Comparison of the Growth Characterization of Spirulina Using Multiple Physiochemical Parameters

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Abstract:

Spirulina is a type of blue-green algae that grows in both salt and fresh water that has drawn a lot of interest because of its potential uses in a variety of industries, including food production, the manufacture of biofuels, and environmental cleanup. Spirulina may increase production of nitric acid and reduce blood pressure, a major risk factors for many chronic conditions. The purpose of this study was to thoroughly characterise Spirulina’s growth patterns in different physicochemical variations used to develop dynamics will help to improve cultivation methods. The modified Zarrouk’s medium [2] containing was used to grow the Spirulina plantensis cultivation. A series of batch culture experiments were carried out to determine their effect on the growth kinetics of Spirulina [1], the growing circumstances, including light intensity, temperature, pH, and salinity were systematically changed. The concentration of biomass, growth rate, and nutrient uptake were tracked throughout time. Models based on mathematics were used to analyse the data from these tests.

The growth characteristics have been determined using various temperatures, pH, light intensities and salinity. The optimal growth yield of the Spirulina were obtained at the temperature regimes of 25-30 C, pH levels between 8.5 to 10.5, light intensities of 1500-3500 lux and salinity of 30 ppt. The determination of the biomass yield and growth rate constants under various circumstances gave important insights into the growth potential of Spirulina. This study also examined the biochemical makeup of Spirulina biomass at various stages of growth. Protein, carbohydrate, fat, and pigment contents varied, according to proximate analyses. The applications of Spirulina in functional meals and nutrient rich food as well as its prospective use as a feedstock for biofuel production are affected by this information. Phycocyanin is the main active compound in Spirulina. It has powerful antioxidant and anti-inflammatory properties [3]

Keywords: Spirulina, biomass yield, growth kinetics, nutrient utilization.

Introduction:

A photosynthetic microorganism belonging to the phylum of cyanobacteria is Spirulina.[1] Spirulina has drawn the attention of researchers and companies all over the world due to its exceptional nutritional value, potential for usage in a range of industries, and ability to help with current environmental issues. Characterising Spirulina's growth patterns is crucial if it is to realise its full potential in fields including environmental sustainability, renewable energy production, and food security. This introduction lays forth the importance of examining the growth characteristics of Spirulina. Spirulina is a filamentous, spiral-shaped cyanobacterium that may be found thriving in a variety of aquatic habitats, including freshwater reservoirs and alkaline soda lakes. It has been
consumed by humans for a very long time, and indigenous communities have known about its nutritional advantages for a very long time. In recent years, Spirulina farming has gone beyond that of its conventional use as a dietary supplement. Its ability to effectively convert sunlight and carbon dioxide into biomass through photosynthesis has gained interest for the production of biofuels and carbon sequestration. Its potential role in environmental bioremediation is also highlighted by its capacity to absorb and eliminate toxins from contaminated water bodies, such as heavy metals and nutrients also responsible for anti-bacterial activities[4].

A thorough grasp of Spirulina's development properties is essential for efforts to maximise its advantages. Numerous variables, including light intensity[5], temperature, pH, food availability, and culture density, have an impact on this microorganism's growth dynamics. The establishment of optimised cultivation techniques that can raise biomass productivity and quality can be accomplished by investigating these characteristics in controlled laboratory environments. With a focus on Spirulina's growth phases, growth rate dynamics, and responses to various environmental conditions[6], this study sets out to comprehensively investigate these traits. We can determine the ideal conditions for developing Spirulina with the highest biomass production and desired biochemical composition by illuminating the complex interplay between these variables. Understanding Spirulina's growth patterns can also help with the creation of sustainable practises that adhere to the ideas of the circular economy and eco-friendly technologies. The development features of Spirulina holds the promise of tackling a variety of global issues, such as environmental pollution and energy sustainability Pharmacy and Pharmaceutical Science[3]. In addition to advancing our knowledge of cyanobacterial growth, this research aims to open the door to useful

I. Collection of Spirulina:

The sample has been collected from the Bharathidasan University in Trichy. The sample is then correctly transferred to a new container with an appropriate growing media (Zarouk's medium) which offers perfect environmental factors such regulated temperature, pH, and light exposure[7]. More inoculum is constantly accessible for larger production tanks as the Spirulina population in the mother culture increases over time.

By regularly monitoring the culture's health, guaranteeing sterility, and periodically transferring a tiny quantity to a fresh medium,[8] vitality can be maintained.

A reliable source for growing the production of this superfood with so many health benefits will eventually be the Spirulina mother culture.

II. Stock Culture Maintenance:

Several vital measures must be taken in order to maintain a healthy Spirulina culture in a lab. Start by producing a sterile, nutrient-rich culture media, often using Zarrouk's medium[8]. Inoculate the medium with a pure strain of Spirulina and keep it lit continuously, ideally with cool-white fluorescent lamps, at a consistent temperature (around 25-30°C). Maintain consistent pH values (about 8.5). To avoid settling and guarantee even distribution, gently agitate the culture. Every 5-7 days, on average, Spirulina biomass should be harvested and replaced in the culture with fresh medium to maintain growth. To avoid contamination, maintain aseptic conditions[9] throughout. For efficient Spirulina culture management in a laboratory setting, properly documented record-keeping and rigorous adherence to sterile methods[10] are essential.
III. Mass Cultivation:

Mass cultivation of Spirulina in tanks, known as photobioreactors, involves the controlled growth of this nutrient-rich microalgae[11]. These tanks are typically cylinder- or rectangle-shaped constructions with aeration and lighting systems to improve growth conditions. Spirulina needs a consistent supply of carbon dioxide, nutrients, and light in order to grow in alkaline, high-pH settings. Inoculating the tanks with Spirulina culture, which multiplies quickly in the regulated environment[12], is the first step in the cultivation process. These tanks are typically rectangular or cylinder-shaped constructions with aeration and lighting systems to enhance development conditions. In alkaline, high-pH environments, Spirulina requires a steady supply of CO2, nutrients, and light to develop.

Medium preparation:

The modified Zarrouk's medium, which contains a variety of salts including sodium bicarbonate, sodium nitrate, sodium chloride, potassium sulphate, dipotassium phosphate, magnesium sulphate, ferrous sulphate, calcium chloride, and ethylenediaminetetraacetic acid, was used to grow the Spirulina platensis cultivation.
IV. Municipal Waste Water:

The municipal waste water has been collected from the Podanur Sewage Treatment Plant (STP) which is a crucial part of the local water supply system. The Podanur STP serves as a pivotal facility in treating wastewater and ensuring its safe disposal while also contributing to the sustainable management of water resources[14]. Collection of Municipal waste water has been the first step in the procedure. At the STP, a number of treatment procedures, including screening, primary sedimentation, biological treatment, and secondary sedimentation, are used to treat this raw sewage[15]. These procedures purge the water of pollutants, organic matter, and dangerous toxins, making it safe for disposal. Once treated, the effluent water from the STP is often discharged into nearby water bodies or used for non-potable purposes like irrigation, reducing the strain on freshwater sources. In some cases, advanced treatment methods may further purify the water to make it suitable for drinking after disinfection[16].

From the STP, a small amount of waste water has been brought to the lab for further processing. As a final stage, Spirulina is added to municipal waste water from the mother culture[17], and subsequent growth is observed.

V. Identification of Optimum Growth of Spirulina in Various Physico Chemical Factors:

a) I. Growth Characteristics of Spirulina on Various pH Levels:

Spirulina cultivation normally requires a pH between 8 and 10. A blue-green microalga called Spirulina has particular metabolic needs that allow it to flourish in an alkaline environment. This pH range helps maintain the purity of the culture by preventing the growth of competing microorganisms[18]. It encourages the Spirulina cells' ideal metabolic and photochemical processes, which leads to strong growth and biomass production. Achieving high-quality Spirulina biomass, which is widely used in applications such as dietary supplements, biofuels, and wastewater treatment, requires maintaining the pH within this range, making pH management a key component of effective Spirulina production[19].

![Growth Characterization of Spirulina on Various pH Values in 7 Days](image)

In accordance with the graph above, pH 8 is more ideal for cell proliferation.

b) Growth Characteristics of Spirulina on Various Temperatures:

The ideal temperature for growing Spirulina normally lies between 20 and 30 C. Being a thermophilic microbe, Spirulina grows best in warm settings[20]. The metabolic processes of Spirulina are most effective in this temperature range, leading to faster growth rates and biomass output. While temperatures markedly over this range might cause stress and decreased output, lower temperatures can slow down growth. For successful Spirulina growing, whether in laboratory settings or large-
scale production[21], it is essential to maintain a constant temperature within the advised range because it directly affects the quality and volume of the harvested biomass.

In accordance with the graph above, 28°C is more ideal for cell proliferation.

c) Growth Characteristics of Spirulina on Various Salinity:

Spirulina cultivation normally requires a salinity level of 20 to 35 parts per thousand (ppt). Many Spirulina strains can thrive in brackish water, which this level equates to. Salinity is essential for preserving the osmotic balance[22] within cells, which protects their structural integrity and metabolic processes. Spirulina can tolerate a range of salinities, but this particular range must be maintained for the plant to develop and produce biomass at its best. It’s important to keep in mind that different strains may have particular salinity preferences, thus modifications may be required depending on the chosen strain[23] and ambient factors. For efficient Spirulina cultivation, proper salinity management is essential.

In accordance with the graph above, 30ppt is more ideal for cell proliferation.

VI. Comparison of Growth Characterization of Spirulina in Fresh Water and Municipal Waste Water

Due to variations in nutritional composition[24], pollutants, and other factors, the growth characteristics of Spirulina in fresh water and municipal wastewater might differ dramatically.

**Nutrient Availability:**

Nitrogen, phosphorus, and a number of trace elements are important nutrients found in freshwater. These minerals are necessary for the growth of spirulina, however their accessibility will depend on the particular freshwater source. Due to the presence of detergents and human waste in municipal wastewater, nutrient concentrations can be greater[25]. This may be a rich supply of nutrients for spirulina, including nitrogen and phosphorus, which can encourage its quick growth.
**pH Ranges:**

Freshwater sources’ pH values might vary, but they commonly fall between 6 and 10 which is neutral and good for Spirulina growth[26]. The pH levels in wastewater may alter significantly if the wastewater treatment process is inadequate. High or low pH levels might have a deleterious impact on the growth of spirulina.

**Temperature:**

The optimal temperature range for the growth of spirulina is between 20 and 35 degrees Celsius, while freshwater bodies can have a wide variety of temperatures[27]. Although it may be impacted by the presence of industrial discharges or seasonal variations, the temperature of municipal wastewater[28] can also change, which may have an effect on the growth rates of spirulina.

**Salinity:**

Freshwater normally has a salinity of 25 to 35 ppt (parts per thousand). Spirulina can flourish in freshwater with salinities that are at the lower end of this spectrum[29]. The salinity of municipal wastewater can vary greatly depending on factors including the source of the wastewater and the treatment processes. It frequently has higher salinity levels due to the presence of dissolved salts, chemicals, and other contaminants. Spirulina may have trouble growing in highly salinized wastewater, especially if the salt concentrations are higher than what the strain can tolerate[30].

We draw the conclusion that these values are more ideal for cell proliferation from the study.

**Conclusion:**

According to the results of the aforementioned study, which compared the development characteristics of Spirulina using a variety of physicochemical parameters, fresh water has higher Spirulina growth rates than municipal waste water.

However, Spirulina can be used to clean up sewage from municipalities because it can clean up the garbage that’s in the water.
Discussion:

The determination of the growth characterization of Spirulina, a commonly cultivated microalga with numerous industrial and nutritional applications, involves assessing multiple physicochemical parameters. These parameters provide insights into the health and productivity of Spirulina cultures. pH levels are crucial as they affect nutrient availability and enzyme activity. Spirulina typically thrives in alkaline conditions, with an optimal pH range of 5-10. Monitoring and maintaining pH within this range is essential.

Temperature is another vital parameter. Spirulina prefers temperatures between 25-30°C for optimal growth. Deviations outside this range can impact growth rates and biomass production. Light intensity and quality are essential factors. Spirulina is photosynthetic and depends on adequate light for growth. Continuous illumination with appropriate wavelengths (blue and red) enhances photosynthetic efficiency. Oxygen levels should be monitored as Spirulina generates oxygen during photosynthesis, and excessive oxygen can inhibit growth. Turbidity, cell density, and biomass measurements are employed to assess Spirulina’s growth kinetics.

The growth characterization of Spirulina involves careful monitoring of parameters such as pH, temperature, nutrient concentrations, light, oxygen, and biomass. These physicochemical assessments are essential for optimizing Spirulina cultivation, ensuring high yields of this valuable microorganism.

Reference:


Kousik saravana is a Biomedical student, Pursuing his degree at srI sakthi institution, Coimbatore. He did CCRP ( Certified Clinical Research Professional) at Deepam Hospital, Chennai. Also, Further He Completed a course "Cancer Biology Specialization" offered by John Hopkins University and "Human Molecular Genetics" Offered by IIT kanpur under the guidance of Dr.Ganesh. He published 3 Research papers in the field of medical microbiology in International journals and also He published one book and filled one patent. Moreover, He was also awarded as "ELIAM SATHANAIYALAR" in Aram Awards conducted by the Aram foundation in south India. Finally, He did so many Hospital trainings and case studies in Multi and super speciality Hospitals.

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BIOGRAPHIES (Optional not mandatory)