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SCIENTIFIC SUBSTANTIATION OF THE EFFECTIVE USE OF ORGANIC FEED ADDITIVES TO IMPROVE LAYING HEN PRODUCTIVITY

421.02 - ANIMAL FEEDING AND FEED TECHNOLOGY

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CONCEPTUAL FRAMEWORK OF THE RESEARCH

Relevance and Significance of the Issue. The rapid growth of the global population has created an urgent need to address one of the top priorities – ensuring the supply of high-quality and environmentally friendly food products, particularly those of animal origin, to people around the world [14, 19].

In the production of food, especially protein-rich products of animal origin that play a key role in the human diet, poultry farming serves as a driving force in the development of animal husbandry, both domestically and globally [1].

Moreover, in today's world, where concerns about environmental sustainability and food quality are growing, there is increasing interest in environmentally friendly methods of food production [13, 21].

In this context, the development and implementation of stimulants and technologies that not only increase poultry productivity and reduce rearing costs but also maintain high product quality and ensure consumer safety is becoming particularly relevant [26]. Such solutions are becoming increasingly in demand in modern poultry farming practices and can have a significant impact on the future development of the industry.

A key element in ensuring efficient poultry production is rational feeding, with particular attention given to the search for new feed resources that can meet the birds' needs for high-quality protein, vitamins, and other essential nutrients required for their normal growth and development [9, 10]. In this regard, there is an increasing need for in-depth research aimed at a comprehensive assessment of the effectiveness of using organic feed additives, such as feather meal and peat, in the feeding of poultry under industrial production conditions. A comprehensive approach will not only help determine their impact on productivity and bird health, but also reveal their potential for enhancing the sustainability and economic efficiency of the poultry industry.

The limited availability of traditional feed resources, along with deficiencies in vitamins and minerals in the diet, presents serious challenges for the modern poultry industry [16, 17]. In order to overcome these challenges and ensure high productivity and the health of poultry, increasing attention is being paid to the use of non-traditional feed components and specialized biologically active additives.

For many years, researchers such as Л. Хорошевская [35], Т. Егорова [18], Н. Тюбина [32], И. Плешакова [29], Р. Файзрахманов [33], Т. Околева [26], Н. Черноградская [36], М. Ибрагимов [19], and В. Федорова [34] have conducted studies focused on the effectiveness and impact of unconventional feeds and specialized additives on poultry productivity. Their work has contributed to the development of strategies and approaches that are most effective in improving production performance in the poultry industry.

However, despite the progress made in studying the efficiency of organic feed additives under industrial poultry farming conditions, many aspects of their effects on

the poultry organism remain insufficiently explored. This is particularly true with regard to the influence of specific additives on metabolic processes in the gastrointestinal tract, as well as their impact on growth performance and productivity of dual-purpose and egg-laying hens

The issues under consideration are of significant interest to the scientific community in the field of poultry farming, as understanding the mechanisms of action of organic feed additives may contribute to the development of new, more effective strategies for industry management. The aim of the present study was to experimentally justify the feasibility and safety of using organic feed additives under industrial poultry farming conditions. To achieve this goal, a comprehensive assessment was carried out to examine the effects of these additives on the physiological indicators of poultry, with the objective of determining optimal dosages and methods of application. The results obtained may make a valuable contribution to the improvement of poultry farming practices aimed at increasing productivity, resilience, and environmental sustainability of production.

The Goal of the Research: to scientifically substantiate the effectiveness of using organic feed additives in the diets of dual-purpose and egg-laying hens, and to develop practical recommendations for their application in order to optimize feeding, increase profitability, and reduce dependence on synthetic components in the context of poultry farming in the Republic of Moldova.

To achieve the goal, the following objectives were set:

- ✓ To analyze current scientific approaches and trends in the use of organic feed additives in the diets of chickens with different production orientations.
- ✓ To assess the impact of various types of organic additives (peat-based and feather-based) on productivity, physiological condition, and product quality in dual-purpose and egg-laying hens.
- ✓ To study the changes in morphological, physiological, and biochemical blood parameters of poultry when organic feed additives are included in their diet.
- ✓ To determine the optimal dosages and schemes for incorporating organic additives into feed, taking into account the physiological condition and productive orientation of the hens.
- ✓ To examine the digestibility and absorption of nutrients in feed by pullets and laying hens when organic feed additives are included in compound feed formulations.
- ✓ To develop scientifically grounded recommendations for the use of organic feed additives in poultry farms in the Republic of Moldova.
- ✓ To evaluate the ecological and sustainable aspects of using organic additives from the perspective of reducing anthropogenic impact and ensuring product safety.
- ✓ To conduct an economic assessment of the effectiveness of using organic feed additives compared to traditional feeding methods.

Scientific Hypothesis. The development and implementation of a scientifically grounded feeding strategy that ensures the optimal use of organic feed additives will

reduce the reliance on synthetic supplements, achieve a balanced relationship between productivity indicators, product quality, and technological process modernization, thereby improving profitability and environmental sustainability in poultry farming.

Synthesis of the research methodology and justification of the selected research methods. The research methodology is based on a comprehensive scientific approach that includes the analysis of current scientific and technical literature, a systematic formulation of the research problem, as well as a clear definition of the objectives, tasks, and structure of the experimental program. The study employed zootechnical, biochemical, and biometric methods traditionally used in poultry research.

Experimental data were processed using biometric analysis, which included one-way analysis of variance (ANOVA) followed by multiple comparisons of means using Tukey's Honestly Significant Difference (HSD) post-hoc test at a 95% confidence level.

All research activities were conducted in strict compliance with approved standards and specialized methodologies applicable to experimental work in agricultural sciences.

Scientific novelty and originality. For the first time in the Republic of Moldova, the use of organic feed additives based on peat and feathers has been scientifically substantiated in the diets of Adler Silver breed hens – dual-purpose and Hy-Line Brown W-36 crossbreed hens of the egg-laying hens production type. Optimal levels and application schemes of these organic additives were established, demonstrating a positive effect on productivity and the physiological-biochemical parameters of the birds. New data were obtained regarding the mechanisms of action of organic feed additives on metabolism, the morpho-physiological condition of the birds, and egg quality. A comprehensive assessment of the ecological and economic benefits of using organic additives compared to traditional synthetic agents was also carried out.

Theoretical Significance. The research results deepen the scientific understanding of the potential application of organic feed additives in the nutrition of farm poultry, reveal the mechanisms of their effects on productivity and physiological condition, and provide a foundation for further scientific developments in sustainable and environmentally safe poultry farming. The data obtained confirm the effectiveness of using organic feed additives as an eco-friendly alternative to synthetic agents, thereby expanding the theoretical basis for rational feeding of farm poultry.

Practical Significance of this thesis lies in the scientific justification and development of recommendations for poultry farms on the effective use of organic feed additives derived from feathers and peat in the diets of chickens with various production purposes. The proposed feeding strategies contribute to increased productivity and product quality, reduced feeding costs, and the elimination of synthetic additives. The research results confirm the feasibility of using organic additives to enhance productivity and flock health, improve the quality of egg and meat

products, and promote the economic and environmental sustainability of poultry production. These findings can be utilized by poultry farms, research institutions, and agricultural educational organizations in the Republic of Moldova in developing programs for rational and sustainable feeding.

Approval of Research Results. The materials of the thesis were presented and discussed at the following International and National Scientific-Practical Conferences: 5th International Congress on Engineering and Life Science, (Pitesti, Romania, 2024); International Scientific and Practical Conference "Science, Education, Culture" (CSU, Comrat, Moldova, 2025, 2024, 2023, 2022, 2021); X National Scientific and Practical Conference "Problems and Challenges of Regional Economy in the Conditions of Globalization" (CSU, Comrat, Moldova, 2024); 4th International Congress on Engineering and Life Science, (Comrat, Moldova, 2023); 4th International Conference on Food, Agriculture and Animal Sciences, ICOFAAS 2023, (Sivas, Turkey, 2023, online); International Scientific Symposium: Modern Trends in the Agricultural Higher Education, (UTM, Chisinau, Moldova, 2023); Conferinţa Tehnico-ştiinţifică a studenţilor, masteranzilor și doctoranzilor (UTM, Chișinău, Moldova, 2023); 5th International Agriculture Congress, UTAK 2022, (Turkey, 2022, online); 31st International Conference on «Chemical, Agriculture, Biological and Environmental Sciences, (ICBEN-22)», (Istanbul, Turkey, 2022); Scientific Symposium «Innovations in animal husbandry and safety of animal products – achievements and outlooks», (SP IBZVM, Chișinău, Moldova, 2021); London International Conference, London, United Kingdom, (UKEY, 2021, online); International Research and Practice Conference «Innovations in Ensuring Quality and Safety of the Livestock Products», (Mykolayiv, Ukraine, 2021); 4th International Agriculture Congress, (UTAK 2021, Online, 2021); 3rd International Agriculture Congress (Tunis, Online, 2020,); 2nd International Agriculture Congress (Ayas, Ankara, Turkey, 2019).

Publications on the subject of the Thesis: The main materials of the thesis have been published in 32 Scientific Papers, including: 1 article in Journals from Web of Science and SCOPUS databases, 5 publication in Recognized International Journals, 1 article in a Journal included in the National Register, category B, 4 papers in proceedings of International Scientific Conferences abroad, 7 papers in proceedings of National Scientific Conferences, 9 abstracts at International Scientific Conferences abroad, 4 abstracts at International Scientific Conferences in the Republic of Moldova, 1 recommendation for production.

The structure and volume of the Thesis: The thesis consists of 150 pages of the main text and includes the following: Contents, Introduction, 4 Chapters, Conclusions, Recommendations for Production, and Bibliography. It contains 39 tables and 42 figures, along with 9 appendixes. The bibliography comprises 219 sources.

Key words: Adler Silver; Hy-Line Brown W-36; Laying hens; Organic feed additives; Poultry farming; Productivity

THESIS CONTENT

1. INNOVATIVE APPROACHES TO LAYING HEN FEEDING USING ORGANIC FEED ADDITIVES

This chapter presents a comprehensive overview of the technological aspects of feeding agricultural poultry. Special attention is given to the importance of organic feed additives as sources of essential nutrients in poultry diets, including the use of feather and peat-based supplements. It is emphasized that modern feeding methods should incorporate organic additives that not only enhance productivity and strengthen bird health but also contribute to the development of more environmentally sustainable feeding systems. This opens new prospects for improving the biological value of diets and increasing the economic efficiency of poultry farming.

2. MATERIAL AND METHODS

2.1. Research Material

The research presented in this thesis was conducted from 2019 to 2024 at the poultry farm SRL “Piliççik-Grup” in the city of Comrat, Comrat district, at the poultry factory SRL “Acustic Tehnologie” in the village of Floreni, as well as in the Department of “Livestock Resources and Food Safety” at the Technical University of Moldova.

The experimental part of the work was carried out in the laboratory of the Department of Livestock Resources and Food Safety within and with the support of the international project “Innovative strategies for improving the biological effectiveness of some unused and environmentally polluting wastes and developing them as poultry alternative feed and additives” (project No. 21.80013.8007.3B), funded by the National Agency for Research and Development (ANCD, Moldova) and the Scientific Council of TUBITAK (Turkey).

To achieve the research goals and objectives, three scientific and production experiments, three physiological trials, and three production-scale validations of the research results were conducted, accompanied by a series of laboratory analyses.

The research material consisted of organic feed additives obtained through the enzymatic processing of feathers and treated peat. For the first time in the Republic of Moldova, these additives were included in compound feeds designed for poultry of meat-and-egg and egg-laying productivity directions.

In the conducted studies, the objects of the scientific and production trials were young stock and meat-and-egg type Adler Silver hens, as well as the Hy-Line Brown W-36 laying hens cross.

Scheme of Scientific and Production Experiment I – to study the effect of feed additives from peat and feathers on the growth and development of Adler Silver breed poultry.

Within the conducted experiment, the method of selecting analogous groups was used, which allowed the formation of three groups of birds (Table 2.1). One group served as the control, receiving the main compound feed used at the poultry farm. The first experimental group (EG1) was supplemented with an organic feed additive from peat at a dose of 1 kg per ton of feed, while the second experimental group (EG2) received an organic feed additive from feathers at a dose of 2 kg per ton of feed.

Table 2.1. Scheme of the First Scientific and Production Experiment

Group	Number of heads	Feeding characteristics
Control (CG)	28000	Basic compound feed (BCF)
Experimental 1 (EG1)	28000	BCF with inclusion of OFAP* 1 kg/ton
Experimental 2 (EG2)	28000	BCF with inclusion of OFAF** 2.0 kg/ton

* *- OFAP- organic feed additive from peat*
** *- OFAF - organic feed additive from feather*

The design of Scientific and Economic Experiment I, conducted on Adler Silver chickens, was carried out in two experimental periods. The first period (from March 6 to April 20, 2019) lasted 35 days and was conducted at the SRL "Piliççik-Grup" poultry farm in the city of Comrat. Each group included 28,000 chickens. The second experimental period lasted from the 35th to the 180th day of the chickens' life, after which 60 chickens were selected from each group to initiate the second stage of the experiment. The choice of the Adler Silver chicken breed was based on its high adaptability to the climatic conditions of southern Moldova and its promising potential for successful breeding.

Scheme of Scientific and Production Experiment II – to determine the effect of organic feed additive from peat on the growth rate, development, and productivity of Hy-Line Brown W-36 laying hens under caged housing conditions. The research was conducted from November 1, 2022, to July 1, 2023, on Hy-Line Brown W-36 laying hens at SRL "Acustic Tehnologie".

Table 2.2. Scheme of the Second Scientific and Production Experiment

Group	Number of heads	Feeding characteristics
Control (CG)	96	Basic compound feed (BCF)
Experimental 1 (EG1)	96	BCF with inclusion of OFAP* 0.5 kg/ton
Experimental 2 (EG2)	96	BCF with inclusion of OFAP* 0.75 kg/ton
Experimental 3 (EG3)	96	BCF with inclusion of OFAP* 1.0 kg/ton
Experimental 4 (EG4)	96	BCF with inclusion of OFAP* 1.75 kg/ton

* *- OFAP- organic feed additive from peat*

Five groups of chickens were formed, each consisting of 96 hens: one control group and four experimental groups (table 2.2). The chickens in the control group received a standard compound feed without any additives. In the experimental groups, different levels of the organic feed additive from peat: 0.5 kg/ton in EG1, 0.75 kg/ton in EG2, 1.0 kg/ton in EG3, and 1.25 kg/ton in EG4.

Scheme of Scientific and Production Experiment III – aimed at determining the effect of the organic feed additive from feather on the growth, development, and productivity of Hy-Line Brown W-36 laying hens. The trial was conducted on five groups of laying hens, each consisting of 96 chickens kept in cages. The control group received the standard compound feed (CF) without any additives, while the experimental groups were fed compound feed supplemented with the organic feed additive from feather (OFAF) at different dosages: EG1 – 2.0 kg per ton of feed, EG2 – 2.5 kg, EG3 – 3.0 kg, and EG4 – 3.5 kg (table 2.3).

Table 2.3. Scheme of the Third Scientific and Production Experiment

Group	Number of heads	Feeding characteristics
Control (CG)	96	Basic compound feed (BCF)
Experimental 1 (EG1)	96	BCF with inclusion of OFAF* 2.0 kg/ton
Experimental 2 (EG2)	96	BCF with inclusion of OFAF* 2.5 kg/ton
Experimental 3 (EG3)	96	BCF with inclusion of OFAF* 3.0 kg/ton
Experimental 4 (EG4)	96	BCF with inclusion of OFAF* 3.5 kg/ton

* *- OFAF - organic feed additive from feather*

During Scientific and Production Experiment II and III, the chickens were housed in Big Dutchman battery cages throughout the entire experimental period. The microclimate parameters in the facilities were maintained in accordance with the recommended guidelines for the Hy-Line Brown W-36 cross.

2.2. Research methods

During the research examined: chemical composition of feed and feed additives, quality indicators of compound feed – according to generally accepted methods of zootechnical analysis [6]; the dynamics of growth, total and average daily weight gains of the chickens (measured through individual weighing at the beginning and end of each month); morphological and biochemical blood parameters (blood samples were collected for biochemical tests in the morning before feeding from the brachial vein of 3 analogous chickens from each group, at the same time at the beginning of the experiment, at the 17^{th} week (midpoint of the experiment), and at the end of the experiment) [12]; biochemical and morphological blood analyses were conducted at the Republican Diagnostic Center in Chisinau; egg production [23]; The amino acid composition of the eggs was determined at the mid-laying period of the hens (the analysis was carried out in the laboratory of the Institute of Chemistry of the State University of Moldova); the slaughter and meat quality characteristics of the hens were evaluated [24, 11]; the economic efficiency of the experiments was assessed. [37, 27].

Statistical data analysis was carried out using the biometric method of variational statistics, with the reliability of the results determined by Student's t-test ($^{*}p\leq0,95$; $^{**}p\leq0,99$; $^{***}p\leq0,999$) [30]. Additionally, one-way analysis of variance (ANOVA) was applied, with differences between group means assessed using Tukey's HSD post-hoc test, grouped according to the Tukey method at a 95% confidence level. All calculations were performed using Minitab 17 software [8]. Graph construction and additional data processing were carried out using Microsoft Excel 2016, part of the Microsoft Office 2016 suite.

3. EFFECTIVENESS OF USING ORGANIC FEED ADDITIVES FROM PEAT AND FEATHER IN THE DIET OF DUAL-PURPOSE LAYING HENS OF THE ADLER SILVER BREED

3.1. Effectiveness of Using Organic Feed Additives from Peat and Feather in Poultry Feeding

The inclusion of feed additives in the daily diet remains an important topic in poultry farming, as rational feeding directly affects the growth, development, and productivity of chickens. In recent years, there has been growing interest in developing more efficient feeding strategies that ensure maximum productivity with minimal costs, which is particularly important for increasing production profitability.

Chemical composition and properties of the organic feed additive from peat. Peat in its natural state is a homogeneous dark-colored mass with a moisture content of 85-95% and up to 50% mineral content in the dry matter. It serves as a natural source of macro- and microelements (Fe, Mg, Ca, K, Zn, and others) [25]. It has been established that the high content of macro- and microelements contributes to the normalization of mineral metabolism, proper growth and development of poultry, and improvement of their reproductive functions [7].

Chemical composition and properties of the organic feed additive from feather.

Feather meal is a high-protein feed product (80-90% protein), enriched with essential amino acids (cystine, glycine, proline) that participate in metabolic processes and help maintain the overall physiological condition of animals [28]. Due to its high biological value, feather meal promotes the growth and development of farm animals and is widely used in modern feeding technologies [4, 15, 22].

3.2. The effect of using organic feed additives on the productive qualities and metabolism of young chickens of the Adler Silver breed

Feeding and housing conditions of the Adler Silver experimental chicks. The young chickens were fed with compound feed according to the recommended feeding standards for poultry [20]. The diet consisted of compound feed: the control group received the basic standard ration; the first experimental group received the basic ration supplemented with 1 kg/ton of organic feed additive from peat; the second experimental group received the basic ration supplemented with 2 kg/ton of organic feed additive from feather. The hens were raised on a floor-based housing system.

Dynamics of live weight in Adler Silver chickens and feed consumption. With the same initial live weight of the chicks at the beginning of the experiment, it was found that the inclusion of the organic feed additive from peat in the compound feed led to a clear trend of increased live weight in the experimental groups. However, the highest live weight was recorded in the second experimental group (553.3 g), where the chickens' weight exceeded the control group by 79.9 g or 16.88%. Compared to the first experimental group, the live weight in the second group was higher by 49.7 g or 9.87%.

The obtained results indicate that the use of the organic feed additive from feather has a positive effect on the growth dynamics and development of the chicks.

Average daily weight gains of chicks during the experiment. During the 1–28-day period, the average daily weight gains of chicks in the first experimental group were 7.84% higher than those in the control group, and in the second experimental group, they were 36.63% higher. During the 29–35-day period, this indicator was 14.87% higher in the first experimental group and 36.70% higher in the second group compared to the control (Fig. 3.1). Over the entire 35-day rearing period, the average daily body weight gain in the control group was 12.87 g, while chicks fed compound feed with the organic feed additive from peat showed gains of 13.76 g, and those receiving the organic feed additive from feather had gains of 15.21 g. The inclusion of the organic feed additive from feather in the compound feed resulted in average daily gains that were 6.96% higher than the control and 10.55% higher than the first experimental group.

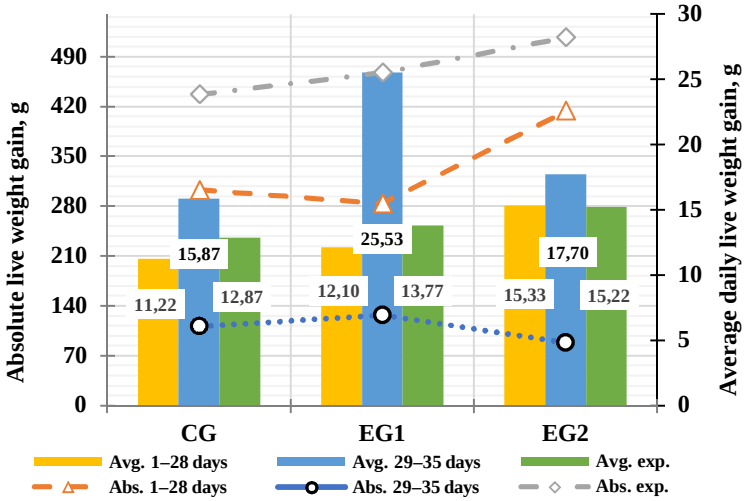

Fig. 3.1. Absolute and average daily live weight gain of chicks, g

Digestibility and assimilation of nutrients when using organic feed additives from peat and feather in poultry feeding. It was found that the inclusion of organic feed additives improved crude protein digestibility: in Experimental Group 1 (EG1) – 87.26% (the highest value), and in Experimental Group 2 (EG2) – 86.03% (table 3.1).

Table 3.1. Nutrient digestibility coefficients of the diets in the experimental chicks, %

Group	Dry matter	Organic matter	Crude protein
CG	71.23±0.35 b	74.25±0.31 b	85.24±0,32 b
EG1	72.34±0.42 ab	76.10±0.37 a	87.26±0,34 a
EG2	73.08±0.32 b	76.45±0.46 a	86.03±0,41 ab
Mean	72.22±0.25	75.60±0.28	86.18±0,25
ANOVA			
F_{group}	***6.41*** **	***9.50*** **	***8.18*** **

Group	Crude fat	Crude fiber
CG	94.44 ±0.45 b	18.40±0.11 b
EG1	96.09 ±0.43 a	19.17±0.10 a
EG2	95.18 ±0.49 ab	19.52±0.22 a
Mean	95.24 ±0.28	19.03±0.12
ANOVA		
F_{group}	***3.25*** *	***14.24*** ***

*The effects were determined using one-way analysis of variance (ANOVA). Differences between means were assessed using Tukey's post hoc test (HSD). Values are expressed as mean ± standard deviation (n = 10). Means marked with different letters indicate statistically significant differences. Significance levels: *: p ≤ 0.1, **: p ≤ 0.01, *: p ≤ 0.001.*

In EG1, the digestibility coefficient of crude fat was also the highest – 96.09%, compared to 94.44% in the Control Group (CG) and 95.18% in EG2. The inclusion of the organic feed additive from peat at 1 kg/ton and the organic feed additive from feather at 2 kg/ton in the basal diet contributed to an increase in the digestibility of dry matter by 1.85% in EG1 and 2.20% in EG2, crude protein by 0.79–2.02%, crude fiber by 0.77-1.11%, and crude fat by 1.65–0.74%.

Morphological and biochemical blood parameters of the experimental chicks. The morphological blood parameters of the young chickens at the end of the experiment showed variations depending on the housing conditions and diet. The hemoglobin level was higher in EG1 (97.75 g/l), indicating more active erythropoiesis. The highest red blood cell count was observed in EG2 (2.880×10^{12}/l), suggesting better oxygen exchange. The platelet count was higher in the control group (3.251×10^{9}/l), which may indicate increased blood clotting activity. Hematocrit was highest in EG2 (36.60%), which could indicate more efficient oxygen transport. The white blood cell count ranged from 27.88 $\times10^{9}$/l (EG1) to 32.89××10^{9}/l (control group), indicating more active immune processes in the control group.

Total blood protein in the chicks varied depending on the group, with the highest level observed in EG2 (46.75 g/l) ($F_{group}=3.32^{*}$) (Fig.3.2). Albumins showed the highest concentration in EG1 (20.44 g/l), which was also confirmed by a significant difference between groups ($F_{group}=28.13^{***}$), while the globulin level, which includes antibodies and other important proteins, was higher in the control group (28.65 g/l) compared to the other groups, reflecting a more pronounced immune system activity in this group. Globulins were highest in the control group (3.13 g/l) and lowest in EG1 (2.80 g/l). Levels of α-, β-, and γ-globulins also varied, with β -globulins being highest in EG1 (18.33 g/l) and lowest in the control group (15.40 g/l).

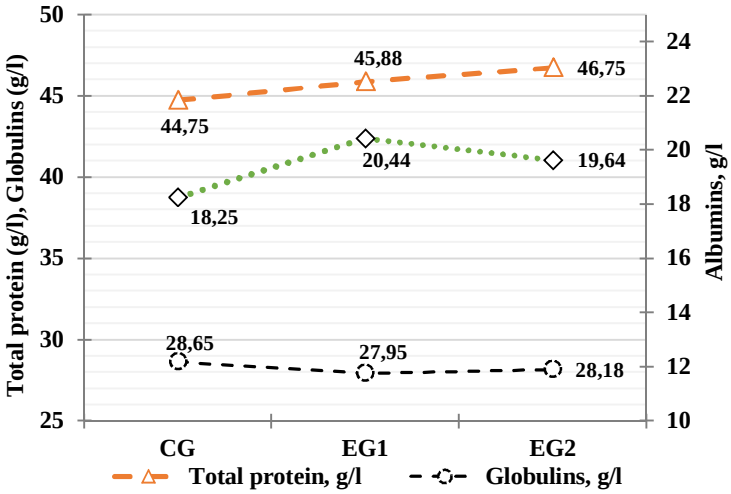

Fig. 3.2. Total Protein Content in the Blood of Hens at the end of the Experiment

Enzyme activity: AST levels were highest in EG2 (248.50 u/l) and lowest in EG1 (194.25 u/l), reflecting differences in liver metabolic processes. Alkaline phosphatase was highest in the control group (28.83 u/l), indicating more active bone metabolism or increased liver activity in this group.

The calcium and phosphorus content in the blood serum of the experimental groups exceeded that of the control group. In particular, the phosphorus level was higher by 34.6% in EG1 and by 45.9% in EG2, while the calcium level was higher by 10.2% in EG1 and by 4.6% in EG2, respectively.

Meat productivity, chemical composition, and organoleptic evaluation of chicken meat quality. The results of anatomical slaughter and data on bird carcass yield indicated that the dressed carcass weight in the experimental groups was higher than in the control group. In the first experimental group (EG1), the dressed carcass weight was 1446 g, and in the second experimental group (EG2) it was 1489 g, which was significantly higher than in the control group by 2.4% ($p<0.95$) and 5.20% ($p<0.95$), respectively (Fig. 3.3). In the experiment, the breast muscle weight in the first and second experimental groups was higher by 4.9% and 10.2%, respectively, compared to the control group (Fig. 3.4).

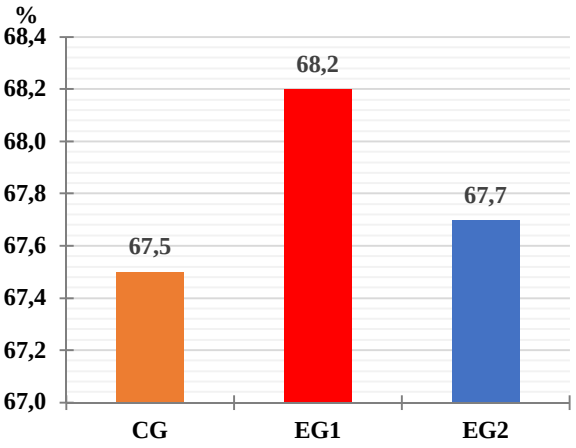

Fig. 3.3. Slaughter Yield, %

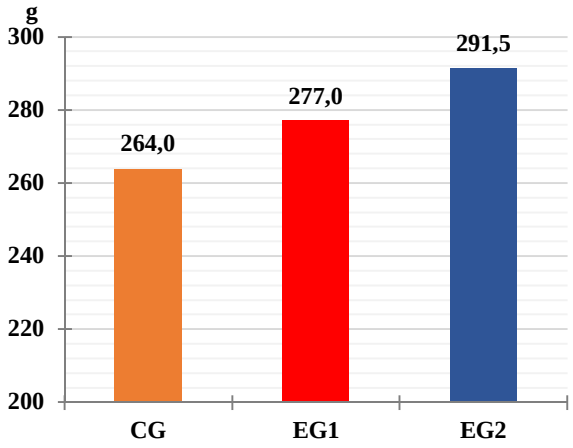

Fig. 3.4. Breast Muscle Mass, g

The yield of breast muscles relative to the dressed carcass weight was 19.2% in the first experimental group (EG1), 19.6% in the second experimental group (EG2), and 18.7% in the control group [5]. According to the slaughter yield data, the control group lagged behind the experimental groups by 0.7% and 0.2%.

Table 3.2. Sensory evaluation of meat and broth quality

Meat (5-point scale)					
Group	**Appearance**	**Aroma (Smell)**	**Taste**	**Hardness, (tenderness)**	**Juiciness**
CG	4.199 ±0.058b	4.105 ±0.050 b	4.104 ±0.052 b	3.703 ±0.064 b	3.596 ±0.072 c
EG1	4.203 ±0.048b	4.098 ±0.052 b	4.202 ±0.052 b	3.799 ±0.078 b	3.903 ±0.069 b
EG2	4.695 ±0.043a	4.397 ±0.049 a	4.702 ±0.051 a	4.400 ±0.083 a	4.201 ±0.065 a
Mean	4.366 ±0.052	4.200 ±0.038	4.336 ±0.057	3.967 ±0.071	3.900 ±0.060
ANOVA					
F_{group}	32.12^{***}	11.46^{***}	38.60^{***}	25.10^{***}	19.35^{***}
Broth (5-point scale)					
Group	**Color, Clarity**	**Aroma (Smell)**	**Taste**	**Richness**	**Strength**
CG	2.801 ±0.062b	3.904 ±0.058b	4.097 ±0.072 b	3.903 ±0.058 b	3.799 ±0.061b
EG1	3.004 ±0.057b	3.903 ±0.059b	4.198 ±0.065 ab	3.996 ±0.055 b	3.805 ±0.050b
EG2	3.601 ±0.071a	4.501 ±0.050a	4.402 ±0.062 a	4.797 ±0.060 a	4.500 ±0.048a
Mean	3.135 ±0.072	4.103 ±0.061	4.232 ±0.044	4.232 ±0.081	4.035 ±0.068
ANOVA					
F_{group}	42.92^{***}	38.13^{***}	5.50^{**}	72.98^{***}	57.73^{***}

*The effects were determined using one-way analysis of variance (ANOVA). Differences between means were assessed using Tukey's post hoc test (HSD). Values are expressed as mean ± standard deviation (n = 10). Means marked with different letters indicate statistically significant differences. Significance levels: *: p ≤ 0.1, **: p ≤ 0.01, *: p ≤ 0.001.*

Analyzing the chemical composition of the breast muscles of laying hens, it can be concluded that the meat from the experimental groups contained a higher protein level compared to the control group. The fat content in the breast meat of the experimental groups was lower than in the control group by 0.79 g in EG1 and 0.60 g in EG2, respectively.

The sensory evaluation showed that the meat from EG1 and EG2 received average scores of 4.04 and 4.48 points, respectively, which were higher than the control group's score of 3.94 points, with differences of 0.10 and 0.54 points, or 2.5% and 13.7% compared to the control (Table 3.2).

Egg production of Adler Silver laying hens and egg quality parameters. Monthly data clearly show higher egg-laying intensity in the experimental groups OG1 and OG2: 65.8% and 67.74% in August, 72.33% and 73.66% in September, and 69.03% and 70.66% in October, respectively. The decline in laying intensity in October is associated with the physiological condition of the chickens; nevertheless, the average monthly laying rates exceeded the control group by 1.61%, 1.00%, and 0.657% in OG1, and by 3.55%, 2.33%, and 2.22% in OG2. This indicates more efficient use of resources and improved production processes in OG2. Feed costs and other direct expenses were also lower, resulting in higher profit and profitability in OG2, which reached 77.7%.

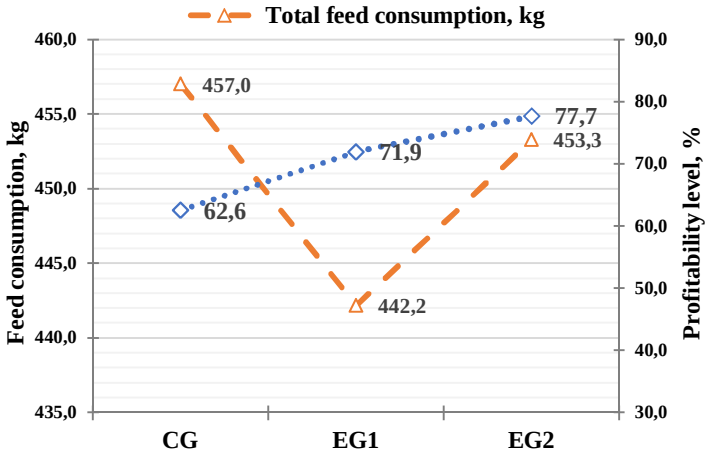

Fig. 3.5. Economic efficiency of using organic feed additives

Economic efficiency of using organic feed additives on the productive qualities and metabolism of young chickens of the Adler Silver breed. The inclusion of the organic feed additive from peat in the diet of laying hens has a positive effect on their health and productivity, reflected in high survival rates, improved production outcomes, and overall profitability of egg production (Fig. 3.5). Based on the above, it can be concluded that there is an inverse relationship between feed consumption and profitability: the lower the feed consumption, the higher the level of profitability. This highlights the importance of optimizing animal nutrition processes to achieve greater profit in agriculture.

4. EFFECTIVENESS OF USING ORGANIC FEED ADDITIVES IN THE DIET OF HY-LINE BROWN W-36 LAYING HENS

4.1. Effect of an Organic Peat-Based Feed Additive on the Productivity of Hy-Line Brown W-36 Laying Hens

Feeding and housing conditions of laying hens. The composition of the compound feed for hens, prepared by the company SRL "Acustic Tehnologie," was

well-balanced, predominantly consisting of cereals such as corn and wheat. Analysis of the nutritional properties of the compound feed for Hy-Line Brown W-36 pullets showed that the feed in the experimental groups had a high energy value, which contributed to better growth of the young chickens.

Dynamics of live weight and survivability of young hens. Live weight plays a significant role in the breeding process of poultry and is an important indicator of reproductive capacity before reaching sexual maturity. During the experiment, it was observed that the live weight of laying hens increased with the duration of the rearing period (Fig. 4.1). The use of the organic feed additive from peat contributed to improved viability of the laying hens and, consequently, their survivability. Overall, throughout the study period, the survivability of hens in all experimental groups (EG1-EG4) exceeded that of the control group by 2.10%, 4.20%, 4.20%, and 3.10%, respectively.

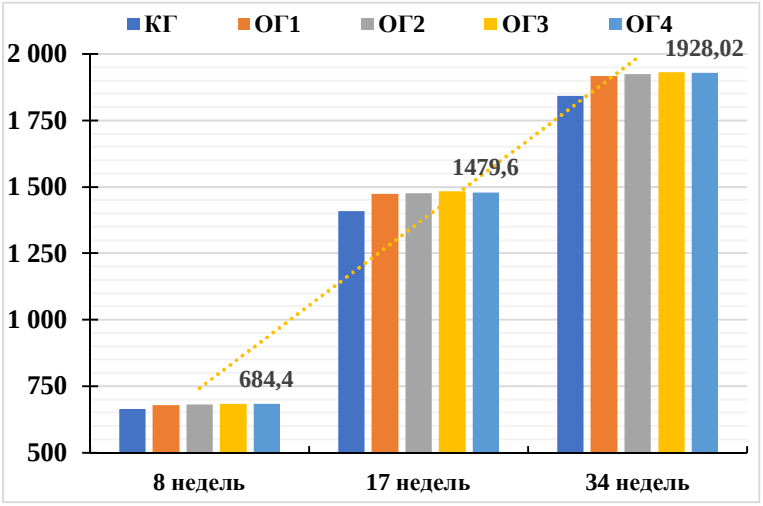

Fig. 4.1. Dynamics of live weight of Hy-Line laying hens with the use of a peat feed additive, g

Digestibility and nutrient absorption when feeding laying hens with a peat-based feed additive. The digestibility coefficient of dry matter in the control group (CG) was 69.70%, the lowest value among all experimental groups. In the experimental groups, this figure reached 71.87% in EG3, indicating more efficient feed utilization. Organic matter digestibility was lower in the CG (70.40%) compared to 73.30% in EG3, reflecting better absorption of organic components in the diet due to the additive in this group. Crude protein digestibility showed some stability (ranging from 83% to 85%), but was lower in the CG at 79.30%, increasing to 83.55% in EG3, confirming improved protein metabolism efficiency. Fiber digestibility increased from 18.50% (CG) to 19.49% (EG3), and crude fat digestibility rose from 80.60% to 83.45%, respectively. Thus, inclusion of the organic peat-based feed additive in the diet of laying hens promotes improved digestibility of dry and organic matter, crude protein, fat, and fiber.

Morphological and Biochemical Blood Parameters. For an objective assessment of feeding efficiency, it is necessary to consider not only general zootechnical parameters but also specific biochemical and morphological indicators. Morphological blood studies showed that at 17 weeks of age, the levels of hemoglobin (Fig. 4.2) and erythrocytes in laying hens were higher than those in hens at 34 weeks of age. This is

explained by more intensive metabolic processes in younger hens. The leukocyte count in the blood of 17-week-old hens was lower than that in 34-week-old hens, which may be due to the higher resistance of the younger 17-week-old hens.

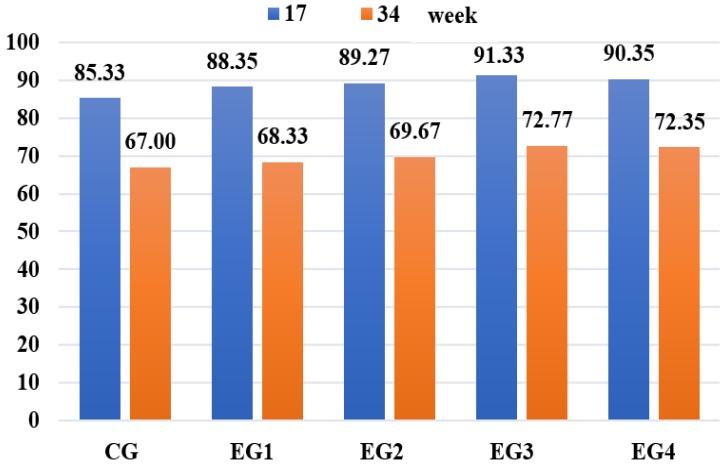

Fig. 4.2. Hemoglobin content in the blood of Hy-Line W-36 laying hens at the beginning of egg production and at the end of the experiment, g/l

Serum studies of laying hens revealed the dynamics of total protein levels and its fractions in control and experimental groups at the beginning and at the peak of egg production. The albumin level in the serum of hens in the third experimental group significantly exceeded the corresponding values in the control group. At 17 weeks of age, the difference was 2.67 g/l or 15.7%, increasing to 4.80 g/l or 27.66% at 34 weeks.

Morphological composition of eggs from laying hens. It was established that the egg weight of laying hens depends on a combination of factors, including the live body weight of the chickens.

Table 4.1. Morphological indicators of eggs at 34 weeks of age of laying hens

Group	Average Albumen Diameter, cm	Albumen Height, mm	Albumen Index, %	Average Yolk Diameter, cm
CG	7.50±0.05 d	7.10±0.07 e	9.47±0.02 d	3.90±0.08 c
EG1	7.71±0.05 c	7.40±0.05 d	9.60±0.02 cd	4.20±0.06 a
EG2	7.80±0.04 b	7.50±0.02 c	9.62±0.01 c	4.08±0.05 bc
EG3	7.90±0.04 a	7.70±0.04 a	9.75±0.02 a	4.10±0.03 ab
EG4	7.80±0.05 b	7.60±0.04 b	9.72±0.02 ab	4.09±0.03 b
Mean	7.74±0.03	7.46±0.04	9.64±0.02	4.07±0.03
ANOVA				
F_{group}	***10.52******	***22.91******	***38.22******	***4.51*****
Group	**Yolk height, mm**	**Yolk index, %**	**Shell thickness, mm**	**Haugh units**
CG	14.50±0.21 d	37.18±0.05 d	0.34±0.01e	74.22±0.06 d
EG1	16.90±0.33 c	40.24±0.09 c	0.35±0.01d	75.14±0.08 c
EG2	17.10±0.40 b	41.91±0.09 b	0.36±0.01c	75.17±0.08 b
EG3	17.26±0.34 a	42.10±0.09 a	0.38±0.01a	75.48±0.09 a
EG4	17.14±0.35 ab	41.90±0.08 b	0.37±0.01b	75.26±0.09 ab
Mean	16.58±0.21	40.66±0.27	0.36±0.01	75.05±0.07
ANOVA				
F_{group}	***12.49******	***635.03******	***2.23****	***35.39******

*The effects were determined using one-way analysis of variance (ANOVA). Differences between means were assessed using Tukey's post hoc test (HSD). Values are expressed as mean ± standard deviation (n = 10). Means marked with different letters indicate statistically significant differences. Significance levels: *: p ≤ 0.1, **: p ≤ 0.01, *: p ≤ 0.001.*

Hens in the third experimental group, which had the highest live body weight, laid eggs with a greater average weight compared to the other experimental groups (Table 4.1). Thus, the egg mass in hens of Experimental Group 3 exceeded that of Group 4 by 0.24 g (0.38%), Group 2 by 0.33 g (0.53%), and Group 1 by 0.17 g (0.27%). The obtained results suggest a correlation between the live weight of hens and the mass of the eggs they produce, with the most likely cause of this relationship being physiological characteristics rather than genetic factors.

An analysis of the chemical composition of the eggs revealed that the protein content in the eggs of the experimental groups significantly exceeded that of the control group by 0.79 g (EG1), 0.73 g (EG2), 0.77 g (EG3), and 0.66 g (EG4), indicating a beneficial effect of the peat-based feed additive on the quality characteristics of the eggs.

Egg Production and Quality in Laying Hens. The experimental use of a peat-based feed additive in the diet of laying hens was accompanied by a significant increase in egg production throughout the entire production cycle. The age at which peak egg production was achieved in all groups ranged between 30 and 34 weeks, which corresponds to the productivity standards for this cross. However, the intensity of egg production varied significantly between groups. The highest egg production rates were recorded in the second and third experimental groups, reaching 88.00% and 88.25%, respectively, which exceeded the control group by 1.65-1.96% [2]. A particularly pronounced effect was observed at the dosage of 1.0 kg of peat-based feed additive per ton of compound feed (EG3), confirming the optimality of this dosage for stimulating egg production. The results of the sensory evaluation indicate a positive effect of including the peat-based feed additive in the diet of laying hens on the taste characteristics of the eggs. The most noticeable improvement in quality was observed with the use of the additive at a dosage of 1.0 kg/ton of compound feed, as confirmed by the high sensory evaluation scores obtained in the third experimental group.

Economic Efficiency of Using Peat-Based Additives in Compound Feeds for Hy-Line Brown W-36 Laying Hens. The inclusion of a peat-based feed additive in the diet of Hy-Line Brown W-36 laying hens resulted in a noticeable economic benefit: profit increases in the experimental groups ranged from 300.2 to 620 lei. Despite higher feed costs in EG4, the highest economic efficiency was observed in EG3: profit amounted to 3,178.6 lei, and profitability reached 17.8%. Meanwhile, in EG4, despite high productivity, profitability was the lowest at 9.9%. Thus, the addition of the organic peat-based additive to compound feed contributes to increased productivity, improved egg quality, and enhanced economic efficiency, with the optimal dosage being 1 kg per ton.

4.2. The Effect of Feather Meal as an Organic Feed Additive on the Productivity of Hy-Line Brown W-36 Laying Hens

Feeding and Housing Conditions of Laying Hens. The laying hens were fed a balanced compound feed that met the requirements for nutrients, vitamins, and

minerals. The diets of the experimental groups included a feather-based organic additive in various dosages, while the control group received only the basic feed. Feeding and watering were carried out according to the standards for industrial poultry farming. The chickens were housed in “Big Dutchman” battery cages, which allowed for effective monitoring of productivity, feed intake, and physiological condition. Microclimate conditions (temperature, humidity, ventilation) were maintained in accordance with the management guidelines for the Hy-Line Brown W-36 cross, minimizing the impact of stress factors.

Dynamics of Live Weight and Survival Rate of Growing Pullets. At the onset of the laying period (at 17 weeks of age), the first experimental group of laying hens demonstrated a significant increase in live weight compared to the control group by 62 g or 4.4%. The second experimental group showed a gain of 53.86 g, which was 3.8% higher than the control. The third experimental group exhibited an increase of 48.82 g, or 3.4%, while in the fourth group, the gain was 40.8 g, corresponding to 2.9%.

By the end of the experiment, at 34 weeks of age, the highest weight gains were also recorded in the experimental groups. Compared to the control, the increase in live weight of hens in EG1, EG2, EG3, and EG4 was higher by 61.25 g (3.3%), 50.46 g (2.7%), 42.36 g (2.3%), and 35.15 g (1.9%), respectively, indicating more intensive growth in these groups. The chickens in the first experimental group, which received a feather-based feed additive at a dosage of 2 kg per ton of compound feed, showed the highest live weight gains. Compared to the control group, the absolute gain was 56.78 g (or 4.8%) higher, the average daily gain was higher by 0.32 g (or 4.9%), and the relative gain increased by 7.63%.

Digestibility and Assimilation of Nutrients When Using Feather Meal as a Feed Additive in Laying Hen Diets. In the control group, the dry matter digestibility coefficient was 72.27%, whereas in the experimental groups it ranged from 73.24% to 74.48%, with the highest value observed in EG1. The digestibility of organic matter was also highest in EG1 (77.87%) compared to 74.15% in the control group, with lower levels in the other experimental groups. Protein assimilation in EG1 reached 85.75% (+4.47% compared to the control), while in the other experimental groups it ranged from 85.28% to 85.53%. Fat digestibility was 75.12% in the control group and 77.86% in EG1, remaining high across the other experimental groups. Fiber digestibility in EG1 was also higher than in the control by +1.39% (19.74% vs. 18.35% in the control group).

The chickens in EG1 also demonstrated the highest efficiency in the utilization of minerals: nitrogen digestibility was 44.21% compared to 42.27% in the control, calcium – 53.53% (control – 51.44%), and phosphorus – 51.93%. These results indicate improved metabolic processes and more efficient nutrient utilization due to the feather meal supplement used in EG1.

Morphological and Biochemical Blood Parameters. It was found that hens from EG1 at 34 weeks of age had better values of blood morphological parameters, including red blood cell count, hemoglobin concentration, hematocrit, and platelet count. Hemoglobin level in EG1 (75.35±0.27 g/l) and red blood cell concentration (3.48±0.04) were statistically significantly higher (F_{group}=21.86***) than in the control group (CG), indicating a positive effect of the additive in the diet. The hematocrit value in EG1 was 27.00±0.04, further confirming improvements in blood parameters.

The biochemical blood analysis of hens at 34 weeks of age showed that the groups receiving the organic additive in their diet (EG1-EG4) demonstrated improved values across most parameters compared to the control group (CG) (Table 4.2).

Table 4.2. Biochemical Blood Parameters of Laying Hens at 34 Weeks of Age

Group	Total Protein, g/l	Albumins, g/l	Calcium, mmol/l	Phosphorus, mmol/l
CG	44.27±0.04 d	17.28±0.01d	2.67±0.01e	1.57±0.01d
EG1	46.65±0.03 a	18.33±0.03a	3.00±0.02a	2.07±0.01a
EG2	46.54±0.03 a	18.00±0.01b	2.94±0.02b	2.05±0.01ab
EG3	46.40±0.01 b	17.67±0.03c	2.87±0.01c	2.02±0.01bc
EG4	46.25±0.02 c	17.25±0.02d	2.79±0.01d	2.00±0.01c
Mean	46.02±0.13	17.71±0.06	2.86±0.02	1.94±0.03
ANOVA				
F_{group}	***1294.18******	***361.57******	***80.33******	***364.78******

Group	AST, u/l	ALT, u/l	Alkaline Phosphatase, u/l
CG	172.00±1.12 a	145.35±1.96 a	719.00±2.38 d
EG1	154.35±1.53 b	136.48±1.54 b	787.00±2.60 a
EG2	145.56±1.67 c	128.75±1.63 c	769.00±2.67 b
EG3	132.86±1.96 d	121.47±2.12 d	763.00±2.42 b
EG4	127.44±1.57 d	115.09±1.51 d	748.00±2.61 c
Mean	146.44±2.37	129.43±1.71	757.20±3.44
ANOVA			
F_{group}	***124.27******	***45.65******	***101.00******

*The effects were determined using one-way analysis of variance (ANOVA). Differences between means were assessed using Tukey's post hoc test (HSD). Values are expressed as mean ± standard deviation (n = 10). Means marked with different letters indicate statistically significant differences. Significance levels: *: p ≤ 0.1, **: p ≤ 0.01, *: p ≤ 0.001.*

The highest levels of total protein (F_{group}=1294.18***), albumins (F_{group}=361.57***), calcium (F_{group}=80.33***), and phosphorus (F_{group}=364.78***) were observed in group OG1, indicating a positive effect of the additive on metabolism. The activity levels of enzymes AST, ALT, and alkaline phosphatase in OG1 were also lower, which may suggest improved functional status of the liver and other organs. All differences between groups were statistically significant, confirming the efficacy of the feed additive on the biochemical blood parameters of hens.

Morphological composition of eggs from laying hens. The influence of the feather-based feed additive on egg weight and the percentage composition of its morphological components was established. Significant changes in the morphological indicators of eggs occurred with age (from 17 to 34 weeks) in laying hens (Table 4.3). The average albumen diameter in the control group ranged from 8.31 cm to 8.60 cm, whereas in the experimental groups it ranged from 8.35-8.70 cm to 8.75-8.90 cm. Albumen height was 7.11-8.22 mm in the control and 7.18-7.78 mm up to 8.62-8.85

mm in the experimental groups, indicating improved egg quality. Yolk height increased from 14.40 mm to 16.47 mm in the control group and from 14.80-17.97 mm to 18.38-19.92 mm in the experimental groups. The average yolk diameter changed from 3.69 cm to 4.09 cm in the control, and from 3.62-3.80 cm to 4.19-4.29 cm in the experimental groups. The yolk index increased on average from 42.79% (at 17 weeks) to 44.01% (at 34 weeks).

Table 4.3. Morphological Characteristics of Eggs at 34 Weeks of Age in Laying Hens

Group	Average Albumen Diameter, cm	Albumen Height, mm	Albumen Index, %	Average Yolk Diameter, cm
CG	8.60±0.02 d	8.22±0.01 d	9.56±0.02d	4.09±0.02e
EG1	8.90±0.02 a	8.85±0.02 a	9.94±0.04a	4.29±0.02a
EG2	8.80±0.02 b	8.73±0.02 b	9.92±0.03b	4.25±0.02b
EG3	8.79±0.01 bc	8.70±0.02 b	9.90±0.02bc	4.22±0.02c
EG4	8.75±0.01 c	8.62±0.01 c	9.85±0.01c	4.19±0.02d
Mean	8.77±0.02	8.63±0.03	9.84±0.02	4.21±0.01
ANOVA				
F_{group}	***42.70*** ***	***289.26*** ***	***40.04*** ***	***16.57*** ***
Group	**Yolk height, mm**	**Yolk index, %**	**Shell thickness, mm**	**Haugh units**
CG	16.47±0.07 e	40.34±0.06 e	0.35±0.01d	84.22±0.32 d
EG1	19.92±0.03 a	46.38±0.03 a	0.39±0.01a	86.46±0.32 a
EG2	19.14±0.03 b	44.80±0.01 b	0.38±0.01b	86.17±0.39 b
EG3	18.80±0.04 c	44.54±0.02 c	0.37±0.01c	85.90±0.40 c
EG4	18.38±0.06 d	43.97±0.04 d	0.37±0.01c	85.55±0.29 cd
Mean	18.54±0.17	44.01±0.29	0.37±0.01	85.66±0.19
ANOVA				
F_{group}	***764.89*** ***	***3860.02*** ***	***2.28*** ***	***6.36*** ***

*The effects were determined using one-way analysis of variance (ANOVA). Differences between means were assessed using Tukey's post hoc test (HSD). Values are expressed as mean ± standard deviation (n = 10). Means marked with different letters indicate statistically significant differences. Significance levels: *: $p \leq 0.1$, **: $p \leq 0.01$, *: $p \leq 0.001$.*

Shell thickness also slightly increased: on average, in the control group from 0.35 mm to 0.37 mm; in the experimental groups – from 0.34-0.37 mm to 0.37-0.39 mm. The Haugh unit score rose from 72.15 to 84.22 in the control group and from 72.95–73.41 to 85.55–86.46 in the experimental groups, indicating improved albumen quality. The statistical significance of differences in the egg morphological parameters between the studied groups was confirmed by ANOVA results.

Amino acid content in hen eggs. The feather additive in the hens' diet improves the amino acid profile of the eggs, enhancing their nutritional value. It was found that the feather additive at a dose of 2 kg/ton (EG1) provides the most pronounced improvement in the amino acid profile of the eggs. The increased levels of key amino acids – leucine, isoleucine, lysine, methionine, and cysteine – indicate a rise in the biological and nutritional value of the eggs. The highest total amino acid content was recorded in group EG1 (12.784%), which is 6.1% higher than in the control group (12.047%). Elevated values were also noted in other experimental groups: EG2 – 12.609%, EG3 – 12.495%, EG4 – 12.408%, demonstrating the additive's effective impact. Significant differences between groups were confirmed by statistical analysis using ANOVA ($p<0.001$) for all amino acids. Thus, the use of the feather additive

contributes to improving the amino acid composition of eggs and increases their biological value.

Egg production and egg quality of laying hens with the use of an organic feather-based feed additive. The use of the feather feed additive had a positive effect on the productivity of laying hens. The egg-laying intensity in the experimental groups increased compared to the control group by 7.2% (EG1), 5% (EG2), 4.4% (EG3), and 3% (EG4), indicating enhanced physiological activity and productive potential of the chickens. The most pronounced results were observed in groups EG1 and EG2. A similar trend was seen in the total egg mass, reflecting the combined weight of all eggs produced in each group. In the experimental groups, the total egg mass exceeded control values by 45.4 kg (9.5%) in EG1, 31.6 kg (6.6%) in EG2, 27.8 kg (5.8%) in EG3, and 20.4 kg (4.3%) in EG4 [3]. These data confirm increased egg production and average egg weight with the use of the feed additive, especially at dosages of 2 and 3 kg/ton of feed.

Economic efficiency of using an organic feather-based feed additive in the compound feeds for Hy-Line Brown W-36 laying hens. The use of the feather feed additive not only enhances the productivity of the hens but also reduces the cost of egg production by optimizing feed consumption and improving the overall health of the chickens. Incorporating this additive into the diet of industrial laying flocks increases profitability and makes production more economically efficient, which is especially relevant for modern poultry farms.

The application of the feather additive in Hy-Line Brown W-36 hens proved economically effective: profit gains in the experimental groups ranged from 167.0 to 233.2 lei, with the best results observed in EG1, where the additive was included at a dose of 2 kg/ton. This confirms that adding the supplement to the diet lowers the cost of eggs through improved nutrient utilization and strengthened bird health, which in turn promotes higher egg production. Thus, the use of the feather feed additive is an effective tool for increasing the economic return of egg production.

GENERAL CONCLUSIONS

1. The studied organic feed additive derived from peat contains the following nutritional characteristics: 0.2 feed units (FU/kg), 10.6 MJ/kg of metabolizable energy, 10.8% crude protein, 3.93% crude fat, 16.5% crude fiber, and 6.2% crude ash. Its high effectiveness is due to the presence of humic acid (up to 28%), which includes 74 organic minerals, 10 vitamins, and 18 amino acids. Humic acid promotes nutrient absorption, enhances metabolism, improves cell membrane permeability, and facilitates the elimination of heavy metals. The mineral composition of the peat is predominantly represented by manganese, copper, zinc, calcium, sodium, and iron. The energy value of 100 g of the concentrate is 510 kcal. This organic feed concentrate is a mixture of high-molecular-weight organic compounds, produced without the use of chemical reagents or salts. It is free of heavy metals and is intended for the production of environmentally friendly meat and egg products.
2. Feather meal represents a significant reserve of protein and can be effectively used in poultry nutrition. Modern low-temperature feather processing technologies (up to 60^0C) help preserve the biological value of keratin – the main protein in feathers, which accounts for up to 85-88% of their mass. The resulting product is highly digestible and

serves as a valuable source of amino acids, including cysteine, which is essential for protein metabolism. In addition, feather meal is rich in minerals (such as calcium, phosphorus, and sodium) and trace elements, which enhance its nutritional value. Thus, incorporating feather meal into poultry diets contributes to providing birds with essential nutrients, maintaining their health, and improving productivity.

3. The use of organic feed additives based on peat and feathers as part of the main compound feed did not have any negative impact on the health or survival of young birds and laying hens. Analysis of morphological and biochemical blood parameters – such as red blood cell count, hemoglobin levels, and total protein – confirmed that these values remained within normal physiological ranges and showed steady development. This indicates improved metabolic processes and optimized metabolism in the chickens. In turn, this had a positive effect on the overall condition and productivity of the flock: the survival rates of young chickens and laying hens in the experimental groups OG1 and OG2 increased by 2–4% compared to the control group. The results confirm the high effectiveness of using organic peat- and feather-based feed additives in poultry farming for maintaining bird health, improving survival rates, and enhancing overall productivity.
4. The inclusion of peat- and feather-based feed additives in the compound feed for laying hens in the experimental groups (EG1 and EG2) during the first scientific and practical experiment led to an increase in the slaughter weight of the chickens. This contributed to an increase in the yield of eviscerated carcasses by 0.7% and 0.2%, respectively, compared to the control group ($p<0.05$). The breast muscle mass also increased by 4.9% in EG1 and by 10.4% in EG2, indicating a positive impact of these changes on the meat quality of the chickens. The rise in dry matter, protein, and fat content in the breast muscle of the experimental laying hens improved the organoleptic properties of both the meat and the broth.
5. The conducted studies demonstrated the positive impact of organic feed additives on the physiological and productive maturity indicators of the experimental chickens. Compared to the control group, the onset of egg-laying in the young hens was observed 5-8 days earlier. The highest peak of egg production was recorded in group EG2 (70.66%), which exceeded the comparable value in the control group (67.96%). Moreover, a higher average egg weight was observed in EG1 (55.53 g) and EG2 (56.0 g) compared to the control group (53.95 g), with a highly significant difference between the groups ($F_{group}=60.54$, $p<0.001$).
6. The results of the study on the productive performance of laying hens showed that the inclusion of an organic peat-based feed additive in the main diet contributes to a more complete and intensive utilization of the chickens' vital resources. This was reflected in a significant ($p<0.05$) increase in egg production in the experimental groups, especially in EG3, where chickens received the peat additive at a dosage of 1 kg/ton of feed. In this group, the number of eggs per initial layer increased by 215 eggs (or 39%), and the laying intensity rose by 26.4%. As a result, 200.5 kg (or 43.2%) more egg mass was produced compared to the control group.
7. It was established that the inclusion of an organic feather-based feed additive in the main diet contributes to an increase in egg production. In the experimental groups, the laying intensity increased compared to the control group by 7.2%, 5%, 4.4%, and 3%,

respectively, indicating higher productivity, especially in groups EG1 and EG2. Egg mass was also higher: the increase amounted to 45.4 kg (9.5%), 31.6 kg (6.6%), 27.8 kg (5.8%), and 20.4 kg (4.3%) compared to the control group. This reflects the overall volume of egg production in each group. The average egg weight in the control group was 61.25 g, while in the experimental groups it was higher by 1.29 g (2.1%), 0.97 g (1.6%), 0.83 g (1.4%), and 0.75 g (1.3%), respectively (F_{group}=22.63, $p<0.001$). The total egg production in the experimental groups amounted to 8,402 eggs (EG1), 8,223 eggs (EG2), 8,181 eggs (EG3), and 8,071 eggs (EG4), exceeding the control group's production by 564 (7.2%), 385 (5%), 343 (4.4%), and 233 (3%) eggs, respectively. Thus, the obtained data confirm the positive effect of the organic feather-based additive on egg production and overall productivity of laying hens.

8. The inclusion of the organic feather-based feed additive in the diets of the experimental poultry led to improved feed conversion efficiency. The feed consumption per unit of production in the experimental groups was lower than in the control group. The feed consumption per 1 kg of egg mass in the control group was 2.70 kg, whereas in the experimental groups it was significantly lower: 2.42 kg in EG1 (10.4% lower), 2.52 kg in EG2 (6.7% lower), 2.56 kg in EG3 (5.2% lower), and 2.64 kg in EG4 (2.3% lower). The feed consumption per 10 eggs was also lower in the experimental groups. The economic efficiency of using the feather-based feed additive in compound feeds for Hy-Line Brown W-36 laying hens was higher, with profitability in the experimental groups ranging from 167.0 to 233.2 lei.
9. The use of a peat-based feed additive in the main compound feed for Hy-Line Brown W-36 laying hens resulted in a significant economic effect. In the experimental groups, profit increased in the range of 300.2 to 620.0 lei. This indicates that the inclusion of the peat additive not only enhances the productivity of the hens but also contributes to substantial economic growth. The additional income generally helps reduce egg production costs and increases profitability. When the peat additive was included in the diet at a dose of 1 kg/ton (EG3), the profitability level exceeded that of the control group by 6.7%.
10. The assessment of the environmental and sustainability aspects of using organic feed additives demonstrated their positive impact on reducing anthropogenic pressure and enhancing environmental safety. The use of such additives contributed to improved digestibility of nutrients and more complete feed utilization, which in turn led to a reduction in the amount of undigested residues in the manure. The application of organic additives supports the development of more closed and environmentally sustainable production cycles in poultry farming, reduces the volume of organic waste, and lessens its negative impact on the environment, including odor emissions and soil contamination.

RECOMMENDATIONS FOR PRODUCTION

In order to improve productivity and economic efficiency in egg-laying poultry farming, it is recommended to promote the use of rations incorporating organic feed additives in industrial poultry production:

- the optimal inclusion level of the peat-based additive in compound feed is 1 kg per ton of feed;
- the effective dosage of the feather-based additive is 2 kg per ton of compound feed.

BIBLIOGRAPHY

1. BLANDON, J., HAMADY, G., ABDEL-MONEIM. M. *The effect of partial replacement of yellow corn by banana peels with and without enzymes on broiler's performance and blood parameters*. Journal of Animal and Poultry Sciences (JAPSC).2015, № 4(1), pp. 10-19. ISSN 2147-9267.
2. CAISIN, L., CARA, A. Effect of peat-based feed additive on performance of laying hens. Journal of Biometry Studies. Vol.4, Iss. 2., Turkey, 2024, p. 67-72. ISSN: 2791-7169.
3. CAISIN, L., CARA, A. Performance of laying hens fed diets incorporated with feather-based feed additive. Journal of Biometry Studies. Vol.3, Iss. 2., Turkey, 2023, p. 27-31. ISSN: 2791-7169.
4. CAISÎN, L., SCRIPNIC, E., BIVOL, L. et al. Recomandări utilizarea făinii din pene ca o sursă de proteină în alimentaţia puilor broiler. Universitatea Tehnică a Moldovei. Chişinău: PrintCaro, 2025. p. 46-47. ISBN 978-5-85748-153-0.
5. CARA, A., Резервы повышения продуктивности кур породы адлерская серебристая. Scientific Journal of Italy «Annali d'Italia» №32, ISSN: 3572-2436, p. 3-8, 2022.
6. CUCU, I., MACIUC, V., MACIUC, D. Cercetarea științifică și elemente de tehnică experimentală in zootennie – Iași: Alfa, 2004. ISBN 973 -8278 -36 -8/
7. LONDERO, A., PIRES, R., GOLIN, L. et. al. *Effect of supplementation with organic and inorganic minerals on the performance, egg and sperm quality and hatching characteristics of laying breeder hens.* Animal Reproduction Science, 2020, Volume 215, p, 106309. ISSN: 0378-4320.
8. MINITAB USER'S GUIDE. Release 17 for Windows, Minitab LLC, 63p.
9. POORGHASEMI, M., SEIDAVI, A., QOTBI, A. et al. *Influence of Dietary Fat Source on Growth Performance Responses and Car- cass Traits of Broiler Chicks.* Asian-Australasian Journal of Animal Sciences. 2013, № 26(5), pp.705- 710 pISSN 1011-2367 eISSN 1976-5517
10. ROWGHANI, E., ARAB, M. Effects of a Probiotic and Other Feed Additives on Performance and Immune Response of Broiler Chicks. In: International Journal of Poultry Science. 2007, Vol.6, № 4, pp. 261–265. ISSN: 1682-8356
11. АНТИПОВА, Л.В. Методы исследования мяса и мясопродуктов. М.: Колос, 2001, с. 376. ISBN5-10-003612-5.
12. БЕССАРАБОВ, Б.Ф. Лабораторная диагностика клинического и иммунобиологического статуса у сельскохозяйственной птицы учебник для вузов. М.: Колос, 2008, с.150. ISBN 978-5-9532-0567-2
13. БОБЫЛЕВА, Г.А., Пути повышения эффективности производства яиц и яйцепродуктов в России. В: Птица и птицепродукты. 2013, № 4, с. 22–25. ISSN: 2073-4999
14. ВЛАСОВ, А. Б. Использование жировых добавок в кормлении сельскохозяйственной птицы. Научный журнал КубГАУ - Scientific Journal of KubSAU, 2013, №89(5), с. 1-16. ISSN: 1990-4665
15. ВОЛИК, В., АЛЕКСЕЕНКО, В., ИСМАИЛОВА, Д., *Белковый корм из пера*. В: Птицеводство, 1991, №8, с.14-15. ISSN: 0033-3239
16. ЕГОРОВ, И.А., *Нетрадиционные корма*. Птицеводство. – 1989. –№ 5. – С. 21-24.

17. ЕГОРОВ, И.А., Эффективность использования в птицеводстве комбикормов с пониженным уровнем животного белка. *В:* Птица и птицепродукты. 2003, № 1, с. 21-24. ISSN: 2073-4999
18. ЕГОРОВА, Т., «Научное – Практическое обоснование использования нетрадиционных кормовых средств, новых биологически активных веществ и кормовых добавок при производстве яиц и мяса птицы», диссертация на соискание ученой степени доктора с/х наук, Сергеев Посад -2017г.;
19. ИБРАГИМОВ, М., «Научные основы и практические приемы использования ферментных препаратов и фосфолипида лецитина в кормлении цыплят-бройлеров, ремонтного молодняка и кур – несушек», диссертация на соискание ученой степени доктора с/х наук, Владикавказ 2020 г.
20. ИМАНГУЛОВ, Ш.А., ЕГОРОВ, И.А., ОКОЛЕЛОВА, Т.М., ТИШЕНКОВ, А.Н., [и др.]. Методика проведения научных и производственных исследований по кормлению сельскохозяйственной птицы. В: Сергиев Посад, 2000, с.35.
21. ЛАНЦЕВА, Н.Н., МОТОВИЛОВ, К.Я., ШВЫДКОВ, А.Н. Экспериментальное обоснование механизма действия высококремнистых минеральных комплексов – кудюритов в птицеводстве. Монография, Новосибирск: Изд-во НГАУ, 2013, с.187. ISBN:978-5-94477-128-5
22. ЛИСИЦИНА, А.А. Ферментные препараты снижают стоимость корма. В: Птицеводство, 2000, №5. с 34-36. ISSN: 0033-3239
23. ЛУКАШЕНКО, В.С., А.Ш. КАВТАРАШВИЛИ, А.Ш., САЛЕЕВА, И.П., ЛЫСЕНКО, В.П., [и др.] Методика проведения исследований по технологии производства яиц и мяса птицы. Сергиев Посад, 2015, с.103. ISBN:978-5-980-20-154-8
24. ЛУКАШЕНКО, В.С., ЛЫСЕНКО, М.А., СТОЛЛЯР, Т.А., КАВТАРАШВИЛИ, А.Ш. [и др.]. Методика проведения анатомической разделки тушек, органолептической оценки качества мяса и яиц сельскохозяйственной птицы. Сергиев Посад, 2013, с.35. УДК 637.54.05(470)
25. МАРТЫНОВ, С.А., 2001. Эффективность включения необработанного торфа в рацион кормления сельскохозяйственных животных. В: Химия и компьютерное моделирование. Бутлеровски сообщения, г. Сыктывкар 2001, №5
26. ОКОЛЕВА, Т., Кормление сельскохозяйственной птицы в вопросах и ответах. Алмата: Нур- Принт, 2019, с. 250. ISBN: 978-601-7590-53-6
27. ПАРМАКЛИ, Д.М., ТОДОРИЧ, Л.П., ДУДОГЛО, Т.Д., Эффективность производства и реализация продукции: современные методы анализа и оценки Учебное пособие. Комратский Государственный университет, научно - исследовательский центр «Прогресс», Комрат: Б.и., 2020, 151р. ISBN 978-9975-83-110-9.
28. ПЕТРУХИН, И.В. Корма и кормовые добавки. В.: Росагропромиздат. 1989, с.526.
29. ПЛЕШАКОВА, И.Г. Использование сорго сорта «Камышинское 75» в кормлении кур родительского стада. Материалы международной научно-практической конференции «Мировые научно-технологические тенденции

социально-экономического развития АПК и сельских территорий». Волгоград: Изд-во «Волгоградский государственный аграрный университет», 2018, Том 1, с. 262-266. ISBN: 978-5-4479-0136-3
30. ПЛОХИНСКИЙ, Н.А., Руководство по биометрии для зоотехников. М.: Колос, 1969, с. 49-58.
31. САМОДЕЛКИН, А.Г., ЕРЕМИН, С.П., Биотехнологические методы повышения эффективности ведения скотоводства. *В*: Вестник Казанского государственного университета. 2014, Том 9, № 4, с.124-127. ISSN 2073-0462
32. ТЮБИНА, А. «Повышение яичной продуктивности кур-несушек при использовании в кормлении биологически активной добавки «Эльтон», диссертация на соискание ученой степени кандидата с/х наук – Волгоград 2018 г.;
33. ФАЙЗРАХМАНОВ, Р., «Метаболизм, продуктивность и качество продукции животных при использовании в их рацион кормовых добавок на основе сапропеля», диссертация на соискание ученой степени доктора биологических наук -Казань – 2018 г.;
34. ФЕДОРОВА, В.В. Использование кормовой добавки из личинок мух Lucilia Caesar в кормлении индюшат. В: Кормление сельскохозяйственных животных и кормопроизводство. 2022, № 4 (201), с. 44-58. DOI:10.33920/sel-05-2204-05
35. ХОРОШЕВСКАЯ, Л., «Новые подходы к повышению мясной продуктивности птицы на основе использование нетрадиционных кормов и биологически активных веществ», диссертация на соискание ученой степени доктора с/х наук – Волгоград - 2016г.
36. ЧЕНОГРАДСКАЯ, Н., «Научно-Практическое обоснование использования нетрадиционных кормовых добавок в животноводстве и птицеводстве Якутии» диссертация на соискание ученой степени доктора с/х наук - Якутск -2020г.
37. ШМАКОВ, Ю.И., КОМАРОВ, Л.Л., ЧЕРЕКАЕВ, Н.В., Методические рекомендации по определению экономического эффекта от внедрения результатов научно-исследовательских работ в животноводстве /М.: *Дубровицы*, 1984, с.29.

LIST OF WORKS PUBLISHED ON THE THESIS THEME

1. Articles in scientific journals

1.1 in journals in Web of Science and SCOPUS databases

1. CAISIN, L., **CARA, A.,** AL KHATIB JEHAD ABD HASSAN, MALENCHI, D. *Effect of feeding a peat feed additive on the performance of laying hens*. GORTERIA, 2024, 64(8) p.2-8 ISSN: 0017-2294. https://gorteria.nationaalherbarium.com/show.php?v=64&i=8

1.2 in recognized foreign journals

2. CAISIN, L., **CARA, A.** *Effect of peat-based feed additive on performance of laying hens.* Journal of Biometry Studies. Vol.4, Iss. 2., Turkey, 2024, p. 67-72. ISSN: 2791-7169. https://prensipjournals.com/ojs/index.php/jofbs/article/view/298/227.

3. CAISIN, L., **CARA, A.** *Performance of laying hens fed diets incorporated with feather-based feed additive*. Journal of Biometry Studies. Vol.3, Iss. 2., Turkey, 2023, p. 27-31. ISSN: 2791-7169. https://prensipjournals.com/ojs/index.php/jofbs/article/view/141/82
4. **CARA, A**., *Резервы повышения продуктивности кур породы адлерская серебристая*. Scientific Journal of Italy «Annali d'Italia» №32, ISSN: 3572-2436, p. 3-8, 2022. https://www.itadiana.com/wp-content/uploads/2022/06/Annali-d'Italia-№32-2022.pdf.
5. IANIOGLO, N., **CARA, A.** *Development the Poultry Sector of the Republic of Moldova Through Clusterisation.* International Journal of Anatolia Agricultural Engineering Sciences (IJAAES). Turkey, Vol. 4, Issue: 1, 2022, p. 10-16. Turkey. ISSN: 2667-7571. https://dergipark.org.tr/tr/download/article-file/1613987
6. CAISIN, L., **CARA, A.,** COJIN, A., HAPKO, S. *The use of unconventional feed additives in feeding chickens for egg production (R. of Moldova).* International Journal of Anatolia Agricultural Engineering (IJAAES), Turcia, Vol. 1, Special lssue: 1, 2019, p. 4-12. ISSN: 2667-7571. https://dergipark.org.tr/tr/download/article-file/902748

1.3. in journals listed in the National Register of specialized journals, with indication of the category

7. PARMACLI, D., **CARA, A.** *Особенности анализа показателей развития птицеводства в динамике*. Vector European. Revistă științifico-practică Nr. 1/2022. Chișinău, 2021, p. 83-90, ISSN: 2345-1106 (Categorie B). https://ibn.idsi.md/sites/default/files/imag_file/83-89_16.pdf

2. Articles in scientific collections

2.1. in the proceedings of international scientific conferences (abroad)

8. CAISIN, L., **CARA, A**. Egg Quality of Laying Hens Fed Different Levels of Feather Meal. In: *31st Istanbul Conference on Chemical, Agriculture, Biological and Environmental Sciences (ICBEN-22)*. Turkey, Istanbul, 2022, p. 36-42, ISBN: 978-989-9121-13-3. https://heaig.org/images/proceedings_pdf/H1122294.pdf
9. ÖZCAN, M., **CARA, A.** Kanatli hayvanlarin beslenmesinde yosun türlerinin (Algler) kullanimi. In: *5th International Agriculture* Congress. Proceedings book. 5-6 December, Online. 2022. p.163-172. e-ISBN: 978-605-80128-8-2. https://utak.azimder.org.tr/wp-content/uploads/2023/01/UTAK2022-Proceedings-Book.pdf.
10. CAISIN, L., **CARA, A.** Estimation of the Productive Potential of Non-Dry Chicken Adlerskaya Silver on the Background of Application of Non-Conventional Feed Additives. In: *4th International Agriculture* Congress. Proceedings book. 16-17 December, Turkey. 2021. p.42-50. ISBN: 978-605-80128-6-8. https://utak.azimder.org.tr/wp-content/uploads/2023/01/UTAK2021_proceedings_book.pdf.
11. PARMACLI, D., **CARA, A.,** Состояние и обоснование резервов роста продукции птицеводства в Республике Молдова. В: *Материалы IX Международной Научно-Практической конференции «Укономічні та соціальні аспекти розвитку україни на початку xxi століття»*, Одеса, 2021,

c.164-167. https://ontu.edu.ua/download/konfi/2021/Collection-of-abstracts-ekonom-19-20-21.pdf

2.2. in the proceedings of national scientific conferences

12. КАЙСЫН, Л., **КАРА А**. Влияние органических кормовых добавок на продуктивность кур-несушек породы Адлерская серебристая. In: *Conferința științifico-practică internațională «Știință. Educație. Cultură»*. Culegere de articole Vol. I., Moldova, Comrat, 2025, p. 530-537. ISBN: 978-9975-83-334-9. https://kdu.md/images/Files/34-a-aniversare-a-universitatii-de-stat-din-comrat-culegere-de-articole-1.pdf
13. **КАРА, А.** Продуктивность кур-несушек при использовании в рационе нетрадиционных кормов. In*: Conferința științifico-practică internațională «Știință. Educație. Cultură»*. Moldova, Comrat, 2024, Vol. 1, 376-382. ISBN: 978-9975-83-295-3. https://kdu.md/images/Files/33-godovshina-kdu-tom-1.pdf
14. **КАРА, А.** Состояние и перспективы развития отрасли птицеводства АТО Гагаузия. In*: Conferința științifico-practică internațională «Știință. Educație. Cultură»*. Moldova, Comrat, 2023, Vol. 1, с. 434-438. ISBN: 978-9975-83-255-7. https://kdu.md/images/Files/mezhdunarodnaya-nauchno-prakticheskaya-konferenciya-nauka-obrazovanie-kultura-posvyashchennaya-32-godovshchine-kgu-tom1.pdf
15. **КАРА, А.** Обмен веществ у кур-несушек при использовании в рационе нетрадиционных кормов. In*: Conferința tehnico-științifică a studenților, masteranzilor și doctoranzilor*. Chișinău, 5-7 aprilie 2023, Vol. IV, с. 178-183. ISBN 978-9975-45-960-0. https://cercetari.utm.md/wp-content/uploads/sites/31/2023/09/Book-Works-Conference-TUM-2023-vol-IV.pdf
16. КАЙСЫН, Л., **КАРА А**. Рост и развитие молодняка птицы породы Адлерская серебристая при использовании нетрадиционных кормовых добавок. In*: Conferința științifico-practică internațională «Știință. Educație. Cultură»*. Moldova, Comrat, 2022, Vol. 1, 237-243. ISBN: 978-9975-83-177-2. https://kdu.md/images/Files/mezhdunarodnaya-nauchno-prakticheskaya-konferenciya-nauka-obrazovanie-kultura-posvyashchennaya-31-oj-godovshchine-kgu-tom-1.pdf.
17. КАЙСЫН, Л., **КАРА А**. Морфологические и биохимические изменения крови кур Адлерской серебристой на фоне применения нетрадиционных кормовых добавок. In*: Conferința științifico-practică internațională «Știință. Educație. Cultură»*. Moldova, Comrat, 2021, Vol. 1, 216-221. ISBN: 978-9975-3496-2-8. https://kdu.md/images/Files/mezhdunarodnaya-nauchno-prakticheskaya-konferenciya-nauka-obrazovanie-kultura-posvyashchennaya-30-oj-godovshchine-kgu-tom--1.pdf
18. КАЙСЫН, Л., **КАРА А**. Нетрадиционные кормовые добавки в комбикормах для кур несушек Адлерская серебристая. In*: Conferința științifico-practică cu participare internațională. Culegere de lucrări științifice*. Moldova, Maximovca, 2021, p. 316-322. ISBN: 978-9975-56-911-8. https://ibn.idsi.md/sites/default/files/imag_file/ul_de_lucrari_Conferinta_65_ISPZMV_2021.pdf

3. Abstracts in scientific collections

3.1. in the proceedings of international scientific conferences (abroad)

19. CAISIN, L., **CARA, A.** Effect of Peat-Based Feed Additive on Performance of Laying Hens. In: *5th International Congress on Engineering and Life Science. 10-12 September, 2024*, Piteşti, Romania, p. 182. ISBN: 978-625-94141-3-3. https://ibn.idsi.md/sites/default/files/imag_file/p-182_7.pdf (IBN)
20. **CARA, A.** Influence of Non-Traditional Feed Additives on the Development of Digestive Organs and Egg Formation in Adler Silver Hen. In: *6th International Agriculture Congress, UTAK 2023, 31 August-4 September 2023*, p.95, ISBN: 978-605-80128-9-9. UTAK2023-abstrack_book.pdf
21. **CARA, A.** Impact of Unconventional Feed Additives on the Growth of Digestive Organs and Egg Formation in Adler Silver Hens. In: *5th International Conference on Food, Agriculture and Animal Sciences, ICOFAAS 2023, (Online)*, Antalya, Turkey, November 23-26, 2023, p.394. ISBN: 978-625-99950-1-4. https://www.icofaas.com/5thICOFAAS.pdf
22. CAISIN, L., **CARA, A.** The Influence of Non-Traditional Feed Additives on The Tasting Evaluation of Hens Meat Adler Silver. In: *5th International Agriculture Congress. UTAK 2022, (Online)*, p.54, 2022, ISBN: 978-605-80128-7-5. UTAK2022-Abstract-Book.pdf.
23. ÖZCAN, M., **CARA, A.** Kanatlı Hayvanların Beslenmesinde Yosun Türlerinin (Algler) Kullanımı. In: *5th International Agriculture Congress. UTAK 2022, (Online)*, p.57, 2022, ISBN: 978-605-80128-7-5. UTAK2022-Abstract-Book.pdf.
24. IÇOĞLU, Y., SEZMIŞ, G., **CARA, A.** Importance of Feed Additives Used in Poultry Rations: Royal Jelly Example. In: *5th International Agriculture Congress. UTAK 2022, (Online)*, p.68, 2022, ISBN: 978-605-80128-7-5. UTAK2022-Abstract-Book.pdf.
25. CAISIN, L., **CARA, A.** Estimation of the Productive Potential of Non-Dry Chicken Adlerskaya Silver on the Background of Application of Non-Conventional Feed Additives. In: *4th International Agriculture* Congress. Abstract book. 16-17 December, Turkey. 2021. p.21. ISBN: 978-605-80128-5-1. UTAK2021_abstract_book.pdf.
26. CAISIN, L., **CARA, A.** Использование нетрадиционных кормовых добавок в кормлении цыплят яичного направления продуктивности. In: *3rd International Agriculture Congress. Abstract Book, 5-9 March Abstract Book*. Tunis. 2020. p.64. ISBN: 978-605-80128-2-0. https://utak.azimder.org.tr/wp-content/uploads/2023/01/ UTAK2020_abstract_book.pdf.
27. CAISIN, L., **CARA, A.,** COJIN, A., HAPKO, S. The Use of Unconventional Feed Additives in Feeding Chickens for Egg Production (R. of Moldova). In: *2nd International Agriculture Congress. Abstract Book, 21-24 November 2019*, Ayaş/Ankara, Turkey, p.81. ISBN: 978-605-80128-0-6. UTAK2019_abstract_book.pdf

3.1. in the proceedings of international scientific conferences (Republic of Moldova)

28. CAISIN, L., **CARA, A.** Performance of Laying Hens Fed Diets Incorporated with Feather-Based Feed Additive. In: *4th International Congress on Engineering and*

Life Science, Comrat, Moldova, November 17-19, p.46, 2023. ISBN: 978-625-94141-1-9. https://icelis.net/comrat/comrat-publication/

29. CAISIN, L., **CARA, A.** Performance and Egg Quality of Laying Hens Fed Diets Containing Feather Meal. In: *International Scientific Symposium: Modern Trends in the Agricultural Higher Education. TUM, Book of abstracts. October 5-6*, Chisinau, Moldova, p.104, 2023. ISBN: 978-9975-64-360-3. https://fsasm.utm.md/wp-content/uploads/sites/40/2023/12/Modern-Trends-in-the-Agricultural-Higher-Education_Book-of-abstracts_2023_UTM.pdf
30. CAISIN, L., **CARA, A.** Increasing the productivity of the poultry cross Hy-Line brown when using non-traditional feed additives in the diet. In: *13th CASEE Conference „Smart Life Sciences and Technology for Sustainable Development”, TUM, Book of abstracts*, June 28-30, Chisinau, Moldova, p.37, 2023. ISBN: 978-9975-64-363-4. 37_43.pdf
31. **КАРА А**. Рост и развитие молодняка птицы при использовании нетрадиционных кормовых добавок. In: *Tezele celei de-a 75-a Conferinţă ştiinţifică a studenţilor, masteranzilor şi doctoranzilor*, Ed. 75, 30 iunie 2022, Chişinău. Chişinău: Universitatea Agrară, 2022, p. 132. ISBN: 978-9975-64-336-8. https://repository.utm.md/bitstream/handle/5014/22720/Conf-UASM-Stud-Doct-Mast-2022-p132.pdf?sequence=1

4. Other works and achievements specific to various scientific fields (recommended for publication/approved by an authorized institution in the field)

32. CAISÎN, L., SCRIPNIC, E., BIVOL, L. ALJABAR, H., **CARA, A**. *Utilizarea făinii din pene ca o sursă de proteină în alimentaţia puilor broiler*. Recomandări. Ministerul Educației și Cercetării al Republicii Moldova. Universitatea Tehnică a Moldovei. Chișinău: Print-Caro, 2025. 48 p. ISBN: 978-5-85748-153-0.

5. Materials Presented at Invention Exhibitions

1. **INVENTICA 2024. MEDALIE DE AUR**. International Exhibition of Inventics. Inventions*: Method of Feeding Laying Hens*. Autori: Caisin L., **Cara, A**., Abd Aljabar Hassan, Bivol, L. Iași, Romania. 03-05.07.2024.
2. **INVENȚII 2024. MEDALIE DE AUR**. Salonul Internațional de Invenții. Inventions*: Method of Feeding Laying Hens*. Autori: Caisin L., **Cara, A**., Abd Aljabar Hassan, Bivol, L. Timișoara, Romania. 13-15.06.2024.
3. **MEDALIE DE AUR**. International Salon of Invention and Innovative Entrepreneurship. Inventions*: Method of Feeding Laying Hens*. Autori: Caisin L., **Cara, A**., Abd Aljabar Hassan, Bivol, L. Chișinău, Moldova. 16-17.05.2024.
4. **INFOINVENT 2023**. **MEDALIA DE BRONZ.** Compartimentul I: Invenţii, soiuri de plante, design industrial. *I.D22 Metodă de hrănire a găinilor ouătoare*. Autori: Caisin L., **Cara, A.**, Abd Aljabar Hassan, Bivol, L. 22-24.11.2023.

6. Projects

1. **21.80013.8007.3B. Proiect bilateral**. Republica Moldova-Republica Turcia. *„Innovative Strategies for Improving the Biological Effectiveness o (Some Unused and Environmentally Polluting Wastes and Developing Thein as Poultry Alternative Feed and Additives”* (2021-2022).

ADNOTARE

CARA Alla **"Argumentarea științifică a utilizării eficiente a aditivilor furajeri organici pentru creșterea productivității găinilor ouătoare"**. Teza de doctor în științe agricole, Chișinău, 2025.

Structura tezei: introducere, patru capitole, concluzii generale și recomandări, bibliografie cu 219 surse, 9 anexe, 42 figuri, 39 tabele. Rezultatele au fost publicate în 32 lucrări științifice.

Cuvinte cheie: Adler Silver; Hy-Line Brown W-36; găini ouătoare; aditivi furajeri organice; avicultură; productivitate.

Scopul cercetărilor: să justifice științific eficacitatea adaosurilor furajere organice în rațiile găinilor de carne-ou și ouătoare și să elaboreze recomandări practice pentru utilizarea acestora în vederea optimizării hrănirii, creșterii rentabilității și reducerii dependenței de componentele sintetice în condițiile aviculturii din Republica Moldova.

Obiectivele cercetării: analizarea abordărilor științifice moderne și a tendințelor în utilizarea adaosurilor furajere organice în hrănirea găinilor de diferite direcții de productivitate; studierea modificărilor indicatorilor morfo-fiziologici și biochimici ai sângelui păsărilor la includerea adaosurilor furajere organice în rație; determinarea dozelor optime și a schemelor de includere a adaosurilor organice în rație, ținând cont de starea fiziologică și direcția productivă a găinilor; investigarea digestibilității și asimilării substanțelor nutritive din furaje de către pui și găini adulte ouătoare la utilizarea adaosurilor organice în compoziția furajelor combinate; elaborarea recomandărilor științifice pentru utilizarea adaosurilor furajere organice în condițiile unităților avicole din Republica Moldova; realizarea unei evaluări economice a eficienței aplicării adaosurilor organice comparativ cu metodele tradiționale de hrănire; evaluarea aspectelor ecologice și sustenabile ale utilizării adaosurilor organice din perspectiva reducerii impactului antropogenic și asigurării siguranței produselor.

Noutatea științifică și originalitatea. Pentru prima dată în condițiile Republicii Moldova, a fost fundamentată științific utilizarea adaosurilor furajere organice pe bază de turbă și pene în rațiile găinilor din rasa Adler Argintie – cu dublă destinație (carne și ouă) și a hibridului Hy-Line Brown W-36, pentru direcția de producție ouătoare. Au fost stabilite doze și scheme optime de aplicare a adaosurilor organice, care au un efect pozitiv asupra productivității și parametrilor fiziologico-biochimici ai păsărilor. S-au obținut date noi privind mecanismele de acțiune a adaosurilor furajere organice asupra metabolismului, stării morfo-fiziologice și calității ouălor. A fost realizată o evaluare complexă a avantajelor ecologice și economice ale utilizării adaosurilor organice comparativ cu mijloacele sintetice tradiționale.

Semnificația teoretică. Rezultatele cercetării confirmă eficacitatea adaosurilor furajere organice ca alternativă ecologică și sigură la mijloacele sintetice, adâncesc înțelegerea influenței acestora asupra productivității și fiziologiei păsărilor și servesc drept bază pentru dezvoltări ulterioare în domeniul aviculturii durabile.

Valoarea aplicativă: Strategiile propuse de hrănire cresc productivitatea, îmbunătățesc calitatea produselor, reduc costurile și permit renunțarea la adaosurile sintetice. Aplicarea acestora contribuie la păstrarea efectivului, la sustenabilitatea economică și ecologică a producției și poate fi utilizată în practica curentă și în programele educaționale din domeniul aviculturii din Republica Moldova.

Implementarea rezultatelor științifice: a fost realizată la fermele avicole SRL „Piliccik Grupp”, raionul Comrat, SRL „Acustic Tehnologie”, satul Floreni, raionul Anenii Noi și în scopuri didactice la Universitatea Tehnică a Moldovei.

АННОТАЦИЯ

КАРА Алла, «**Научное обоснование эффективного использования органических кормовых добавок для повышения продуктивности кур-несушек**». Диссертация доктора сельскохозяйственных наук, Кишинэу, 2025.

Структура диссертации: введение, четыре главы, общие выводы и рекомендации, библиография из 219 источников, 9 приложений, 42 рисунка 39 таблиц. Результаты опубликованы в 32 научных работах.

Ключевые слова: Адлерская серебристая; Hy-Line Brown W-36; куры-несушки; органические кормовые добавки; птицеводство; продуктивность.

Цель работы: научно обосновать эффективность органических кормовых добавок в рационах кур мясо-яичного и яичного направлений и разработать практические рекомендации по их применению для оптимизации кормления, повышения рентабельности и снижения зависимости от синтетических компонентов в условиях птицеводства Республики Молдова.

Задачи исследований: проанализировать современные научные подходы и тенденции в использовании органических кормовых добавок в кормлении кур различного направления продуктивности; изучить изменения морфо-физиологических и биохимических показателей крови птицы при включении органических кормовых добавок в рацион; определить оптимальные дозировки и схемы включения органических добавок в рацион с учётом физиологического состояния и продуктивного направления кур; изучить переваримость и усвояемость питательных веществ кормов молодняком и взрослыми курами-несушками при использовании в составе комбикормов органических кормовых добавок; разработать научно обоснованные рекомендации по использованию органических кормовых добавок в условиях птицеводческих предприятий Республики Молдова; провести экономическую оценку эффективности применения органических кормовых добавок в сравнении с традиционными методами кормления; оценить экологические и устойчивые аспекты применения органических добавок с позиции снижения антропогенной нагрузки и обеспечения безопасности продукции.

Научная новизна и оригинальность. Впервые в условиях Республики Молдова научно обосновано использование органических кормовых добавок на основе торфа и пера в рационах кур породы Адлерская серебристая – мясо-яичного и кросса Hy-Line Brown W-36 яичного направлений продуктивности. Установлены оптимальные дозировки и схемы применения органических добавок, оказывающих положительное влияние на продуктивность и физиолого-биохимические параметры птицы. Получены новые данные о механизмах действия органических кормовых добавок на обмен веществ, морфо-физиологическое состояние и качество яиц. Проведена комплексная оценка экологических и экономических преимуществ применения органических добавок по сравнению с традиционными синтетическими средствами.

Теоретическая значимость. Результаты исследования подтверждают эффективность органических кормовых добавок как экологически безопасной альтернативы синтетическим средствам, углубляют понимание их влияния на продуктивность и физиологию птицы и служат основой для дальнейших разработок в области устойчивого птицеводства.

Практическая значимость. Предложенные кормовые стратегии повышают продуктивность, улучшают качество продукции, снижают затраты и позволяют отказаться от синтетических добавок. Их применение способствует сохранности поголовья, экономической и экологической устойчивости производства и может быть использовано в практике и образовательных программах в сфере птицеводства Республики Молдова.

Внедрение научных результатов: проводилось на птицефабриках SRL "Piliccik Grupp", Комратский район, SRL “Acustic Tehnologie”, с. Флорены, Новоаненский район и в учебных целях в Техническом Университете Молдовы.

ANNOTATION

CARA Alla**, "Scientific Substantiation of the Effective Use of Organic Feed Additives to Improve Laying Hen Productivity".** Thesis Doctor in Agricultural Sciences, Chisinau, 2025.

The Thesis Structure: introduction, four chapters, general conclusions and recommendations, bibliography with 219 sources, 9 appendices, 42 figures, 39 tables. Research results have been published in 32 scientific papers.

Key words: Adler Silver; Hy-Line Brown W-36; Laying hens; Organic feed additives; Poultry farming; Productivity

The Goal of the Research: to scientifically substantiate the effectiveness of organic feed additives in the diets of dual-purpose and egg-laying hens, and to develop practical recommendations for their use to optimize feeding, improve profitability, and reduce dependence on synthetic components in the context of poultry farming in the Republic of Moldova.

The Objectives of the Research: to analyze current scientific approaches and trends in the use of organic feed additives in the diets of poultry with different productivity types; to study changes in the morphological, physiological, and biochemical parameters of blood when organic feed additives are included in the diet; to determine optimal dosages and inclusion schemes for organic additives based on the physiological condition and productive type of hens; to assess the digestibility and bioavailability of nutrients in feeds for both young and adult laying hens when organic additives are included in compound feeds; to develop scientifically grounded recommendations for the use of organic feed additives under the conditions of poultry farms in the Republic of Moldova; to conduct an economic evaluation of the effectiveness of organic feed additives in comparison with traditional feeding methods; and to assess the environmental and sustainability aspects of using organic additives in terms of reducing anthropogenic impact and ensuring product safety..

Scientific Novelty and Originality. For the first time in the Republic of Moldova, the use of organic feed additives based on peat and feather meal in the diets of Adler Silver (dual-purpose) hens and Hy-Line Brown W-36 (egg-laying) crossbred hens has been scientifically substantiated. Optimal dosages and application schemes of organic additives have been determined, demonstrating a positive impact on productivity and the physiological and biochemical parameters of poultry. New data have been obtained on the mechanisms of action of organic feed additives on metabolism, morpho-physiological status, and egg quality. A comprehensive assessment of the ecological and economic advantages of using organic additives compared to traditional synthetic agents has been carried out.

Theoretical Significance. The study results confirm the effectiveness of organic feed additives as an environmentally safe alternative to synthetic agents, deepen the understanding of their impact on poultry productivity and physiology, and provide a basis for further developments in sustainable poultry farming.

Practical Significance. The proposed feeding strategies increase productivity, improve product quality, reduce costs, and enable the elimination of synthetic additives. Their application promotes flock health, as well as the economic and environmental sustainability of production, and can be utilized in practical settings and educational programs within the poultry industry of the Republic of Moldova.

Implementation of Scientific Results was carried out at the poultry farms of SRL "Piliccik Grupp" in the Comrat district, SRL “Acustic Tehnologie” in Floreni village, Anenii Noi district, and for educational purposes at the Technical University of Moldova.

CARA ALLA

SCIENTIFIC SUBSTANTIATION OF THE EFFECTIVE USE OF ORGANIC FEED ADDITIVES TO IMPROVE LAYING HEN PRODUCTIVITY

421.02 - ANIMAL FEEDING AND FEED TECHNOLOGY

Summary of the Doctoral Thesis in Agricultural Sciences

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