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Technology of Industrial Cultivation of Spirulina

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Abstract: The technology of growing spirulina in greenhouse conditions in open-type cultivators is given. As a result, the yield increased by 5–10 times in comparison with traditional technologies at constant material costs.

Keywords: spirulina, technology, biomass, biochemical composition, cultivation.

Spirulina is a microscopic algae that lives mainly in warm water bodies. Spirulina is one of the most ancient species on Earth, therefore it has an extraordinary adaptability to various environmental conditions. In the process of evolution, passing through tough conditions of competition, spirulina cells acquired the ability to divide under favorable conditions at the highest rate (biomass doubling in 5 hours). The biomass of spirulina is suitable for consumption by both simple organisms and fish and animals. Moreover, the uniqueness of the biochemical composition of spirulina biomass makes it attractive for people to consume spirulina as a source of the most important components involved in metabolism. The growing shortage of such substances in the human diet, especially for residents of large cities and environmentally unfavorable areas, leads to various health disorders, including death. According to numerous medical opinions, in order to prevent such manifestations, doctors recommend the use of spirulina biomass as a dietary supplement. The very regular use of spirulina (1-2 g per day) reduces the risk of many diseases to almost zero. The most important is the fact that spirulina, as a food supplement, is the same organism as higher plants (dill and carrot), the use of which, unlike artificial preparations, does not entail any side effects. Due to its usefulness, spirulina biomass has been the subject of business in many countries of the world for more than half a century. At first, the collection of spirulina was carried out directly in the natural reservoirs of Africa and America, which, due to their geographical location and the chemical composition of the water, had favorable conditions for the growth of spirulina. In the future, the demand for spirulina began to increase, which led to the development of technologies for growing spirulina in artificial reservoirs. Today, spirulina biomass is produced and consumed on a commercial basis in more than 60 countries of the world: Mexico, Russia, Japan, India, China, Thailand, the USA, where the production of spirulina exceeds thousands of tons per year.

Biology and taxonomy

Spirulina (*Arthrospira*) platensis (Nordst.) Geitl. is a filamentous planktonic cyanobacterium. According to one of the most common modern microbiological classification systems, the taxonomic position of Cyanobacteria reflects the scheme:

Kingdom	Prokaryotae
Domain	Bacteria
Division	Gracilicutes
Class	Oxyphotobacteria
Groups	Cyanobacteria
Order	Oscillatoriales

Genus Species	Arthrospira *Arthrospira platensis*

According to the algological classification system, the taxonomic position of *Spirulina* (*Arthrospira*) platensis reflects the scheme:

Kingdom	Prokaryotae; Monera (Bacteria)
Class	Cyanophyceae
Division	Cyanophycota
Order	Nostocales
Family	Oscillatoriaceae
Genus	Arthrospira
Species	*Arthrospira platensis*

The species name is synonymous with Arthrospira platensis (Nordstedt) Gomont., Spirulina platensis (Nordstedt) Geitler (1925), Spirulina jenneri var. platensis Nordstedt. Spirulina.(A.) platensis, like all prokaryotes, has a low level of cellular differentiation (no chromatophores, true nucleus, nucleoli, vacuoles, mitochondria, endoplasmic reticulum, etc.). Non-branching spiral-shaped trichomes (threads or filaments) of cylindrical cells are surrounded by a mucous membrane and are capable of sliding and rotational movement. Under the influence of various physical and chemical factors, the filaments can straighten out. Typical pigments, in addition to chlorophyll a and carotenoids, are phycobiliproteins.

There is no sexual process in cyanobacteria. S. (A.) platensis reproduces with the help of hormogonia - short-chain, capable of movement, sections of filaments formed by fragmentation of maternal trichomes along necridia (specialized cells undergoing lysis).

Chemical composition

Below is the average composition of spirulina biomass in terms of organic and inorganic indicators.

Component	%
Protein	55-70
Carbohydrates	10-20
Fats	5
Ash content	7
Nucleic acids	6,5
Chlorophyll *a*	0,93
Humidity	6-8

Component	g/100 g
Nitrogen	10,68
Phosphorus	1,14
Sodium	1,74
Potassium	1,88
Magnesium	0,35
Calcium	1,1
Sulfur	0,63

Component	mg/kg
Iron	945
Manganese	64
Zinc	28
Chlorine	5
Iodine	100
Copper	15
Nickel	5,8
Cobalt	1,5
Chromium	5
Selenium	7

Application

A wide range of applicability of spirulina consists of two main areas: the use of biomass itself and the use of spirulina biomass as a raw material for obtaining any valuable substances. The first direction includes a variety of ways to use spirulina biomass as a food additive in the diet of humans and animals, the use of spirulina biomass in biomedical procedures of a therapeutic and prophylactic nature. A special place is occupied by the use of spirulina biomass as a source of trace elements (iodine, selenium, etc.) that are essential for a full-fledged human life. Spirulina biomass, as a ready-to-eat product, is used in various fields of human activity: medicine, cosmetics, sports, animal husbandry, beekeeping, fish farming, poultry farming, veterinary medicine, etc.

The second direction is no less important - obtaining any substances from the biomass of microalgae, such as: amino acids, proteins, various carbohydrates, lipids, pigments, vitamins, etc. In spirulina, natural dyes (pigments) phycobiliproteins (phycocyanins) come first). Fortunately, the content of such pigments in spirulina is quite high (about 10%), which always makes it possible to use biomass as a raw material for the production of pigments. Some entrepreneurs find the phycocyanium event more cost-effective due to the high prices of natural dyes.

Production technology

For any microbiological objects, biomass production technologies are similar. For highly specialized purposes, microalgae are grown under strictly controlled conditions (controlled biosynthesis), in special cultivators, in order to obtain biomass with a given biochemical composition. The most simple technology for growing spirulina, because, having a high degree of adaptability, spirulina does not require expensive equipment (specialized cultivators) that provide strictly defined conditions for cell growth. Where environmental and climatic conditions make it possible, spirulina is grown in open-air ponds or pools in standard agricultural greenhouses. An important advantage of such production is the use of natural light (an energy resource), which significantly reduces the cost of the final product.

Let us briefly describe the main stages of the production of spirulina biomass in a conventional agricultural greenhouse, which is easily amenable to the necessary re-equipment.

Training. Construction and installation of swimming pools in the greenhouse, if necessary, preparation of water tanks, preparation of the necessary tools for harvesting and washing the crop, preparation of a biomass drying unit. The larger the total area of the pools, the greater the yield can be, therefore, the size of the biomass drying unit, water consumption, the number of staff, etc. depend on this.

Start of production. At this stage, a small amount of spirulina biomass is placed in a pool with a specially prepared nutrient medium. As biomass increases, harvesting is not carried out, but other basins are filled. Thus, I act until all the pools are filled**.**

Harvesting. Since the growth rate of microalgae is quite high, harvesting is carried out daily. When a certain density is reached in the pools, part of the spirulina biomass floats to the surface, which allows harvesting directly from the surface.

Top dressing. As spirulina grows and harvests, the environment in which the microalgae grows becomes depleted. To replenish the lack of nutrients, mineral salts are periodically added to the medium - a source of nitrogen, phosphorus, iron, magic, etc.

Biomass washing. Since spirulina grows in water with a high content of various inorganic salts (nutrient medium), the collected biomass must be washed. To do this, the biomass is placed on a sieve and washed with ordinary fresh water.

Drying of biomass. The washed biomass of spirulina is dried with warm air at a temperature not exceeding 60°C. To do this, the biomass is applied in a thin layer on polyethylene and dried for 3–4 hours, avoiding direct sunlight, since intense sunlight leads to the destruction of pigments, which significantly reduces the quality of spirulina biomass.

Biomass storage. Already dried spirulina biomass is collected in airtight storage containers, such as plastic bags. Impermeability is desirable because dried microalgae biomass is quite hygroscopic. Store spirulina in a dark place at room temperature. It is highly undesirable to get moisture on the dried spirulina biomass. In such situations, the biomass is not subject to re-drying, since the high protein content and moisture are the most favorable environment for the development of bacteria. Sometimes a few minutes of vigorous activity of bacteria are enough for the spirulina biomass to acquire the characteristic look and smell of spoiled products.

The advantage of our technology over others

Our laboratory has developed a technology for growing spirulina in traditional greenhouses, which has a number of advantages over traditional methods. The very increase in yield by 5–10 times in comparison with traditional technologies at constant material costs puts our offer beyond any competition. The success of the proposed technology lies in the fact that it is based on a fundamentally different approach to the cultivation of microalgae. Let's briefly list the main advantages:

1. The technology is based on the continuous cultivation method. In other words, a certain volume of suspension is exchanged daily for fresh nutrient medium in all pools. A certain volume of the suspension is drained from the pool, in return, the same volume of fresh nutrient medium is added to the pool. The drained volume of the suspension goes to the sieve for harvesting. Harvesting from the surface of the pool and filtering the drained volume increases the harvesting performance by an order of magnitude.
2. Daily addition of fresh nutrient medium eliminates the lack of any components necessary for the growth of spirulina.
3. The composition of the nutrient medium is organized in such a way that the depletion of all components during the growth of spirulina takes place evenly. This allows rational use of expensive mineral salts, which are necessary for the preparation of nutrient media.
4. Microalgae continuous cultivation mode makes it easy to create the optimal temperature in the pools by changing the volume in the pool. Moreover, a sharp decrease or increase in volume does not reduce the growth rate of microalgae, since spirulina is adapted to the conditions of daily exchange in the pool of a part of the suspension for a nutrient medium.
5. Regular stirring of the suspension in the pools greatly increases the growth rate of spirulina, since stirring removes excess oxygen from the suspension. It is known that high oxygen concentrations inhibit the growth of any plants, because. Oxygen is a by-product of photosynthesis.

References

1. H. Durand-Chastel. La Spirulina Algue de vie// - in: Spirulina, Algae of Life. –Monaco. – Musee Oceanographique. – 1993. p.7-12.
2. E.W. Becker. Development of Spirulina Research in a Developing Country –India// - in: Spirulina, Algae of Life. – Monaco. – Musee Oceanographique. – 1993. – p. 141-157.
3. Kravchenko L.B., Gladkich L.B. The effect of selenium enrichment on the biological activity of spirulina and phycocyanin //Vopr biol med farm chemistry -2006 - № 3 – P. 17-21
4. Trushin E.N., Gladkich E.N. The influence of spirulina and selenium-spirulina on the parameters of the immune response in rats // Problems of nutrition -2007 - № 2 – P. 21-25
5. Gladkich O.L. Spirulina - a natural source of biologically active substances // Proceedings of the II All-Russian Scientific and Practical Conference of Young Scientists and Specialists "Environment and Health" Ryazan,-2007 – P. 174-176
6. Quereshi et al. Immune Enhancement Potential of Spirulina// - J. Poultry Sci.- 1994. – V. 73. - p. 46-56.
7. Nusratova M., Yarkulova Z. The use of cyanobacteria in wound healing// Scientific Progress vol. 3 (4), (2022), p.754-758