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ACCUMULATION OF BIOMASS *SPIRULINA PLATENSIS,* ENRICHED WITH COBALT, UNDER DIFFERENT TECHNOLOGICAL PARAMETERS

Вплив інтенсивності освітлення на нарощування біомаси спіруліни та накопичення у ній Кобальту проводили за підвищених концентрацій цього металу у поживному середовищі (доза перевищувала показники контролю у 120 разів). Встановлено, що оптимальними світловими режимами, які дають змогу максимально наростити біомасу спіруліни збагачену Кобальтом є такі: з першої до третьої доби – 1300 люкс; з четвертої до шостої доби – 2400 люкс; впродовж сьомої та восьмої доби – 3900 люкс; на дев'яту та десяту добу культивування культури – 4800 люкс. За товщини поживного середовища 10–15 см і за наявності у ньому підвищених доз Кобальту інтенсивність нарощування біомаси спіруліни є найвищою.

Ключові слова: азотнокислий Кобальт, біомаса, поживне середовище, світловий режим, спіруліна.

Statement of the problem, analysis of recent research and publications. Widespread use of algae in various fields of human activity has necessitated the development of highly efficient technologies for industrial algae biomass production and biosynthesis of biologically valuable substances. There are a lot of photo-bio-reactor constructions for intensive cultivation of microalgae, which use natural and artificial sources of light energy. Artificial light sources have a number of advantages over natural. They can create a much larger area of radiation than sunlight. The most important indicator is the ability to control lighting conditions, so you can control the intensity of the microalgae culture growth. As a result, it is possible to influence the biochemical composition (quality) of biomass and get high rate of biosynthesis of the substances that make up its structure [2, 7, 8].

The combination of cultivation parameters (medium duct velocity, biomass density, illuminance, temperature, cultivators design, etc.) determines productivity of cultures, speed and selective assimilation of nutrients, values of their optimal and limiting concentrations and also direction of structural and energetic processes in cells [3, 4].

Industrial technology of Spirulina biomass accumulation is oriented at autotrophic type of nutrition, thus culture is grown on mineral medium [1, 6].

The liquid, which is used for the production of spirulina is a solution of mineral salts in the water. It must supply spirulina with all the chemical elements of, the nutrient medium pH should be between 8 and 11 [1, 5].

Aim of work – to establish the optimal technological parameters of cultivation (illuminance, nutrient medium thickness), which provide maximum biomass accumulation of Spirulina platensis with high concentrations of cobalt.

Materials and research methods. In our studies we used pure culture of trihoma cyanobacterium Spirulina platensis (Gom.) Geitl. strain LGU-603, deposited in the Culture Collection of the Botanical Institute of the Leningrad University.

Biomass of cyanobacteria were cultured on modified Zarruka nutrient medium in closed conditions by using fluorescent lamps of 40 watts each. The period of study was 10 days. During cultivation Spirulina platensis culture medium was continuously stirred using a compressor with barbotage tubes.

Spirulina was cultivated in glass rectangle containers with culture medium thickness: 10, 15 and 25 cm.

Optical density of culture medium with the culture of unicellular algae were determined during the experiment with the aid of FEC-56M.

Results and discussion. Effect of illuminance intensity on the growth of spirulina biomass and accumulation of cobalt was carried out by high concentrations of this metal in the nutrient medium (dose greater than control values in 120 times) (table 1).

Table 1 – **Study of the influence of light intensity on increasing biomass of Spirulina by high doses of cobalt**

Doba	Illuminance, lux	Optical density
1–3	1100	0,56
	1200	0,58
	1300	0,61
4–6	2000	0,99
	2200	1,04
	2400	1,08
7–8	3300	1,34
	3600	1,38
	3900	1,40
9–10	4000	1,53
	4400	1,58
	4800	1,62

During the first three days of cultivation a positive impact was found of higher illuminance intensity on algae biomass increase. Thus, the highest optical density of the culture medium for cell culture was 1300 lux illuminance. The figure was higher than 1100 lux illuminance and 1200 lux, respectively by 8,9 and 5,1 %.

From the fourth to the sixth day illuminance intensity was kept at 2000–2400 lux. With 2400 lux of accumulaing *Spirulina platensis* cells were greatest, as proved by increasing absorbance by 9,0 and 3,8 % compared to variants where the cultivation of spirulina was conducted with 2000 and 2200 lux.

On the seventh and eighth days of growing spirulina under high cobalt concentration in the nutrient medium the cells growth trend did not change, yet with increasing illuminance intensity biomass of algae increased. The smallest gains were in the culture with 3300 lux illuminance. In 3900 lux illuminance intensity the optical density values were higher than in 3300 and 3600 lux, respectively, by 4,5 and 1,5%.

Increasing illuminance intensity had a positive impact on increasing the number of cells in spirulina nutrient medium by 9–10 day of cultivation. Under 4800 lux illuminance Spirulina platensis biomass increase was most intense. This figure was higher relative to the variants where illuminance of 4000 and 4400 lux was used, respectively, by 5,9 and 2,5 %.

Thus, the optimal light conditions that allow to build biomass of cobalt-enriched spirulina from the first to the tenth day are: 1300, 2400, 3900 and 4800 lux.

Light access to Spirulina cells may be regulated by the illuminance intensity and thickness of the nutrient medium in which the algae is cultivated. And in the first variant to obtain Spirulina platensis biomass the energy consumption increases.

Effect of high cobalt doses on the cell division of spirulina in the nutrient medium of different thickness are shown in fig. 1. After the first day of spirulina cultivation on nutrient media with different layer thickness and increased levels of cobalt were found significant differences in increasing culture cells.

On the second day, it was found that the optical density of the culture medium with the thickness of 25 cm was the lowest, the rate was lower than the versions used where the thickness of 10 and 15 cm, respectively, 16,7 and 14,3%. The highest growth of cells relative to the first day of cultivation were found for nutrient medium thickness of 10 cm , the figure rose to 38,4 %.

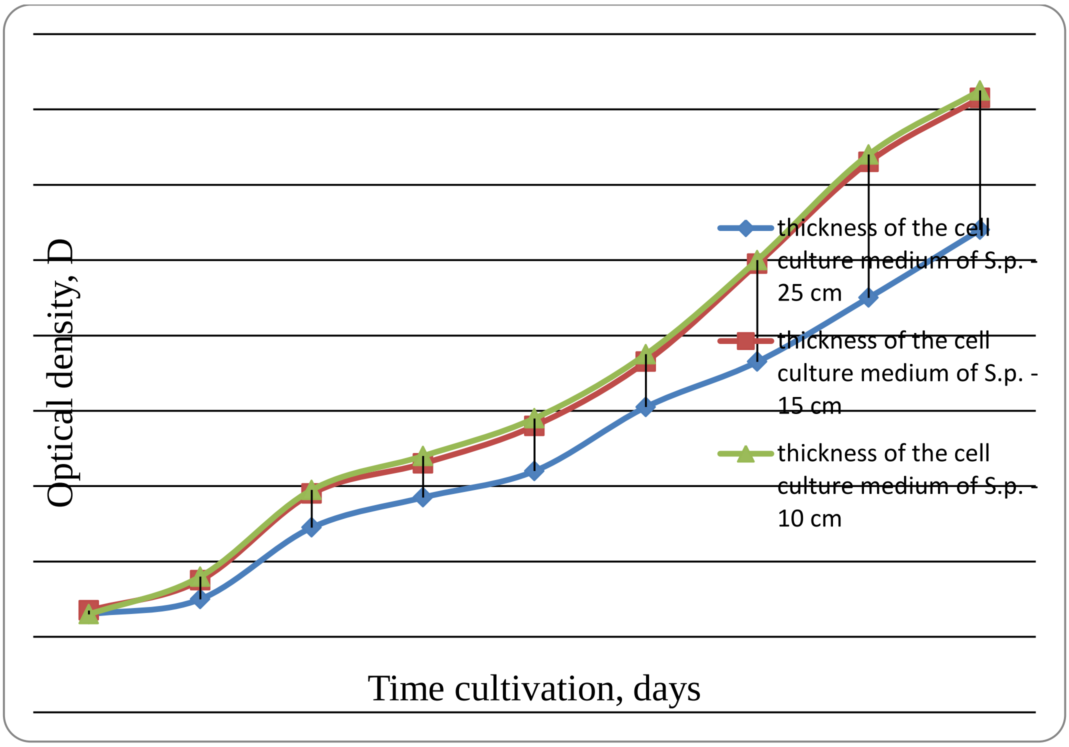

Figure 1. **Effect of high cobalt doses on accumulating spirulina under conditions of varying the nutrient medium thickness.**

During the third day the number of cells increased in relation to the second day, respectively, by 63,8, 65,7 and 63,3 % (nutrient medium thickness 10 cm, 15 and 25 cm). The relative spirulina mass increase were maximal under conditions with Spirulina culture medium in thickness of 10 and 15 cm.

On the fourth day light intensity was 2400 lux. Under these conditions, the optical density of the culture medium of cells in culture (thickness 10 cm and 15 cm) increased relative to the third day of cultivation, respectively, by 15,2 and 13,7 %. During the cultivation of spirulina in nutrient medium with thicker layer of 25 cm, the weight gain of Spirulina platensis was minimal, as proved by reduction in absorbance relative to conditions where the thickness of the medium was 10 and 15 cm, respectively, by 16,2 and 13,6%.

At the end of the fifth day, the cell culture increasing tendency preserved – with the thickness decrease of the nutrient medium, the weight of spirulina intensely increased. With respect to the initial amount (first day) optical density of culture medium for the layer thickness of 10 cm, 15 cm and 25 increased by 3.0 times, 2,8 and 2,5 respectively.

We noted the maximal increase of optical density in the nutrient medium with a layer thickness of 10 cm (sixth day of cultivation). This figure was higher, relative to conditions where the thickness of the culture medium was 15 and 25 cm by 2,1 and 17,3 %, respectively.

On the seventh day light intensity was increased to the value of 3300 lux. During this period, the lowest intensity increasing cell spirulina noted in the variant where the culture medium had the greatest thickness. The optical density in nutrient media (layer thickness of 10 cm, 15 cm and 25) in this period increased relative to the sixth day of cultivation at 26,3 %, 27,9 and 14,8 %, respectively. Trend of the impact of high doses of cobalt and thickness nutrient medium, which is cultivated spirulina on increasing cell culture on the eighth day was similar to the results obtained during the seven days of cultivation.

On the ninth day light intensity was increased to 4000 lux. During this period, noted the least capacity for cell culture nutrient medium layer thickness of 25 cm and the largest – with a thickness of

10 cm for the nine days of Spirulina biomass increased relative to the initial amount (first day) at 6,3 and 4,9 times, respectively.

Therefore, to maximize the capacity of Spirulina cells in nutrient medium with high concentration of cobalt content the thickness of the latter shall be kept at 10–15 cm.

Conclusions and recommendations for further research. 1. Optimal light conditions that contribute to accumulating of Spirulina platensis biomass at high doses of cobalt in the nutrient medium are as follows: from the first to the third day – 1300 lux, from the fourth to the sixth day – 2400 lux, during the seventh and eighth days – 3900 lux, in the nineth and tenth day of culture cultivation – 4800 lux.

2. The cultivation of Spirulina platensis on nutrient medium with a high content of cobalt and thickness of 10–15 cm makes it possible to increase cells biomass enriched with this metal.

Promising area of research is to establish the cultivation process parameters of spirulina enriched with zinc.

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Наращивание биомассы *Spirulina platensis* обогащенной Кобальтом при различных технологических параметрах

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Влияние интенсивности освещения на наращивание биомассы спирулины и накопления в ней Кобальта проводили при повышенных концентрациях этого металла в питательной среде (доза превышала показатели контроля в 120 раз). Установлено, что оптимальными световыми режимами, которые позволяют максимально нарастить биомассу спирулины, обогащенную Кобальтом, являются: с первых по третьи сутки – 1300 люкс, с четвертых по шестые сутки – 2400 люкс; в течение семи и восьми суток – 3900 люкс, на девятые и десятые сутки культивирования культуры – 4800 люкс. При толщине питательной среды 10–15 см и при наличии в ней повышенных доз Кобальта интенсивность наращивания биомассы спирулины наивысшая.

Ключевые слова: азотнокислый Кобальт, биомасса, питательная среда, световой режим, спирулина.

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