a source of sustenance for humans and animals in products for beauty care. As our country people are predominantly vegetarians, so *spirulina* can be a very good option as a source of protein. As the doubling time of *spirulina* is very less compared with other algae and also its cost effective. In this study, maximum productivity with highest protein content was observed in summers whereas least was seen during monsoons due to warm humid climatic conditions which indirectly favours bacterial growth for contamination. Another *Spirulina* attribution has a higher PER(Protein Efficiency Ratio) than any other vegetable, cereal or soybean. *Spirulina* is considered as super food as it has all the essential nutrients present in it.

## ACKNOWLEDGEMENT

We are very thankful to the Director, Maulana Azad National Institute of Technology Bhopal, India for the continued support and guidance to complete this research work.

**Conflict of interest**: No

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**How to cite this article:** Soni, R.A. Sudhakar, K. and Rana, R.S. (2019). Influence of Temperature and Light Intensity on the Growth Performance of *Spirulina platensis. International Journal on Emerging Technologies,* **10**(2): 19-22.