REPUBLIC OF AZERBAIJAN

On the rights of the manuscript

ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

INVESTIGATION OF PRODUCTIVITY INDICATORS DURING THE ADAPTATION OF DAIRY CATTLE TO HEAT STRESS

Specialty 3110.03 – "Special zootechnics, technology of production of livestock products"

Field of science: Agrarian sciences

Applicant: **Konul Akbar Guliyeva**

Ganja – 2026

The work was performed at Scientific Research Institute of Animal Husbandry and Fisheries of the Ministry of Agriculture of the Republic of Azerbaijan.

Scientific supervisor: - Doctor of Biological Sciences, Professor
Mirza Mikayil Aliyev

Official opponents: - Corresponding Member of ANAS, Doctor of Biological Sciences, Professor
Panah Zulfugar Muradov
- Doctor of Philosophy in Agrarian Sciences, Associate Professor
Rafig Bayram Allahverdiyev
- Doctor of Philosophy in Agrarian Sciences, Associate Professor
Gunay Isfandiyar Sadigova

One-time Dissertation council BFD 4.01 of the Supreme Attestation Commission under the President of the Republic of Azerbaijan operating under the Azerbaijan State Agrarian University of the Ministry of Agriculture of the Republic of Azerbaijan

Chairman of the Dissertation council:
Doctor of Biological Sciences,
Fuad Mamay Gulubeyov

Scientific secretary of the Dissertation council:
Doctor of Philosophy in Veterinary Sciences
Maryam Iqza Musayeva

Chairman of the scientific seminar:
Doctor of Agrarian Sciences, Professor
Arif Alirza Tagiyev

GENERAL DESCRIPTION OF THE RESEARCH

Relevance of the research and the degree of its development. The aim of the agrarian reforms implemented by the country's leadership has been the reliable provision of the population with food products. The implementation of socio-economic development programs, as well as the realization of large-scale projects, has contributed to the development of the agricultural sector, including an increase in the production of livestock products. The work carried out within the framework of the "State program on reliable provision of the population of the Republic of Azerbaijan with food products for 2008–2015" has given impetus to the development of various sectors of agriculture. The implementation of projects and programs has served the food security of the country's population. In order to achieve this goal, reforms have been implemented in the country in the reconstruction of profitable production and market infrastructure, as well as in the work of controlling the quality of livestock products. Over the last 10 years, the goal has been set to double the non-oil sector. The growth observed in the non-oil sector is one of the important indicators of the sustainable development of the country's economy. It is expected that the projects currently being implemented and those planned for implementation in the future will make a significant contribution to the further strengthening of this sector in the coming years. The 11 percent growth recorded in the non-oil economy has had a positive impact on the development of various areas of economic activity.[1],[2],[3]

The import of animals carrying the heredity of improved breeds from foreign countries in the form of live animals and semen, as well as the use of those animals as improvers in local breeds, and measures aimed at improving the genetic potential of cattle breeds kept on

[1] Əliyev H.Ə. Müstəqilliyimiz əbədidir (çıxışlar, nitqlər, bəyanatlar, müsahibələr, məktublar, məruzələr, müraciətlər, fərmanlar). Bakı, Azərnəşr, 2007, s. 536

[2] Əliyev İ.H. "2008 - 2015 - ci illərdə Azərbaycan Respublikasında əhalinin ərzaq məhsulları ilə etibarlı təminatına dair Dövlət Proqramı"nın təsdiq olunmasına dair AR Prezidentinin 25 avqust 2008 - ci il tarixli sərəncamı. Bakı, 2008, s. 38.

[3] Əliyev İ.H. Nazirlər Kabinetinin 2013 - cü ilin birinci yarısının sosial - iqtisadi inkişafının yekunlarına və qarşıda duran vəzifələrə həsr olunmuş iclasında dövlət başçısının nitqi. "Yeni Azərbaycan", 16 sentyabr 2013 - cü il.

entrepreneurial farms, serve to meet the country's population's demand for food products.

The main part of the provision of food products consumed is obtained from various branches of the livestock sector.

The loss by imported improved breeds of their individual characteristics is related to the improper use by those animals of environmental factors and to the difficulty of their growth and development, according to physiological groups, in adapting to the geographical climate.

In large livestock complexes, greater importance is attached to the intensification of livestock production by reducing the impact of various stress factors. This, in turn, contributes to an increase in livestock products. To achieve the goal, providing cattle with a balanced feed ration is an important factor. In many cases, such feeding cannot meet the animals' energy requirements and their needs during adaptation to the resulting heat stress.

For this reason, it is considered important to add various biologically active substances to the feed portions when feeding animals during the summer months. In order for the ration to be nutritionally complete, the use of biologically active substances containing polyphenols has contributed to increasing adaptive capacity during heat stress and to increasing product production.

For adaptation to heat stress and increasing productivity, the preservation of genetic potential, the reduction of negative environmental factors, and the implementation of nutritionally complete feeding are considered important. When including various feed additives in the ration, their functional groups and categories should be taken into account.

In large cattle complexes and family farms, conventional feed additives are used for the purpose of increasing milk and meat productivity. The selection of the composition of biologically active substances is of great importance. Recently, the use of feed additives for adaptation to heat stress and increasing production during the summer months has become widespread. The premixes used, along with adapting animals to stress factors, are intended to increase reproductive capacity, normalize production capacity, and create

favorable conditions for the growth and development of the offspring obtained. For this reason, the topic is considered highly relevant.

The dissertation work is devoted to the investigation of problems arising during the implementation of the tasks defined in strategic documents adopted in the Republic of Azerbaijan in the direction of strengthening the reliable provision of the population with food products, in particular, the "State program on reliable provision of the population of the Republic of Azerbaijan with food products for 2008–2015" and the "State program on the socio-economic development of the regions of the Republic of Azerbaijan for 2009–2013." The research was carried out in accordance with the plans of scientific research work on the topic "Development and improvement of a balanced feed ration and norms for agricultural animals bred in Azerbaijan" (2016–2018, registration No. 4.2.4.6), conducted at the Azerbaijan State Agrarian University, as well as on the topic "Development and application of the technology of balanced feed rations using mineral-vitamin and protein supplements appropriate to the productivity and age groups of ruminant animals" (2014–2017, registration No. 0193 Az 4023), conducted at the Scientific Research Institute of Animal Husbandry of the Ministry of Agriculture of the Republic of Azerbaijan.

Object and Subject of the Study. The object of the study comprises Holstein-Friesian dairy cows raised at the livestock farm of "Nüsr-Ət Aqro" LLC, located in the Barda district, and representing different physiological stages. The subject of the study is the investigation of the effects of supplementing the animals' diets with the Flavo Vital complex of biologically active substances during adaptation to heat stress, particularly its effects on milk productivity, growth and development dynamics, and body condition, as well as the economic efficiency of its application.

Purpose and objectives of the research. One of the main objectives of our research is to study the restoration of impaired metabolism during heat stress and its effect on milk productivity by adding bioactive substances to the ration, taking into account their functional groups and categories.

In order to study the restoration of metabolism impaired in the

animal organism due to heat stress, as well as the importance of bioactive substances in adaptation to the resulting stress and their effects on the growth and development of young animals, the reproductive capacity of cows, body condition score during different physiological periods, milk productivity, and dry matter intake of fattened animals, the following objectives were set:

1. To identify the requirement for bioactive substances to be added to the feed ration for the adaptation of cows in different physiological conditions to heat stress;

2. To determine the compositional functional characteristics and mechanism of action of the biologically active substance complex to be used;

3. To include the Flavo Vital biologically active substance complex in the rations of newly calved, highly productive, and late dry-period cows during the summer months. Thus, by reducing heat stress, to study its effect on the chemical composition of milk productivity, body condition, the growth and development of young animals, and dry matter intake in order to determine zootechnical and economic efficiency;

4. To study the economic efficiency of the research depending on the biologically active substance used in the feed ration, to apply the obtained results in production, and to provide recommendations.

Research methods. The research work to be carried out according to the topic and plan was conducted at the livestock farm of "Nüsr-ət Aqro" LLC located in the Barda district. The animals of the experimental and control groups were selected according to the principle of analogues from the Holstein-Friesian breed cows available at the farm.

For the purpose of carrying out the work envisaged by the research topic, a number of laboratory, scientific-economic, and production experiments were conducted.

The laboratory, scientific-economic, and production work carried out in the laboratories of the Animals Husbandry and Fisheries Research Institute and the Azerbaijan State Agrarian University, as well as at the farm of "Nüsr-ət Aqro" LLC, constituted the main part of the research.

Chemical and biochemical analyses were carried out in parallel according to accepted standard methodologies.

A specific methodology was used for the analysis of each feed and feed additive.[4],[5],[6]

In accordance with the research program, the feed additive used for conducting the experimental work was imported from the Federal Republic of Germany on order. Vitamins and fermentative components having a synergistic effect were used in the preparation of the Flavo Vital biologically active substance complex.

Scientific-economic and production experiments were carried out in two variants: the group in which the Flavo Vital biologically active substance complex was applied and the control group kept under conventional feeding conditions. In order to determine the chemical composition of the feeds used in the variants, raw feed samples were subjected to laboratory analysis.

The effect of adding the polyphenol-containing Flavo Vital biologically active substance complex to the feed ration of dairy cows during the summer season on the restoration of impaired metabolism and on the production indicators of livestock products was investigated during 2013–2021.

In accordance with the purpose of the research, the following issues related to the effect of the use of feed additives in animals of different physiological and age groups were studied:

1. The growth, development, clinical indicators, and biochemical and morphological composition of the blood of calves up to 18 months of age.

2. Indicators of absolute gain, daily weight gain, and relative gain during intensive rearing up to 18 months of age.

3. Milk productivity, body condition score, longevity, and reproductive capacity of cows by physiological groups: calving ability, onset of estrus, fertilization percentage, service period,

---

[4] Abbasov S.A., Abbasov R.T. Genetika və seleksiyanın əsasları, -Bakı,-2016,-420s

[5] Abbasov S.A., Mehdiyev M.Ə., Ruşanov A.E. və b. Heyvandarlıq. Dərslik. Gəncə: -2011, -258 s.

[6] Калашников А.П., Щеглов В.В и др. Нормы и рационы кормления сельскохозяйственных животных. Учебник, Москва: -2003, -422 с.

stillbirth, and breeding value of the animal.

In accordance with the methodology, during the research, in the months when live weight was measured, the following body measurements were taken in the experimental and control group animals: height at the withers, back and pelvic height, straight and oblique body length, chest width and depth, pelvic width, chest and cannon girth, around the shoulder blade, half-back girth, and head length and width. In addition, at the dairy farm of "Nüsr-Ət Aqro" LLC, the average milk productivity of cows during lactation, milk fat percentage, and the main quality indicators of milk were analyzed.

A biometric analysis of the final indicators of the scientific research work was carried out based on mathematical models. Here, the standard deviation – σ, coefficient of variation – Cv, arithmetic mean – X, error of the arithmetic mean – m, reliability criterion – td, and probability – P were calculated according to Student's criterion.

Main provisions submitted for defense:

- Determination of the animal's requirement for bioactive substances, depending on its physiological condition, during the adaptation of high milk-producing cows to heat stress;
- Investigation of the effects of the polyphenol-containing feed additive Flavo Vital on the growth of young animals, the development of body measurements, body condition across physiological groups, and milk productivity during the summer months;
- The effect of Flavo Vital on the monthly indicators of absolute and relative growth in young animals;
- Analysis of nitrogen balance and mineral metabolism when Flavo Vital is added to the diet of cows during the summer months;
- Investigation of the effect of the biologically active substance complex on the fat content of cow's milk.

Scientific novelty of the research work. The effects of the polyphenol-containing biologically active substance complex Flavo Vital on metabolism and its efficiency in the production of livestock products have been analyzed for the first time in this research. Based on the results of the research, the inclusion of this polyphenol-rich complex in the diets of cows was evaluated in terms of nutrient utilization and digestibility, the achievement of high milk productivity

with lower feed consumption, the qualitative and quantitative indicators of milk, reproductive capacity, body condition across physiological groups, adaptation to heat stress, dry matter intake, and the growth and development of young animals.

Theoretical and practical significance of the research work. The practical significance of the research conducted lies in the fact that, for the first time in the Republic, scientific research in this field has made it possible to practically investigate, based on the results of the study, the importance of feed additives in the adaptation of dairy cattle to heat stress, improvement of reproductive performance, maintenance of desirable body condition scores, increased milk productivity, positive changes in the hematological parameters of cows, production of healthy offspring, and the intensive growth and development of calves. The second practical significance of this research is the possibility of obtaining vigorous young calves that are resistant to heat stress. The Flavo Vital biologically active substance complex improves feed conversion and digestibility and regulates dry matter intake across different physiological groups.

High-producing dairy cows in different physiological groups better utilize diets containing the biologically active substance complex. Feeding animals the bioactive substance complex provides good results in terms of dry matter intake.

When the Flavo Vital biologically active substance complex is properly used in the diets of animals, metabolism proceeds more efficiently, the intensity of metabolic processes increases, and the physiological functions of the organism improve. As a result, the growth and development of calves proceed normally, their health indicators and rate of development improve, desirable body condition is maintained, dry matter intake is optimized in fattening animals, milk productivity in cows increases, milk composition improves, and the technological processing and quality of milk yield better results.

The milk productivity of the animals in the control group was lower than that of the experimental group, while the experimental treatment had a positive effect on adaptation to heat stress.

Feeding cows with the biologically active substance complex improves hematological blood parameters and metabolism, enhances

nutrient utilization and digestibility, and promotes increased milk productivity by improving dry matter intake and the conversion of feed into energy. It also normalizes the amount of fat obtained from milk, its compositional quality, and its technological properties. During the hot months, the profitability of milk production in animals receiving the biologically active substance complex was 5.43% higher than in the control group. The use of the biologically active substance complex is therefore recommended for preventing stress that may occur during the summer months and for increasing milk productivity in cows.

Approbation and application of the work. The results and individual provisions of the dissertation have been extensively discussed at the following scientific conferences: the Nationwide Scientific and Practical Conference "20 Years of Land Reform in Azerbaijan: Achievements and Prospects" (Baku, 2016); the Scientific Discoveries III International Scientific Conference (Karlovy Vary, Czech Republic; Moscow, Russia, January 30–31, 2018); the International Scientific Conference "Current Problems of Modern Natural and Economic Sciences" (Ganja State University, May 4–5, 2018); the World Scientific Reports International Scientific Conference (International Scientific Conference, Paris, France, 2023); the International Scientific and Practical Conference "The Fourth Industrial Revolution and Innovative Technologies", dedicated to the 100th anniversary of the National Leader H. Aliyev (Ganja, 2023); and the International Scientific and Practical Conference "Innovations in Agriculture and Ecology" (III International Scientific and Practical Conference, Ryazan, 2025).

Name of the organization where the dissertation research was carried out. The laboratory analyses for the research were conducted at the "Feeding and Feed Analysis" laboratory of the Scientific-Research Institute of Animal Husbandry and Fisheries, as well as in the laboratories of the Azerbaijan State Agricultural University, while the scientific field experiments were carried out at the facilities of "Nüsr-ət Aqro" LLC.

Total volume of the dissertation in characters, indicating the volume of its individual structural sections. The dissertation

consists of an introduction, five chapters, conclusion and recommendation, and a list of 177 references. It includes 8 figures, 32 tables, and 6 diagrams. In terms of its structure, the title pages and table of contents comprise 3 pages and 4,793 characters; the introduction comprises 7 pages and 12,879 characters; the first chapter comprises 48 pages and 89,823 characters; the second chapter comprises 20 pages and 28,679 characters; the third chapter comprises 31 pages and 50,283 characters; the fourth chapter comprises 21 pages and 31,391 characters; the fifth chapter comprises 15 pages and 24,218 characters; the conclusions comprise 3 pages and 4,331 characters; the recommendations comprise 1 page and 502 characters; and the list of 177 references comprises 16 pages and 23,824 characters. The main text of the dissertation, excluding figures, tables, diagrams, and the list of references, comprises 130 typed pages or 224,586 characters.

CONTENT OF THE WORK

The introduction presents the relevance of the topic, the formulation of the problem, and the general characteristics of the dissertation.

The first chapter, entitled "Literature Review," presents an extensive review of the literature on the current state of cattle breeding in the Republic and the factors affecting productivity; the effects of vitamins and biologically active substances on the restoration of metabolism in the animal organism; the physiological characteristics of the B-group vitamin complex; the effects of heat stress on animals depending on environmental factors and their adaptation to stress; the effects of the use of feed additives in the diet and in the feeding of dairy animals by physiological groups on productivity; and the productive characteristics of high-yielding cattle.

The second chapter is entitled "Research object and methodology." It includes the methodology of physiological balance experiments, chemical and biochemical analyses, and the methodology for the biometric analysis of small samples.

The research work to be carried out according to the topic and plan was conducted at the livestock farm of "Nüsr-ət Aqro" LLC located in the Barda district. The animals of the experimental and control groups were selected, according to the principle of analogues,

from Holstein-Friesian cows available at the farm.

For the purpose of carrying out the work envisaged within the framework of the research topic, a number of laboratory, scientific-farm, and production experiments were conducted.

In accordance with the research program, the feed additive used for conducting the experimental work was imported from the Federal Republic of Germany on order. Vitamins and fermentative components having a synergistic effect were used in the preparation of the Flavo Vital biologically active substance complex.

The chemical composition of the feed additive was determined in terms of dry matter, crude protein, crude fat, crude fiber, crude ash, nitrogen-free extractive substances (NFES), as well as the contents of phosphorus, calcium, sodium, and magnesium.

To determine the composition of the Flavo Vital bioactive compound complex, chemical and biochemical analyses were performed. Total nitrogen was determined by the Kjeldahl method, crude fat by diethyl ether extraction, and crude fibre by the Kürschner–Hanak method. Vitamins B_1, B_6, and B_9 were determined using standard fluorometric and colorimetric methods, vitamin B_{12} microbiologically, vitamin B_2 according to E. M. Maslennikova, and niacin by the Haes method.

Scientific-production experiments were conducted to investigate the effects of feed additives of different compositions on the productivity indicators of cows, the composition of the products obtained, and body condition. The control and experimental groups were formed from Holstein-Friesian cows that were comparable in terms of stage of lactation, age, milk productivity, breed, milk fat and protein content, live weight, duration of lactation, and other characteristics, with 12 animals in each group.

At the same time, considering the heat stress adaptation characteristics of calves born to the experimental cows, the effects of the feed additive on their growth and development, clinical and physiological status, and hematological and biochemical blood parameters were comparatively investigated. Complete blood counts were performed using a Mindray automated hematology analyzer. Hemoglobin levels were determined using both the analyzer and a

Sahli hemometer, while erythrocyte and leukocyte counts were assessed by the Mindray analyzer and verified manually with a Goryaev hemocytometer. Total serum protein was determined using an IRF-22 refractometer, protein fractions by the nephelometric method, and AST and ALT activities by the Reitman–Frankel method.

During the experiments, cows' body condition scores (BCS) were assessed according to their physiological stages using visual and palpation methods.

Growth and development may be adversely affected by heat stress, inadequate feeding, and unfavorable housing conditions. Therefore, regular monitoring of body measurements is essential. Absolute, average daily, and relative weight gains were calculated to assess growth intensity, with relative gain determined according to S. Brody's method. Based on the body measurements, body conformation indices reflecting exterior and constitutional characteristics were calculated, and their dynamics were analyzed according to the methodology developed by A. A. Aghabayli.

During the experiments, the body condition score of the cows was assessed according to their physiological condition. Evaluation of milk productivity was carried out during control milkings at 10-day intervals, while milk fat (%), protein (%), and the amount of fat in the milk (kg) were studied during the first 100 days of lactation. The average quality indicators of milk were determined by control milkings every 10 days and according to the average productivity during the month. During the statistical processing of the biometric analysis of the results obtained, the significance of differences was assessed using Student's criterion.

During the experiments, the physicochemical and technological properties and chemical composition of cow's milk were determined. Casein was determined by the Mattiopul method; dry matter, lactose, ash, and caloric value by calculation; fat content by the Gerber acid method; acidity by titration; milk purity by filtration; protein by formal titration; rennet coagulation ability according to Barabanshchikov; and density using a milk areometer. Fermentation tests were conducted at 37–38 °C, while rennet coagulation was studied at 38–40 °C with the addition of a fermenting substance. The number and size of fat

globules were determined microscopically by the Goryaev method, and bacterial contamination was assessed using the standard methylene reductase test [4,11].

During the evaluation of dairy products, fat content was determined by calculation, moisture content by the evaporation method, the number of bubbles by the chemical method, taste quality by sensory evaluation, and iodine content according to Gyub.

The third chapter presents the experimental section. The effects of vitamins on the composition of the biologically active substance complex, the restoration of impaired metabolism in the animal organism, the utilization of feeds and feed additives, the digestibility of nutrients, the use of calcium and phosphorus in the diet during adaptation to heat stress, and the morphological and biochemical parameters of animal blood were experimentally investigated [6,18].

In the experiments conducted, vitamins B_1, B_2, B_6, B_9, and B_{12}, calcium D-pantothenate, and niacin were selected as the main components of the biologically active substance complex. In addition, the chemical composition and structural characteristics of the complex, the proportions of its components, and the amount per 1 kg of feed were determined. The vitamins and active fermentative components contained in 1 kg of the Flavo Vital biologically active substance complex were determined through laboratory analyses (Table 1).

Table 1

Amounts of vitamins and active fermentative components in 1 kg of the Flavo Vital biologically active substance complex

Serial No.	Name of vitamin and active fermentative component	Amount in 1 kg of Flavo Vital	Category and functional group
1.	Vitamin B1	150 mg	3a821
2.	Vitamin B2	100 mg	Riboflavin-5
3.	Vitamin B6 – pyridoxine hydrochloride	90 mg	3a831
4.	Vitamin B12	1800 μg	Cyanocobalamin
5.	Niacin	1250 mg	3a314
6.	Calcium D-pantothenate	335 mg	3a841
7.	Folic acid	27 mg	3a316

During our research, the inclusion of the Flavo Vital bioactive complex in the diets of cows eliminated acidosis while promoting

adaptation of the organism to oxidative stress caused by an imbalance between free radicals and antioxidants.

According to the digestibility of the concentrate feed containing biologically active substances in the diet, the highest values were observed in the control group (97.82%) and experimental group (99.85%) of high-producing dairy animals.

The digestibility coefficients of the concentrate feed containing the Flavo Vital biologically active substance complex were 98.18% and 99.80% in the control and experimental groups of newly calved animals, respectively, while the corresponding values in late dry animals were 98.62% and 99.74%. Compared with the control group, the digestibility of the concentrate feed was higher in the experimental group by 1.62% in newly calved animals, 2.03% in high-producing animals, and 1.12% in late dry animals [5,8,16].

In our research, digestibility was calculated as a relative value. Digestibility was studied based on the ratio of digested nutrients to consumed nutrients. The expression of the obtained values as percentages is referred to as the digestibility coefficient. At the beginning of the research, samples were taken from the feeds to be analyzed and were examined. First, the chemical composition of the feed samples was determined [8,16]. The analyzed samples were weighed, and the diet was prepared on this basis. The diet was used in the daily feeding of the animals until the end of the experiment [8,16]. The moisture content of the feeds did not change during the experimental period. The duration of the experiment was 21 days. Fourteen days were allocated for the adaptation of the animals to the experimental conditions. During this period, the digestive system of the animals adapted to the feeds.

When the digestibility of nutrients was studied in cows at different physiological stages, the digestibility of dry matter, organic matter, crude protein, crude fat, crude fiber, and nitrogen-free extractive substances (NFES) in the experimental group was higher than in the control group.

Taking into account the nutrient indicators in the diet of different physiological groups, the dynamics of nutrient digestibility were presented (Diagrams 1–3).

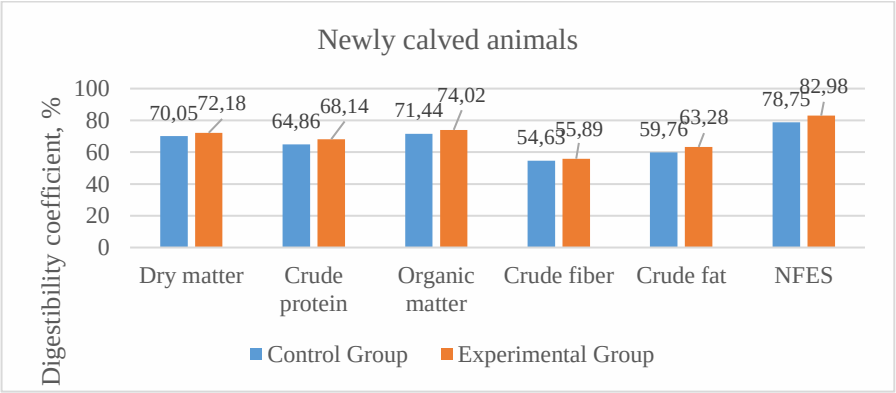


Diagram 1. Digestibility of nutrients in the diet of newly calved animals, %

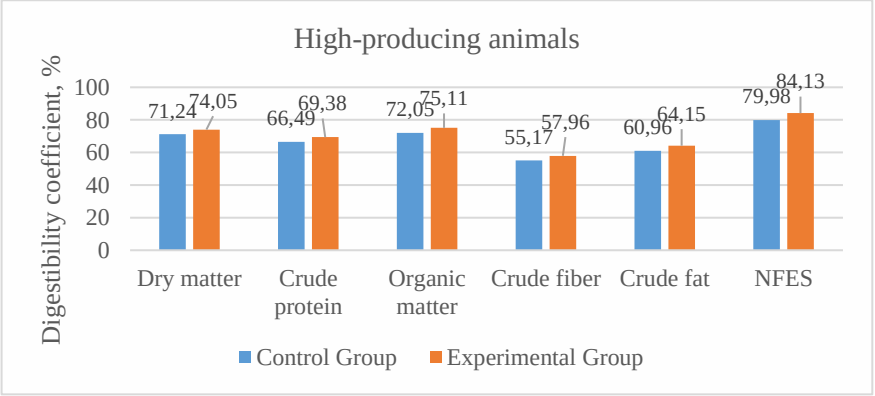


Diagram 2. Digestibility of nutrients in the diet of lactating cows, %

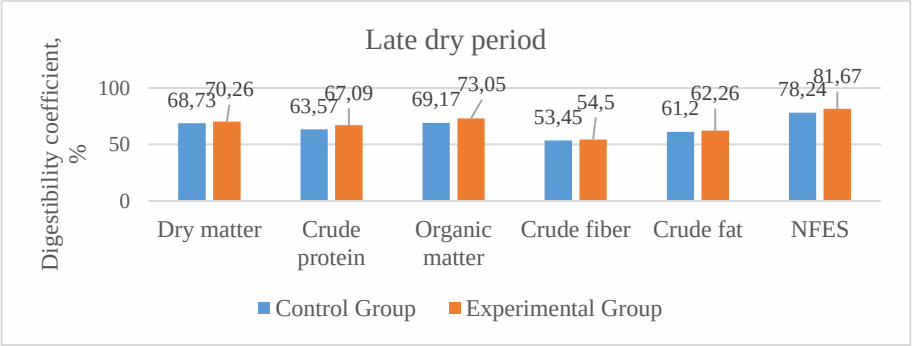


Diagram 3. Digestibility of nutrients in the diet of cows in the late dry period, %

During the research, nitrogen balance and calcium-phosphorus utilization were studied in the diets of cows at different physiological stages fed with a polyphenol-containing bioactive complex [10,18].

To determine protein concentration in cows at different physiological stages, nitrogen balance was investigated in animals fed the Flavo Vital bioactive substance complex.

During the study, nitrogen balance was positive in all physiological groups, and adding the biologically active compound complex to the diet improved protein metabolism. Compared with the control group, nitrogen intake from feed in the experimental group was higher by 14.87 g, or 4.51% (344.31 g), in recently calved cows; by 16.22 g, or 4.85% (350.73 g), in high-producing cows; and by 14.81 g (340.36 g) during the late dry period. Consequently, nitrogen utilization and excretion also changed, with experimental cows utilizing nitrogen more efficiently for milk synthesis and body retention.

As a result, feed utilization in the diets of cows differed between the two groups. Consequently, nitrogen intake also differed. This indicator was higher in the cows of the experimental group.

It was determined that, under heat stress conditions, the inclusion of the Flavo Vital biologically active substance complex in the diets of cows improves nutrient utilization and, at the same time, has a positive effect on increasing the utilization of calcium and phosphorus by the body.

The morphological and biochemical composition of the blood varies depending on the physiological condition of the animal, feeding and management practices, climatic factors, and heat stress.

The results of the research show that the effects of feeding animals at different physiological stages with the biologically active complex for adaptation to heat stress were reflected in the morphological parameters of the blood.

In the cows of the experimental group of newly calved animals, the hemoglobin level in the blood was 3.9% higher than in the control group ($P<0.01$), while the erythrocyte count was 18.2% higher. The leukocyte count was 8.6% lower than in the control group.

In the experimental group of high-producing animals, the hemoglobin level was 4.5% higher than in the control group ($P<0.05$).

The erythrocyte count was 9.62% higher in the experimental group than in the control group, while the leukocyte count was 3.4% lower.

In cows during the late dry period, hemoglobin concentration was 5.0% higher ($P<0.01$), while the erythrocyte count was 15.67% higher compared with the control group.

During the summer months, the inclusion of feed additives containing the bioactive substance complex (Flavo Vital) in the diets of cows at different physiological stages improved blood composition and resulted in increased hemoglobin levels and erythrocyte counts [6].

The fourth chapter is entitled "Discussion of the Research." It investigates the effects of feeding with the biologically active substance complex, as well as changes in the milk productivity of cows and milk quality, based on the growth and development of calves. Growth was studied on the basis of data on the growth of body parts and changes in live weight gain. Systematic measurements were carried out to study the growth of the animals investigated on the farm. Thus, it was possible to prevent excessive growth or growth retardation [7,12,15,19].

The indicators of live weight, absolute and daily weight gain, relative growth, and growth rate of the calves obtained from cows in the control and experimental groups are presented in Table 2.

Table 2

Growth dynamics

Indicators		Live weight, kg	Absolute gain, kg	Daily weight gain, g	Relative growth, %	Growth rate, %
Control group	**At birth**	34.79±1.40				
	At 1 month	56.07±3.11	21.28±1.32	700	61.16±4.02	46.84±1.33
	At 3 months	101.82±2.28	45.75±1.94	752	81.59±6.88	57.95±3.28
	At 6 months	184.05±4.02	82.23±3.40	901	80.76±7.72	57.53±3.76
	At 9 months	288.23±5.39	104.18±4.10	1142	56.60±4.20	44.17±3.50
	At 12 months	385.13±7.51	96.90±7.85	1062	30.15±5.60	26.20±3.76
Experimental group	**At birth**	37.29±1.16				
	At 1 month	59.40±2.24	22.11±1.97	727	59.29±9.87	45.74±6.72
	At 3 months	107.95±3.78	48.55±3.66	798	81.73±8.92	58.02±7.55
	At 6 months	196.42±7.90	88.47±3.81	970	81.95±3.97	58.13±2.63
	At 9 months	302.51±6.55	106.09±7.04	1163	54.01±12.99	42.52±7.44
	At 12 months	417.66±9.80	115.15±12.30	1262	38.06±10.38	31.98±8.38

The increase in the live weight of young animals was calculated using the biometric method, and the biometric indicators are reflected in Diagrams 4–6.

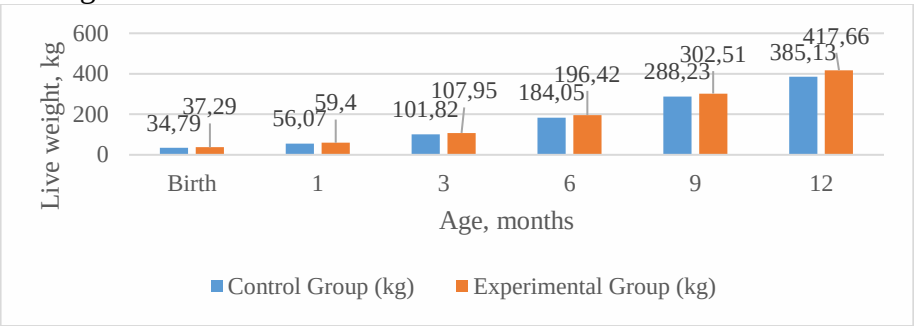


Diagram 4. Arithmetic mean values of live weight gain by month

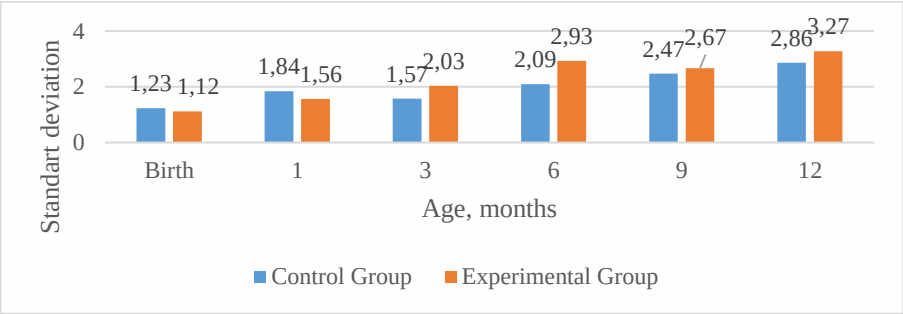


Diagram 5. Diagram of standard deviation according to live weight gain

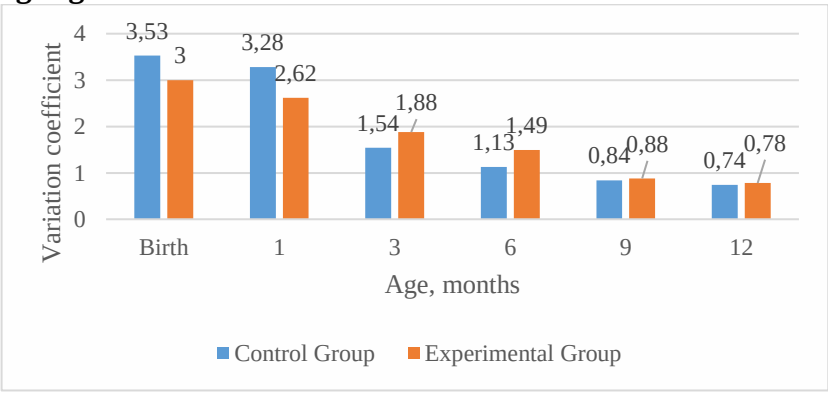


Diagram 6. Diagram of the coefficient of variation based on live weight gain

The analysis of the diagrams shows that, during the comparative evaluation of the calves obtained from both groups, the animals in the experimental group had higher indicators than those in the control group. It was determined that the addition of a biologically active substance to the diet improved productivity indicators by reducing the negative effects caused by heat stress in animals.

The milk productivity of the animals in the control and experimental groups was studied, and biometric analyses were performed. During the research, the milk productivity of the cows differed to some extent.

The milk productivity of the cows in the experimental group, whose diet contained a polyphenol-containing bioactive substance, was 2966.3 kg. This indicator was 312.60 kg (11.78%) higher than that of the animals in the control group (2653.7 kg) [17, 20] (Table 3).

Table 3

Milk productivity of cows (per head)

Indicators	Groups						Td
	I group – Control			II group – Experimental			
	X±m	σ	Cv	X±m	σ	Cv	
Average milk productivity, kg	2653.7±194	15.53	0.58	2966.3±210*	16.42	0.55	3.88
Milk fat content, %	3.72±0.02	0.58	15.6	3.95±0.02*	0.59	15.28	5.35
Protein content in milk, %	3.34±0.01	0.55	16.5	3.39±0.01	0.56	16.52	3.57
Amount of fat in milk, kg	98.69±3.20	2.99	3.03	117.15±2.42	3.22	2.81	3.99
Amount of protein in milk, kg	88.63±2.80	2.84	3.2	100.55±2.23	3.02	3	3.58
Total production, kg	31844.4			35595.6			
Amount of milk at standard fat content, kg	2742.15			3254.69			

P<0,05; **P<0,01

The chemical composition of milk from cows supplemented with the Flavo Vital bioactive compound complex was superior to that of the control group. Milk protein content was 13.45% higher, while milk fat content was 18.70% higher (P<0.05) in the experimental group.

The fifth chapter examines the assessment of milk quality through the application of innovative technologies, the effect of the feed additive on fat quality, and the effect of using the polyphenol-containing Flavo Vital biologically active substance complex on the efficiency of milk production [9,11,12,15]. An economic assessment

was carried out of the cost of milk production, total income obtained, and profitability indicators for the cows in the control and experimental groups. To calculate the economic efficiency of the research, costs for materials and technical resources, feed additives, labor, veterinary services, roughage and concentrated feed, and other expenses were determined. Based on market milk prices, net income was calculated by subtracting total costs from sales revenue.

The indicators of the economic efficiency of using the Flavo Vital biologically active substance complex showed that, on average, the total revenue obtained from milk production in the experimental group of cows (2929.22 manats) was 461.29 manats higher than in the control group (2467.93 manats). The profit (net income) obtained during the research was also 329.29 manats higher in the cows of the experimental group (1239.52 manats) compared with the control group (910.23 manats). Profitability in the experimental group was 42.31% (Table 4).

Table 4

Economic efficiency of milk production
(On average, per head)

Indicators	Group	
	Control	Experimental
Average milk production during the experimental period, kg	2653.7	2966.3
Milk fat content, %	3.72	3.95
Milk obtained by conversion to standard fat content, kg	2742.15	3254.69
Expenditure on milk production, manats	1557.70	1689.70
Production cost of 1 centner of milk, manats	58.7	56.96
Selling price of 1 centner of milk, manats	90.00	90.00
Revenue from milk sales, manats	2467.93	2929.22
Profit, manats	910.23	1239.52
Profitability, %	36.88	42.31

The research conducted showed that, during the summer months, when heat stress is observed, the inclusion of the Flavo Vital biologically active substance complex in the diets of lactating cows increases the economic efficiency of milk production.

GENERAL CONCLUSIONS

1. In order to enable animals to express the genetic potential of their breed under heat stress conditions on farms, to create conditions

for intensive rearing of young animals, and to ensure their adaptation, the addition of the Flavo Vital biologically active substance to the diet is considered appropriate.

2. The results of laboratory, scientific-farm, and production experiments showed that the correct selection of the categories and functional groups of B-group vitamins and active fermentative components makes their application more effective. This, in turn, improves the mineral-vitamin, energy, and nutritional value of the utilized feeds.

3. The composition of the Flavo Vital biologically active substance has a positive effect on improving the feeding of animals during hot periods. In the experimental group of newly calved animals, compared with the control group, the digestibility of dry matter was higher by 2.13%, organic matter by 2.58%, crude protein by 3.28%, crude fat by 3.52%, crude fiber by 1.26%, and nitrogen-free extractive substances (NFES) by 4.23%. In high-producing animals, these indicators were higher than in the control group by 2.85%, 3.06%, 2.93%, 3.19%, 2.86%, and 4.19%, respectively. In cows in the late dry period, the experimental group whose diet contained the Flavo Vital biologically active substance complex had higher digestibility of dry matter by 1.51%, organic matter by 3.94%, crude protein by 4.4%, crude fat by 0.98%, crude fiber by 2.06%, and nitrogen-free extractive substances (NFES) by 3.43%.

4. Experimental group animals at different physiological stages whose diets contained the biologically active substance complex showed higher mineral utilization and nitrogen balance than the control group animals. In newly calved cows, the experimental group used 25.78% of dietary nitrogen for retention in the body and milk production, whereas the control group used 22.09%. In the experimental group of newly calved animals, 22.76% of ingested nitrogen and 34.76% of digested nitrogen were used for milk production. In the control group, these indicators were 20.19% and 32.48%, respectively. Highly productive cows in the experimental group used 31.63% of dietary nitrogen for milk production and body retention, compared with 25.71% in the control group. In the highly productive experimental group, 25.18% of ingested nitrogen and

36.58% of digested nitrogen were used for milk production. In the control group of highly productive cows, these indicators were 20.75% and 31.34%, respectively.

5. In newly calved cows of the experimental group, 26.42% of the calcium consumed with feed was utilized for milk production and retention in the body, whereas this indicator was 24.56% in the control group. The calcium utilized by the experimental group animals for milk synthesis (21.90%) was higher than in the control group. In the control group, this figure was 2.23 % lower. In highly productive cows of the experimental group, 27.67% of the calcium consumed with feed was utilized for milk production and retention in the body. This indicator was 23.94% in the control group. The amount of calcium utilized for milk production in the experimental group was 4.23% higher compared with the control group.

6. The phosphorus balance in cows at different physiological stages was higher in the experimental group compared with the control group. In newly calved animals of the experimental group, phosphorus utilization for milk production was 0.89% higher than in the control group. In high-producing animals, the phosphorus utilization rate was 28.93% in the experimental group and 26.47% in the control group.

7. The addition of the biologically active substance complex to the diet had a positive effect on improving the growth and development indicators of the calves. Although the growth indicators of the calves of the experimental group cows were 1.1% lower than those of the control group at 1 month of age, they were higher by 0.1%, 0.6%, and 5.78% at 3, 6, and 12 months of age, respectively. In the calves of cows fed the biologically active substance complex, the bone index was recorded to be higher by 0.38%, 0.24%, and 0.15% during the respective periods, while the fullness index was higher by 2.12%, 0.51%, and 1.06%, respectively, compared with the control group.

8. It was determined that, during the summer months, the milk productivity of cows in the experimental group fed the Flavo Vital biologically active substance complex increased by 11.78%, milk protein by 13.45%, and milk fat by 18.70% compared with the control group. The size of the fat globules in the milk of cows in the experimental group was 8.38% higher than in the control group.

9. The addition of a certain amount of the Flavo Vital biologically active substance complex to the diet of cows improves the technological properties of milk and has a positive effect on cheese processing. Milk obtained from the experimental group animals is considered to be of higher quality for cheese processing.

10. In order to reduce heat stress and improve metabolism in dairy cows, the addition of the Flavo Vital biologically active substance complex to the diet resulted in a profit of 1239.52 manats, or a net income 329.29 manats higher than that of the control group. The profitability of milk production in the cows of the experimental group was 42.31%, which was 5.43% higher than in the control group cows.

RECOMMENDATIONS FOR PRODUCTION

1. In order to reduce the negative effects of heat stress during the summer months and to normalize metabolism in Holstein-Friesian cows raised in our country, the addition of 165 g of the Flavo Vital biologically active substance complex to the diet is recommended.

2. The inclusion of feed additives in the diet is recommended to ensure normal growth and development of calves, improve reproductive performance in cows, maintain body condition score (BCS), and increase milk yield and quality.

The main provisions of the dissertation are reflected in the following published articles:

1. M.M.Əliyev, K.Ə.Quliyeva – "Gövşəyən heyvanların adaptasiyasına təsir edən amillər" // Azərbaycan Milli Elmlər Akademiyası Gəncə bölməsi. Xəbərlər məcmuəsi. Gəncə:-2016,-s.25-29.

2. M.M.Əliyev, K.Ə.Quliyeva – "Gövşəyən heyvanların orqanizmlərinin daxili mühiti həyat fəaliyyətinin əsasıdır" // Azərbaycan Aqrar Elmi Azərbaycan Respublikası Kənd Təsərrüfatı Nazirliyinin elmi-nəzəri jurnalı. Bakı: -"Tərəqqi", 2016-cı il, s.71-73.

3. K.Ə.Quliyeva – "İntensiv yemləməyə keçmənin heyvan orqanizminin turşu-qələvi balansına təsiri" // Azərbaycan Respublikası Kənd təsərrüfatı Nazirliyi Aqrar Elm və informasiya məsləhət mərkəzi Kənd Təsərrüfatının İqtisadiyyatı Elmi-tədqiqat institutu "Azərbaycanda Torpaq İslahatı - 20: Nailiyyətlər və Perspektivlər" mövzusunda ümumrespublika elmi-praktiki konfransın materialları. Bakı: -2016, -s. 367-369.

4. M.M.Алиев, K.A.Кулиева – «Физиологические показатели у телят при адаптации к температуре 38^0C» - // Вестник российской сельскохозяйственной науки. Москва: -2017, -c. 51-54.

5. K.Ə.Quliyeva – “Boğaz inəklərin rasionunda yem əlavələrinin əhəmiyyəti” // ADAU-nun elmi əsərləri, Gəncə:-2018,-s. 76-78.

6. M.M.Əliyev, K.Ə.Quliyeva - “Yem əlavələrinin inəklərin qanının morfoloji və biokimyəvi göstəricilərinə təsiri” // Gəncə Dövlət Universiteti. Elmi Xəbərlər, Fundamental, humanitar və təbiət elmləri seriyası, Gəncə: -2018, -s. 38-41.

7. V.A.Mirzəyev, K.Ə.Quliyeva – “Bioloji aktiv maddə kompleksi ilə yemləmənin cavanların böyümə və inkişafına təsiri” // Azərbaycan Aqrar Elmi Azərbaycan Respublikası Kənd Təsərrüfatı Nazirliyinin elmi-nəzəri jurnalı. Bakı: -“Tərəqqi”, 2018, -s 76-79.

8. M.M.Алиев, K.A.Кулиева – «Переваримость питательных веществ комплексного рациона с биоактивными веществами» // «Вестник» АПК Ставрополья Научно-практический журнал. Ставрополь: -2018, -c. 57-59.

9. 15. K.Ə.Quliyeva – “Flavo vital bioloji aktiv maddə kompleksindən istifadənin inəklərin süd istehsalında iqtisadi səmərəliliyi” // Azərbaycan Respublikası Təhsil Nazirliyi, Gəncə Dövlət Universiteti. Müasir təbiət və iqtisad elmlərinin aktual problemləri. Beynəlxalq elmi konfrans. Gəncə: -2018, - s. 176-178.

10. 16. K.A.Кулиева – «Использование кальция и фосфора рациона при адаптации к тепловым стрессам» // Материалы конференции. Scientific Discoveries III Международная конференция Чехия, Карловы Вары-Россия, Москва: -2018, -c. 94-99.

11. K.Ə.Quliyeva – “Bioloji aktiv maddə ilə yemləmənin inək südünün texnoloji xassələrinə və yağın keyfiyyətinə təsiri” // ADAU-nun Elmi əsərləri, Gəncə: -2019, -s 67-70.

12. K.Ə.Quliyeva – “Bioloji aktiv maddə kompleksi ilə yemləndirmənin süd məhsuldarlığına və südün kimyəvi tərkibinə təsiri” // Azərbaycan Aqrar Elmi Azərbaycan Respublikası Kənd Təsərrüfatı Nazirliyinin elmi-nəzəri jurnalı. Bakı:- “Tərəqqi”, -2019, -s 109-112.

13. K.Ə.Quliyeva – "Havanın temperaturunun gövşəyən heyvanların orqanizminə təsiri" // Aqrar sahədə elmi araşdırmalar və heyvandarlıqda innovasiyalar. Heyvandarlıq Elmi-Tədqiqat İnstitutunun jurnalı. Göygöl: -2020, -s.204-207.

14. В.А.Мирзаев, К.А.Кулиева – «Показатели продуктивности гибридов черно-пестрой и голштинской пород крупного богатого скота и потенциал рождаемости» // Бюллетень науки и практики. Научный журнал. Нижневартовск: 2022, -с. 246-253.

15. В.А.Мирзаев, Г.Р.Мамедова, К.А.Кулиева – «Хозяйственные показатели продуктивности животных разных селекций по группам» // Бюллетень науки и практики. Научный журнал. Нижневартовск: -2023, -с. 199-205.

16. К.А.Кулиева – «Кормление коров по физиологическим группам» // Бюллетень науки и практики. Научный журнал. Нижневартовск: -2023, -с. 179-183.

17. V.A.Mirzəyev, G.K.Nəcəfova, K.Ə.Quliyeva – "Qruplar üzrə Holştin cinsli heyvanların ət və süd məhsuldarlığı" // Azərbaycan Texnologiya Universiteti, Elmi xəbərlər məcmuəsi. Gəncə: 2023, -s 26-31.

18. Г.К.Наджефова, К.А.Кулиева – «Использование кальция и фосфора в рационе коров при адаптации к тепловому стрессу» // Материалы конференции "World Scientific Reports". İntrnational scientific conference, Paris: -2023, -с. 5-9.

19. K.Ə.Quliyeva – "Yay aylarında yemləmənin qaramalın bədən kondisiyasına təsiri" // ATU, Ümummilli Lider H.Əliyevin 100 illiyinə həsr olunmuş "Dördüncü Sənaye İnqilabı və İnnovativ Texnologiyalar". Beynəlxalq Elmi-praktik konfransın materialları. Gəncə, 2023: -s. 187-190.

20. К.А.Кулиева – «Влияние комплекса биологически активных веществ в рационе на свертываемость молока при производстве сыров» // Инновации в сельском хозяйстве и экологии» Материалъ III Международной научно –практической конференции (15января 2025 года, г. Рязанъ: ФГБОУ ВО РГАТУ), -с. 91-94.

The defense will be held on "04" December 2026 at 10^{00} at the meeting of the BFD 4.01 One-Time Dissertation council under the Azerbaijan State Agrarian University.

Address: AZ 2000, Republic of Azerbaijan, Ganja city, Atatürk Avenue, 450.

Dissertation is accessible at the library of the Azerbaijan State Agrarian University.

Electronic version of the abstract is available on the official website of the Azerbaijan State Agrarian University.

Abstract was sent to the required addresses on "28" October 2026.

Signed for print: 20.10.2026
Paper format: (210×297) 1/4
Volume: 37338
Number of hard copies: 20