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Д.В. Сокольский атындағы «Жанармай,
катализ және электрохимия институты» АҚ

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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
АО «Институт топлива, катализа и
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NAS RK is pleased to announce that News of NAS RK. Series of chemistry and technologies scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of chemistry and technologies in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of chemical sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Химия және технология сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия химии и технологий» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по химическим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары. Химия және технология сериясы».

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BIOCHEMICAL INDICATORS AND APPLICATION OF *Cyanobacteria Spirulina* MICROALGAE IN THE CATTLE FEEDSTUFF

Abstract. The qualitative and quantitative compositions of the valuable biologically active substances, species and strains of microalgae are related the genus of *Cyanobacteria Sp.platensis* and *Sp.labgrinthifosmis* that were isolated from local nature and grown in semi-production facilities were considered. In order to adapt for mass cultivation, algae were first grown in greenhouse conditions. The algae were cultivated within 12 days. The productivity in the tubular cultivator with stirring of *Sp.platensis* was 3.8 g / l, protein (73.0%), and *Sp.laberinthiformis* was 2.6 g / l of protein (63.1%). Similar studies were carried out in the open-air conditions that showed an increase in the amount of illumination causes a significant restructuring of the entire photosynthetic apparatus of algae. The accumulation of *Sp.labyrinthiformis* 2.7 g / l a.d.c., protein 62.21%, and *Sp.platensis* 4.08 g / l, protein 75.3%, were within 10 days. The content of protein and carotenes sharply increases in comparison with the greenhouse conditions. It was found that the addition of *Sp.platensis* suspension, as a protein-vitamin supplement for the bulls' feedstuff, stimulates physiological processes that improves the biochemical parameters of their blood, the digestibility coefficient of nutrients by 8-9%, positive mineral balance, increases live weight gain (17.4%) and slaughter yield of the bulls (3.6%). So, the suspension of *Sp.platensis* is recommended for use as a protein-vitamin supplement in livestock farms that will allow having a significant economic effect in livestock farming, in average 20-25% profits per yearly.

Key words: antioxidants, biologically active substances, cultivation, genus, microalgae, phyto-cultures, *Spirulina*.

Introduction. The biological active substances and antioxidants of natural plant origin have widely application in the enrichment of the functional features and nutritional values in various applications [2,10].

Moreover, the study of the phyto-cultures useful properties by physiological, biochemical and ecological in aquatic ecosystems, pharmaceutical forms, food industry, perfumery industry has a significant value, as an antioxidants in removing of the negative effect of free radical processes [3,12].

Recently, the algal research directions actively carried out in the field of the isolation of new genus and strains of microalgae [23]. Algae growing technology, including continuous cultivation of photosynthetic cells of microalgae and the isolation of new genus and strains are actively carried out in the special installations and at the optimal environmental conditions [12].

The growth and development of algae are closely interrelated with external factors, under the influence of which the structural, functional and biochemical characteristics of the cell change. Selection of new highly active microalgae-producers of essential compounds in the natural conditions would expand the area of their practical application [9], as for instance a feedstuff for cattle [11] and poultry [19].

Chlorella and *Spirulina* are two of the most well-known microalgae genus. Both microalgae genus have a significant content of proteins, vitamins, pigments, fatty acids, sterols, among others, which make

their production/application by the food industry quite interesting. They are remarkable sources of functional foods, nutraceuticals and food supplements [4].

Arthrospira platensis (hereafter referred to as '*Spirulina*') is a uni-cellular microalgae which grows in fresh water, in salt water, as well as in brackish bodies of water. It grows best in a highly alkaline environment of pH 10-12 [6].

Many researchers *Spirulina* biomass are interested in them as biologically active substances and as an additional food product enriched with a number of important micronutrients biomass *Spirulina* increases the possibility the possibility of preventing certain diseases [16].

Cyanobacteria *Spirulina* contains phenolic acids, tocopherols and ß-carotene which are known to exhibit antioxidant properties [18]. *Spirulina* has hypolipidemic, antioxidant, and antiinflammatory activities [7].

It was noted that during *Spirulina* cultivation in open reservoirs and especially in closed photobio-reactors its biomass may be additionally enriched with some trace elements such as iron, iodine, selenium, zinc, copper, manganese and chromium in high bioavailable form [17].

The developing of the conditions for the industrial cultivation of *Spirulina*, the study of the biochemical side of photosynthesis seems to be extremely important, despite the fact that research on the cultivation of microalgae under various light conditions conducted for a long time. However, the influence of various environmental factors, in particular, illumination and temperature on the productivity and biochemical composition of *Spirulina* was not studied enough. The absorption of visible light is important for the implementation of the process of photosynthesis. In cyanobacteria, it is carried out using a unique set of pigments chlorophyll "A", phycobilins, carotenoids that have 600-664 nm of a maximum absorption in the solution. It was found in all photosynthetic organisms capable of photosynthesis with the release of oxygen in cyanobacterial cells. The quantitative content of chlorophyll in the cells of blue-green algae, it is variable in different species and depends on the cultivation conditions [15].

Owing to the above mentioned information, the work purpose was to study the comparative characteristics of a biochemical composition and biological value of the blue-green algae biomass under various cultivation conditions for the usage as a protein-vitamin supplement to the cattle main diet.

Objects and methods. The research object were *Cyanobacteria* or blue-green algae *Spirulina platensis* from the collection of St.Petersburg State University, Russia; and the second *Spirulina labyrinthiformis* that was isolated from the Shardara water storage of the Turkestan region, Kazakhstan [13] and supplied from the collection of the Scientific Research Institute "Botanica" of the Academy of Sciences of Uzbekistan. All species are known algae-logically pure. The algae were grown in a modified nutrient medium by Zarrouk [22]. The productivity of algae was taken into account by the change in dry weight (g / l) that was determined by the gravimetric method [21].

The content of photosynthetic pigments chlorophyll and β-carotene was determined by spectrophotometric method [8].

The content of β-carotene in fresh paste was determined by the Murri method [8], the content of ascorbic acid titration in the extract of 2.6-dichlorophenolindophenol [8], the total carbohydrate content was determined by the Antronov method [8], the total protein content by the amount of nitrogen (N*6.25) by the semi-micro Kjeldahl method [8], the total amount of lipids by extraction of chloroform - methanol mixture (3:1) [8].

In order to study the effect of the *Spirulina platensis* suspension on the cattle growth, in collaboration with the staff of the Research Institute of Animal Husbandry of Uzbekistan, under the professor K.K.Karibaev guidance, a research experiment was carried out in the Galla-Kuduk farm, Uzbekistan.

The coefficient of digestibility of nutrients and the chemical composition of gobies' meat were determined according to the generally accepted method [20].

Total protein content in the blood was determined by the refractometric method [5]

At the beginning and at the end of each experiment, the biochemical analysis of blood in bulls was performed by the Kudryavtsev method [14].

Static processing of the obtained data was processed by the Microsoft Excel program and using generally accepted standard methods.

Results and discussion. For industrial and semi-industrial cultivation of algae, the open systems mostly are often used, owing to the manufacture of that is relatively inexpensive in the comparing to

closed cultivation systems. In this regard, the study of external factors influence in the open cultivation, as well as the search of optimal conditions for open cultivation in order to obtain a stable biomass with a desired biosynthesis of the main assimilates was provided.

In the open cultivation, the same mineral media are used as in the laboratory where the algae were cultivated. However, modified and diluted mineral media are used on a large scale for economic efficiency. It is also necessary to take into account a source and concentration of the main biogenic chemical elements (nitrogen, phosphorus, carbon) and trace elements.

For mass cultivation, algae firstly were grown in greenhouse conditions. Under greenhouse conditions, the algae *Sp.platensis* and *Sp.labyrinthiformis* were grown in a tubular cultivator with bubbling stirring and in a tray installation without stirring (table 1).

Table 1 – Influence of cultivation methods in greenhouse conditions and main components

Indicators	*Spirulina labyrinthiformis*						*Spirulina platensis*					
	In a tubular cultivator with stirring			In a tray installation without stirring			In a tubular cultivator with stirring			In a tray installation without stirring		
Days	6	9	12	6	9	12	6	9	12	6	9	12
Dry substance, g/l	1,2	2,1	2,6	0,91	1,9	2,4	1,9	2,8	3,8	1,4	2,4	3,0
Chlorophyll A, mg/l	3,8	5,4	1,2	4,4	4,8	2,0	3,1	5,4	2,0	8,2	9,0	2,6
β- carotene, mg%	3,6	3,2	3,6	3,1	1,1	4,0	1,2	3,1	3,6	2,6	6,1	1,2
Ascorbic acid, mg%	140,1	200,1	215,1	120,9	150,2	170,1	100,0	110,1	120,3	128,0	134,5	125,0
Total lipids, %	9,8	10,4	12,8	10,4	12,4	12,5	10,4	15,8	18,4	9,1	8,1	12,0
Total protein, %	60,0	62,0	63,1	37,1	58,0	62,1	69,1	70,1	71,0	66,0	69,2	73,0
Total carbohydrates, %	7,0	8,5	11,5	7,2	8,0	9,5	6,5	7,2	7,7	6,3	7,0	7,5

As can be seen from the experiments, cultivation in a tubular cultivator with stirring turned out to be more favorable conditions for *Sp.platensis*, while for *Sp.platensis*, a tray installation without stirring. This is apparently explained by the morphological differences of cells, in particular, their sizes. The larger trichomes of *Sp.platensis* preferentially accumulate in the surface of the film; therefore, mixing to some extent disrupts their vital functions. And for small trichomes of *Sp.labyrinthiformis* that are suspended in the water column, mixing creates the best conditions for lighting and aeration.

The methods of industrial cultivation of various microalgae using of the open reactors for mass culture were studied in Kazakhstan. By such approach natural energy resources can be widely used. Consequently, this method is most effective in the southern regions of Kazakhstan with an abundance of sunlight and favorable temperature conditions [9].

Open cultivation conditions for *Spirulina* were characterized by the following conditions: growth in tray installations without stirring on a modified Zarruk nutrient medium, where the illumination range was 50-100 klx and a temperature of 25-38^{0}C (table 2). Open conditions were accompanied by obtaining the highest productivity of crops, exceeding greenhouse conditions. At the same time, the accumulation of

Table 2 – Content of photosynthetic pigments, main biochemical components and vitamins of *Spirulina* in open cultivation conditions without stirring

Species, strain	Dry biomass, g / l	Pigments, mg / g		Total protein, %	Total lipids, %	Total carbohydrates, %	Vitamins, mg%	
		Chlorophyll "A"	Carotenoids				Carotene	Ascorbic acid
Spirulina platensis	4,08	11.0,±0,53	7.2±0,11	75.3±1,1	14.48±0.23	5,40±0,40	242.1±2,88	130.0±2,38
Spirulina labyrinthiformis	2,7	6.30±0,49	5.40±0,18	62.21±1,25	16.0±0,35	21.0±0,41	203.0±2,46	200.0±3,40

biomass in *Sp.platensis* reached 4.08 g / l, and in *Sp.labyrinthiformis* up to 2.7 g /l within 10 days. It is known that in open cultivation conditions there is a direct dependence on environmental factors, primarily on illumination and temperature and the season. Experiments have shown that in an open installation, the pigment content increased in two crops. In *Sp.platensis*, the content of chlorophyll "A" was 11.0 mg / g, for carotenoids - 7.2 mg / g, the content of protein in *Sp.platensis* increased to 75.3% (and this is the maximum value) and for *Sp.labyrinthiformis* - to 62.21%. A high percentage of proteins allows to obtain high productivity of *Sp.platensis* under these conditions.

However, open conditions were accompanied by less accumulation of vitamins due to the negative influence of high insolation from light. The content of ascorbic acid was noted for *Sp.platensis* at 130 mg% and for *Sp.labyrinthiformis* at 200 mg%. The content of vitamin A (β-carotene) for two cultures was 242.1 mg% and 203 mg%, respectively. The active metabolism of cultures in open conditions was accompanied by a different rate of synthesis of a number of substances, including storage compounds (carbohydrates), the content of which in *Sp. labyrinthiformis* exceeds *Sp.platensis* by four times over, it is 21%. Since an active accumulation of biomass was observed under these conditions, the increased content of carbohydrates is not explained by the deterioration of conditions, yet by the genetic characteristics of the strain.

Mostly *Sp.labyrinthiformis* is a producer of carbohydrates. Carbohydrates are the main energy material of the plant and animal world. The biosynthetic activity of microalgae depends on the mode of cultivation technology, in conditions of sunlight in the open air, the season of the year, the type of installation and mixing. For the number of super producers of protein is 75.3%, and β-carotene is 242.1mg% high productivity is 4.08g / l can be attributed to *Sp.platensis*. In addition, the cell membrane of *Sp.platensis* is thin and easily destroyed, in the cells of valuable substances of animal organisms [23].

In this regard, the studies in the application of the *Sp.platensis* suspension as a bio-stimulator of a high-protein vitamin growth and a feed additive in the cattle diet were carried out, that were not yet used in animal husbandry in Kazakhstan and Uzbekistan.

The lack of certain elements in the cattle diet is especially observed towards the end of the winter period that is associated with a decrease in the β-carotene content in feed during storage and a violation of the harvesting technology.

The shortage of vitamin feed in the summer is associated with drying out of vegetation. A deficiency of certain substances in the diet leads to the appearance of pathological processes in the body of animals, metabolic disorders, a decrease in productivity and an over consumption of feed per unit of production.

Sp.platensis suspension was grown in open tray installations with a total working volume of 1000 liters. Scientific research experiments were carried out at the farm "Galla-Kuduk" under the professor K.K.Karibaev guidance. By the principle of analogs, 4 groups of 10 black-and-white bulls in each group were selected, at the age of 15-16 months. The experiment was carried out within four months (June-September) according to the following layout (table 3).

Table 3 – Experiments layout

Group	Bulls quantity	Diet composition
Control	10	BD (basic diet)
I-experimental	10	BD + 1liter of *Spirulina suspension*
II- experimental	10	BD + 2liter of *Spirulina suspension*
III - experimental	10	BD + 3liter of *Spirulina suspension*

The experimental animals were in the same feeding conditions: group, three times a day, drinking from auto-drinkers. The bulls were individually weighed once a month in the morning before feeding. Signs of negative influence, symptoms of poisoning, lethargy, deterioration of appetite, emaciation during the experiment were not observed. Feeding was carried out according to the established technology of the industrial complex [1].

The digested feed and its residues were taken into account daily by groups; the health status, appetite and behavior of the animals were monitored. The animals of the experimental groups received one, two and three liters of *Spirulina* suspension everyday per head to the main diet. The area of the experimental territory, lighting, ventilation of the sanitary state, corresponded to the veterinary requirements, feeding and watering were carried out at a certain time according to the daily routine adopted in the farm.

An important indicator of the biological value of nutrition is a change in the live weight of the experimental animals. Variations in live weight and average daily gain over the period of the experiment can be judged from the data in table 4.

Table 4 – Live weight and average daily gain of bull calfs, within four months

Group	Live weight, kg		Weight gain		
	at the beginning	at the end	absolute gain, kg	average daily gain, g	% of control
Control	413.5 ±16,9	525.5±21,1	112.0	933.0	100.,0
I- experimental	413.0±21,9	532.5±20,1	119.5	995.8	106.7
II- experimental	413.0±17,9	541.0±17,4	128,0	1066,6	114.3
III - experimental	412.0±14,8	543.5±13,0	131.5	1095.8	117.4

All experimental groups in terms of weight gain exceeded the control group. The largest average daily gain in live weight over the period of the experiment was given by bulls of the third experimental group, their weight gain exceeded the control group by 17.4% or 162.8 g; in the second experimental group, the increase in weight gain, compared with the control, was 14.3% or 133.6 g.

Experiments have shown that the optimal concentration of the *Spirulina* suspension is 2-3 l / day per 1 bull. Further increase in the suspension of *Spirulina* is impractical due to imbalance in the feed [11].

At the end of the experiments, in order to determine the metabolic rate in the body, 9 bulls were selected for slaughter or 3 bulls from each group: control, second and third.

Due to the fact that in the first experimental group, the weight gain was only 6.7%, and for the next studies, the data of this group were not taken into account.

The body weight of the selected bulls approximately showed the characteristic average weight of the group. Slaughter weight and meat yield data are shown in table 5.

Table 5 – Results of control slaughter of the bulls, in average

Indicators	Group		
	Control	II- experimental	III- experimental
Pre-slaughter live weight, kg	525.0	535.0	543.0
Fresh carcass weight, kg	286.3	298.6	312.4
Fresh carcass yield, %	54.5	55.0	57.5
Internal fat mass, kg	8.3	10.5	12,3
Slaughter weight, kg	294.6	309.1	324.7
Slaughter output,%	56.1	57.7	59.7

By an increasing of the suspension of *Spirulina* up to 3 liters / day, all analyzed indicators have increased. Live weight increased by 18 kg, fresh carcass weight increased by 26 kg, slaughter weight - by 30 kg, internal fat mass by 4 kg. As it seen, the *Spirulina* suspension, as a vitamin supplement, had a positive effect on increasing the slaughter yield that in the third experimental group exceeded the control group for 3.6%.

Experiments have shown that *Spirulina* suspension affects the chemical composition of bulls meat. The percentage of fat in the meat of the third experimental group is 0.88% higher, and the water content is 1.1% less than the control.

The biochemical composition of the experimental bulls' blood was taken into account at the beginning and at the end of the experiment. Blood ensures the normal functioning of tissues and organs. The composition of blood is labile and depends on many factors, such as age, sex, season of the year, feeding, housing conditions and other factors (table 6).

Table 6 – Biochemical parameters of the bulls' blood

Group	B-carotene, mg%		Protein, %		Calcium, mg%		Phosphorus, mg%		Reserve alkalinity mg, %	
	at the beginning	at the end	at the beginning	at the end	at the beginning	at the end	at the beginning	at the end	at the beginning	at the end
Control	0.171±0.02	0.186±0.01	7.39± 0.12	7.40±0.26	18.5±2.18	17.0±0.67	7.3±0.50	8.3±0.49	460.0±30.5	420±23.1
I-experi-mental	0.164±0.02	0.193±0.01	7.52± 0.35	7.82± 0.18	17.7±2.76	17.5±1.32	6.6±0.64	7.9±0.16	420.0±20.0	460.0±28.4
II-experi-mental	0.181±0.02	0,226±0,02	6.80±0.188	7.33±0.41	17.8±1.01	18.0±0.87	6.86±0.52	7.9±0.42	466.0±24.1	460.0±23.1
III-experi-mental	0.178±0.05	0.220±0.01	7.19±0.53	7.93±0.18	16.3±1.59	17.5±0.76	6.53±0.30	7.9±0.09	480.0±11.5	466.0±33.4

In the experimental groups, there was a significant increase of β-carotene (0.178-0.220m g%). Phosphorus content (6.53-7.9m g%), protein content (7.19-7.93 mg%), calcium 16.3-17.5 mg%). There was also a slight increase in the content of protein (up to 7.93%), calcium (17.5%) and reserve alkali (466 mg /%). Such data show that the biochemical parameters of the blood of animals improved, which is possibly associated with the use of *Spirulina* suspension in the diet.

After addition of *Spirulina* suspension in the bulls' diet, with the cost of feeding decreasing, the total productivity increased. Therefore, in the experimental groups, more livestock products were obtained in monetary terms than from the control group. The high economic effect was obtained in the third group that had *Spirulina* suspension in the daily diet, by 3 liters per head. So, in average 20%-25% profits per yearly could be available.

Conclusion. The analyzes showed that in the biomass of *Spirulina* under greenhouse conditions, the maximum accumulation of chlorophyll "A" is 9.0 mg / g. In 9 days, and in open cultivation conditions is 11.0 mg / g. At the same time, under greenhouse conditions, the productivity of *Sp.platensis* was 3.8 g / l, protein 73.0%, and in *Sp.labyrinthiformis* 2.6 g / l, protein 63.1%. Technological modes of cultivation of the studied species of *Spirulina* in the open air were accompanied by obtaining the highest efficiency in the chemical composition and protein synthesis. At the same time, the accumulation of biomass of *Sp.platensis* reached 4.08 g / l, protein 75.3%, and in *Sp.labyrinthiformis* 2.7 g / l a.d.c., protein 62.21% within 10 days compared with greenhouse conditions. The results of the study of the pigment apparatus of *Spirulina* under open cultivation conditions indicate that light adaptation provides the most versatile levels of the functional organization of the photosynthesis by sharply increasing the protein content and productivity. *Sp.platensis* has a significance, as a source of protein and as producers of valuable compounds for the food industry, also in the agriculture, as a protein-vitamin and biostimulating additive for animal feed. It was found that the addition of *Sp.platensis* suspension, as a protein-vitamin supplement to the main diet of beef cattle, 3 liters per day per 1 bull, stimulates physiological processes that improves the biochemical parameters of the blood of animals, the digestibility coefficient of nutrients by 8-9%, positive mineral balance, increases live weight gain (17.4%) and slaughter yield of bull calves (3.6%). Thus, the suspension of *Sp.platensis* is recommended for use as a protein-vitamin supplement in livestock farms that will make it possible to obtain a high economic effect in livestock farming, in average 20-25% profits yearly.

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Cyanobacteria Spirulina МИКРОБАЛДЫРЛАРЫНЫҢ БИОХИМИЯЛЫҚ КӨРСЕТКІШТЕРІ ЖӘНЕ ІРІ ҚАРА МАЛ АЗЫҒЫНА ҚОЛДАНУ

Аннотация. Жергілікті табиғаттан оқшауланған және жартылай өнеркәсіптік жағдайда өсірілген *Cyanobacteria Sp.platensis* және *Sp.labgrinthifosmis* бөліміне жататын биологиялық белсенді заттардың, микробалдырлардың түрлері мен штамдарының сапалық және сандық құрамы қарастырылады. Балдырды жаппай өсіруге бейімдеу үшін алдымен жылыжайда 12 күн өсірілді. *Sp.platensis* араластыру арқылы құбырлы культиваторда өнімділігі 3,8 г/л ақуыз (73,0%), ал *Sp.labyrinthiformis* 2,6 г/л ақуыз (63,1%) құрады. Ұқсас зерттеулер араластырусыз ашық культивация жағдайында жүргізілді әрі жарықтандырудың ұлғаюы балдырдың бүкіл фотосинтетикалық аппаратын айтарлықтай қайта құратынын көрсетті. *Sp.labyrinthiformis* 2,7 г/л ақуыз 62,21%, 203,0 мг% каротин және *Sp.platensis* 4,08 г/л, ақуыз 75, 3%, 242,1мг% каротин 10 күн ішінде пайда болды. Ақуыз бен каротин мөлшері жылыжай жағдайымен салыстырғанда жылдам артады. Осыған байланысты біз *Sp.platensis* суспензиясын жас ет өндірісіндегі ірі қара малдың рационында ақуызы жоғары дәрменді жемшөп қоспасы ретінде қолдану бойынша зерттеулер жүргіздік.Нәтижесінде барлық эксперименттік топтар салмақ жоғарылату бойынша бақылаудан асып түсті.

Бұқа қорегіне *Sp.platensis* суспензиясын ақуыз және дәрумендік қоспа ретінде III топтың (әр басына тәулігіне орта есеппен 3 литр суспензия қосу) физиологиялық үдерісті ынталандырады, қанның биохимиялық көрсеткіштерін жақсартады, қоректік заттардың сіңу коэффициенті 8-9%, оң минерал тепе-теңдік, тірі салмақ өсімін (17,4%) және сою өнімділігін (3,6%) арттырады. Тәжірибелер *Spirulina* суспензиясы еттің химиялық құрамына әсер ететіндігін көрсетті. Үшінші эксперименттік топтың етінде май үлесі бақылау тобына қарағанда 0,88%-ға жоғары, ал су мөлшері 1,1%-ға аз. Тәжірибелік топтарда β-каротиннің (0,178-0,220 мг%), фосфор құрамының (6,53-7,9 мг%), ақуыздың (7,19-7,93 мг%), кальцийдің 16,3 едәуір артатындығы байқалды (17,5 мг%). Сонымен, *Sp.platensis* суспензиясын ірі қара мал азығына ақуыз және дәрумендік қоспа ретінде қолдануға ұсыныс беріледі, бұл орташа есеппен мал шаруашылығында жақсы экономикалық нәтиже алуға мүмкіндік береді, яғни орташа есеппен жылына 20-25% құрайды.

Түйін сөздер: антиоксиданттар, биологиялық белсенді заттар, өсіру, тұқымдас, микробалдырлар, фитокультуралар, *Spirulina*

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БИОХИМИЧЕСКИЕ ПОКАЗАТЕЛИ И ПРИМЕНЕНИЕ МИКРОВОДОРОСЛЕЙ *Cyanobacteria Spirulina* В КОРМАХ КРУПНОГО РОГАТОГО СКОТА

Аннотация. Рассмотрены качественные и количественные составы ценных биологически активных веществ, виды и штаммы микроводорослей, относящихся к отделу Cyanobacteria Sp.platensis и Sp.labgrinthifosmis, выделенных из местной природы и выращенных в полупроизводственны условиях. Для приспособления к массовому выращиванию водоросли сначала выращивали в тепличных условиях. Их культивировали в течение 12 дней. Продуктивность в трубчатом культиваторе при перемешивании Sp.platensis составила 3,8 г / л, белка (73,0%), а у Sp.labyrinthiformis - 2,6 г / л белка (63,1%). Накопление биомассы Sp.labyrinthiformis 2,7 г / л а.с.в., белка 62,21%, 203,0 мг % каротина и Sp.platensis 4,08 г / л а.с.в., белка 75,3%, 242,1мг % каротина происходило в течение 10 дней. Резко увеличивается содержание протеина и каротинов по сравнению с тепличными условиями. В связи с этим мы проводили исследования по применению суспензии Sp.platensis как высокобелковой витаминой кормовой добавки в рационе молодняка скота мясного направления. В итоге все опытные группы по приросту веса превосходили контрольную.

Установлено, что добавление суспензии Sp.platensis в качестве белково-витаминной добавки к корму бычков (в среднем 3л суспензии в сутки на одну голову) стимулирует физиологические процессы, улучшая биохимические показатели их крови, коэф-фициент усвояемости питательных веществ на 8-9%, положительный минеральный баланс увеличивает прирост живой массы (17,4%) и убойного выхода (3,6%). Эксперименты показали, что суспензия Spirulina влияет на химический состав мяса бычков. В мясе третьей опытной группы процентное содержание жира на 0,88% выше, а содержание воды на 1,1% меньше, чем в контрольной группе. В опытных группах наблюдалось значительное увеличение β-каротина (0,178-0,220 мг%), содержание фосфора (6,53-7,9 мг%), содержание белка (7,19-7,93 мг%), кальция 16,3-17,5 мг%). Таким образом, суспензия Sp.platensis рекомендована к применению в качестве белково-витаминной добавки в корм крупного рогатого скота, что позволит иметь значительный экономический эффект в животноводстве, в среднем 20-25% прибыли в год.

Ключевые слова: антиоксиданты, биологически активные вещества, культивирование, род, микроводоросли, фитокультуры, *Spirulina.*

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