

Effect of peat-based feed additive on performance of laying hens

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Abstract

A strategy for improving the efficiency of the poultry industry is balanced nutrition for poultry, which plays a key role in achieving maximum productivity while maintaining health and reducing production costs through the use of feed additives or unconventional feed ingredients. Feed additives are mainly used to meet the needs of birds, improve their health, stimulate digestion, increase feeding efficiency, and enhance disease resistance. They positively affect the gastrointestinal tract, metabolism, immune system, suppress pathogens, and improve intestinal integrity.

For this purpose, the research aimed to determine the impact of using a peat-based bioregulatory feed additive on the egg productivity of laying hens of the same-age industrial flock of the "Hy-Line Brown W-36" cross and to conduct a qualitative assessment of the eggs. A total of 480 laying hens (day-old), divided into five groups, were raised for 240 days. The feeding of hens in the groups consisted of five experimental diets: a basal diet and the basal diet mixed with a peat-based feed additive at levels of 0.5, 0.75, 1.0, and 1.25 kg/t.

Experimental data showed a positive effect of using a peat-based feed additive in the composition of compound feeds for laying hens on their growth, overall productivity and product quality. The feed intake, calculated at a gram/hen/day rate, was high in Groups 1 and 2; however, the control group exhibited an even greater overall feed intake. A larger egg weight was noted for Groups 3 and 4. Based on these results, this study found that certain supplements did successfully improve egg shell integrity in older laying hens compared to a control. Thus, the use of peat-based feed additive for laying hens has a greater effect on egg-laying intensity (85.38%), average egg weight (63.24g), egg mass yield (664.1kg). The results obtained emphasize the necessity of including organic bioregulators in the diets of laying hens to achieve optimal productivity.

Keywords: Feed additives, Laying hens, Performance, Egg production

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1. Introduction

In poultry farming, feed constitutes one of the primary expenses, accounting for approximately 65-70 percent of the total production cost. Modern poultry feeding strategies must include not only protein and energy sources but also other essential elements such as limiting amino acids, vitamins, antioxidants, enzyme preparations, and various biologically active substances. Deficiencies or imbalances in these critical components can result in metabolic disorders, stunted growth, decreased

productivity, and poor product quality. Therefore, incorporating specialized feed additives and biologically active substances into poultry diets is crucial for enhancing productivity and maintaining health. Given the challenges of feed shortages and rising costs, it is important to explore innovative ways to improve the biological value of feed rations. Optimizing compound feed formulations to meet the nutritional needs of poultry is essential. This requires a comprehensive approach that integrates both scientific research and the practical implementation of innovative



feeding solutions to address the limitations of traditional feed components and ensure that poultry receive all the essential elements for optimal growth and development (Papunidi et al., 2018; Ponomarenko et al., 2020; Tarasova, 2020).

The components of feed rations, including the addition of necessary biologically active additives, not only help maintain poultry health but also enhance egg production parameters, such as egg size and quality.

In modern poultry farming, the effective use of feed additives is a key aspect of optimizing feeding, as they enhance the nutritional completeness of feeds and their bioavailability to poultry. The efficiency of nutrient absorption directly influences the reduction of feed costs per unit of production, which, in turn, is crucial for economic viability.

The rapid development of the feed additives market and the continuous emergence of new formulations underscore the need for their testing under various conditions. Scientific research and practical experience demonstrate that the proper use of feed additives is essential for achieving high egg production. Investments in scientifically validated feed additives are justified by the overall improvement in efficiency and profitability of poultry farming (Kryukov et al., 2020).

The effectiveness of using available feed complexes in poultry farming is determined by several key aspects, including quantitative, qualitative, and economic indicators. These aspects are interrelated, and their combined improvement creates optimal conditions for enhancing poultry productivity. The overall enhancement of these parameters enables the maximization of agricultural poultry productivity. Qualitative and quantitative improvements in poultry nutrition can lead to increased productivity, better bird health, and reduced production costs, ultimately boosting the overall efficiency and profitability of poultry farming (Danilenko et al., 2022).

The use of high quality and safe feed additives, as well as regular monitoring of gut health, are important measures

to maintain poultry health and productivity (Belkaid & Hand, 2014).

The aim of the present study was to determine the effect of a natural biologically active feed additive (peat-based additive) on the performance of laying hens, including egg productivity, egg weight, growth performance, daily feed intake, and morphometric parameters of eggs.

2. Material and Methods

2.1. Experimental site, design, animals and management

The experiment was conducted at the poultry farm AO "Floreni" and in the laboratory of the Department of Animal Science and Quality Control of the Technical University of Moldova. A total of 480 laying hens of the cross "High Line Brown W-36" aged from 17-34 weeks were individually weighed and randomly assigned to four experimental treatments. Each treatment consisted of 5 groups and 96 hens in each replicate. A completely randomized design (CRD) was used in this experiment (Fisinin, 2004).

Before feeding the experimental diets to laying hens, the feed ingredients were analysed at the Department of Animal Resources and Product Quality Control of the Technical University of Moldova. The experiment lasted 17 weeks (17-34 weeks of hens' age), during which five groups received different diets (Table 1): basic ration (CG), basic ration supplemented with 0.5 kg/ton of peat-based feed additive (EG1), basic ration supplemented with 0.75 kg/ton of peat-based feed additive (EG2), basic ration supplemented with 1.0 kg/ton of peat-based feed additive (EG3) and basic ration supplemented with 1.25 kg/ton of peat-based feed additive (EG4). The experimental diets were prepared using local ingredients and formulated to maintain a constant energy to protein ratio to meet the minimum requirements for laying hens (Fisinin, 2009).

All diets were isocaloric and isonitrogenous. The composition, calculated nutrient content, and feed cost of the different dietary treatments are shown in Table 2.

Table 1. Scheme of the experiment

Group	Number of laying hens	Features of Feeding
Control group (CG)	96	Basic compound feed (BCF)
Experimental group 1 (EG1)	96	BCF + PFA* 0.5 kg/ton
Experimental group 2 (EG2)	96	BCF + PFA* 0.75 kg/ton
Experimental group 3 (EG3)	96	BCF + PFA* 1.0 kg/ton
Experimental group 4 (EG4)	96	BCF + PFA* 1.25 kg/ton

*PFA: peat feed additive

Table 2. Composition of the basal diet (%)

Ingredients	Content	Nutrients	Content
Corn	63.15	Metabolic energy (MJ/kg)	11.67
Wheat bran	4.74	Crude protein	16.00
Soybean meal	21.24	Calcium	3.23
Limestone	7.76	Total phosphorus	0.62
Dicalcium phosphate	0.40	Available phosphorus	0.32
Soybean oil	1.53	Methionine	0.38
Choline chloride	0.09	Lysine	0.85
NaHCO ₃	0.09	Methionine + Cysteine	0.72
Mineral premix	0.90	Isoleucine	0.52
Methionine	0.05	Threonine	0.54
Phytase	0.03	Tryptophan	0.17
Vitamin premix 1	0.03	Valine	0.68

¹The premix for per kilogram diet included: vitamin A, 12,000 IU; vitamin D₃, 1500 IU; vitamin E, 25 IU; vitamin K₃, 1.0 mg; vitamin B₁, 1.6 mg; riboflavin, 5.0 mg; pantothenic acid, 15 mg; nicotinic acid, 20 mg; vitamin B₆, 6.0 mg; biotin, 0.2 mg; folic acid, 0.5 mg; vitamin B₁₂, 0.01 mg; choline, 500 mg; copper, 20 mg; iron, 90 mg; zinc, 80 mg; manganese, 80 mg; iodine, 0.45 mg; selenium, 0.2 mg. ²Metabolic energies are calculated value and others are measured values.

2.2. Measurements

Feed consumption

Prior to feeding each morning, the required amount of feed for each group was weighed. The residual feed was collected and weighed again the following morning. The feed given and the feed residue were measured in grams using an electronic digital scale, and the averages were calculated. Daily feed consumption was recorded, and the average feed intake per bird per day was determined.

Body weight

The hens' body weights were measured in grams using an electronic digital balance. The initial body weight of each hen was recorded and measurements were repeated monthly. Body weight of birds was measured in grams using electronic digital scales.

Egg production

Egg production (EP) was recorded daily, and egg weight (EW) was measured biweekly. Before determining EW, a sample of 12 eggs from each experimental group was stored for 24 hours at room temperature. The intensity of egg production, egg weight, feed costs per 10 eggs and per kilogram of egg mass, egg mass output per laying hen, and the organoleptic qualities of the eggs were evaluated. Samples of eggs were randomly collected from each experimental group every month to assess egg quality parameters (Ergun et al., 1987).

Egg quality parameters were *shape index*, *shell strength*, *shell thickness*, *albumen index*, *yolk index*, *yolk color*, and *Haugh unit*. Shape index (%) = [(egg width (cm)/egg length (cm)) × 100; shell strength (kg/cm × cm) was determined by using a machine with spiral pressure system; shell thickness (mm) was determined in three different parts (upper and lower ends and middle) by using

a micrometer; albumen index (%) = [(albumen height (mm)/average of albumen length (mm) and albumen width (mm)) × 100; yolk index (%) = [(yolk height (mm)/yolk diameter (mm)) × 100; yolk color was determined by using commercially available yolk color fan according to the CIE standard colorimetric system; Haugh unit = 100 × log (H + 7.57 - 1.7 × W × 0.37), where H = albumen height (mm) and W = egg weight (g)].

Feed conversion ratio

Feed conversion ratio (FCR) was expressed as kilogram of feed consumed per kilogram of egg produced. Feed conversion ratio for all treatments was calculated.

Poultry's safety

Monitoring of the bird's safety in all groups was carried out throughout the experiment, which is an important aspect for determining the health and well-being of hens.

2.3. Statistical analysis

The obtained egg mass data were processed using the biometric method of variation statistics. The significance level of the obtained data was determined by Student's t-test as * $p \geq 0.95$, ** $p \geq 0.99$, *** $p \geq 0.999$. Graphs were generated using Microsoft Excel 2016 applications. Data from the results of organoleptic evaluation of eggs were analyzed using one-way analysis of variance (ANOVA). Differences between means for each experimental group were assessed using Tukey's post hoc test (HSD), grouping using the Tukey method, and 95% confidence. Calculations were performed using the program Minitab 17.

3. Results and Discussion

The experimental introduction of a peat-based feed additive into the diet of laying hens is associated with a significant increase in egg production throughout the

laying period (Table 3). The maximum effect is observed with the optimal dosage of the additive – 1.0 kg/ton of feed. These results suggest a direct correlation between the dose of the feed additive and the level of egg production of poultry. Thus, the best results are achieved by incorporating a peat-based feed additive at a dosage of 1.0 kg/ton of feed into the diet of laying hens. It is important to note that a lower concentration of this additive does not significantly affect hen productivity. These findings provide valuable practical recommendations for optimizing egg production and effectively using organic bioregulators in poultry production.

Under current conditions, the main problem of poultry farms using highly productive crosses of foreign breeding is to ensure optimal feeding and care conditions for full development of genetic potential.

Practice shows that modern crosses, especially of foreign origin, are extremely sensitive to the conditions of keeping at domestic poultry farms due to fluctuations in temperature and humidity at different times of the year, changes in feed rations and their quality, as well as changes in light regime. All these factors have a negative impact on egg production and health of the flock. Additionally, the process of adaptation of imported laying hens to the infectious environment of domestic poultry farms does not always lead to successful results.

One of the key indicators determining the successful productivity of laying hens is the intensity of egg production, which requires an integrated approach to the creation of optimal housing conditions and management of influencing factors on the genetic potential of poultry.

Hens from the experimental groups were more resilient to negative environmental impacts, particularly the third experimental group. This indicates that environmental factors had minimal effect on the egg production of the third group, which received the peat-based feed additive at a dosage of 1.0 kg/ton of feed. The age at which peak egg production was reached was approximately the same for all groups, ranging from 30 to 34 weeks, which is consistent with the standards for this breed. However, the intensity of egg production varied significantly. The highest values for this indicator were recorded in the

second and third experimental groups – 88.00% to 88.25%, which is 1.65% to 1.96% higher than the control group.

During the four-month period of comparative analysis relative to the control group, an increase in the average egg production intensity was observed in the different experimental groups. In the first experimental group this increase was 1.09%, in the second - 1.56%, and in the third - 1.92%, indicating increased egg production activity compared to the control group. In the fourth experimental group, the increase was 1.20%.

The laying hens of the third experimental group had the highest gross egg collection, which reached 10502 eggs. This exceeds the number of eggs in the control group by 3266 pieces, which is an increase of 45.13%. Compared with the first experimental group, the difference was 1765 pieces or 16.81%, and with the second 879 pieces or 8.37%. Compared to the fourth experimental group, the third group showed a superiority of 164 pieces, which is an increase of 1.57%.

It is important to note that in the experimental groups, better safety and high egg production was also noticed in both initial and middle laying hens. These values were higher by 18.18% and 20.74% in the first experimental group, 27.45% and 32.98% in the second, 39.08% and 45.18% in the third, and 38.36% and 42.86% in the fourth.

For tasting evaluation of poultry products, the method of organoleptic evaluation was used, which allows a more accurate assessment of the general response of the poultry organism to the impact of both internal and external factors affecting the physiological state and quality of the produced products.

Tasting evaluation of eggs was carried out using a five-point scale. The results demonstrate the positive effect of peat feed additive on the quality of egg products. The third (4.27 points), fourth (4.06 points) and second (4.05 points) experimental groups, in which increased doses of peat feed additive were used, received the highest scores in the tasting analysis (compared to the control group). Eggs from the first experimental group received a slightly lower number of points, amounting to 4.02, which practically does not differ from the indicators of the control group (Table 4).

Table 3. Results of egg production of laying hens

Indicators	Group				
	CG	EG1	EG2	EG3	EG4
Feed consumption per day, g	120±0.4	110±0.4	106±0.3	102±0.3	100±0.2
Feed consumption per 10 eggs, kg	1.79±0.02	1.42±0.02	1.26±0.02	1.11±0.01	1.10±0.01
Per initial laying hen, pieces	550±1.5	650±1.7	701±1.7	765±1.8	761±1.8
Total eggs produced, pcs.	7236±5.8	8737±6.2	9623±6.5	10502±6.8	10338±6.9
Oviposition intensity, % (123 days)	59.00±0.71	71.03±0.72	78.00±0.75	85.38±0.83	84.03±0.81
Egg mass yield, kg	463.6±9.0	561.4±9.0	606.9±9.1	664.1±9.5	649.4±9.2
Average egg weight, g	61.29±0.57	62.91±0.74	63.07±0.38*	63.24±0.45**	62.16±0.69

* $p < 0,05$, ** $p < 0,01$

Table 4. Results of organoleptic evaluation of eggs (according to 5-point system, $n=10$)

Group	Aroma of the albumen	Colour of the albumen	Taste of the albumen	Degree of separation of the albumen from the yolk	Aroma of the yolk	Colour of the yolk	Taste of the yolk
CG	4.25±0.05 ^c	4.50±0.03 ^b	4.38±0.01 ^c	2.13±0.005 ^a	4.25±0.02 ^c	4.35±0.02 ^b	4.25±0.01 ^c
EG 1	4.50±0.02 ^b	4.50±0.01 ^b	4.50±0.01 ^b	1.38±0.009 ^c	4.38±0.02 ^b	4.38±0.02 ^b	4.50±0.01 ^b
EG 2	4.50±0.03 ^b	4.50±0.02 ^b	4.50±0.03 ^b	1.63±0.017 ^b	4.35±0.02 ^b	4.38±0.01 ^b	4.50±0.01 ^b
EG 3	5.00±0.04 ^a	4.63±0.01 ^a	5.00±0.01 ^a	1.25±0.010 ^d	4.50±0.01 ^a	4.50±0.01 ^a	5.00±0.01 ^a
EG 4	4.50±0.04 ^b	4.63±0.02 ^a	4.50±0.02 ^b	1.38±0.007 ^c	4.38±0.01 ^b	4.50±0.01 ^a	4.50±0.01 ^b
Mean	4.55±0.04	4.55±0.01	4.58±0.03	1.55±0.045	4.37±0.01	4.42±0.01	4.55±0.04
ANOVA	55.82 ^{***}	15.48 ^{***}	206.62 ^{***}	1097.05 ^{***}	30.36 ^{***}	24.68 ^{***}	754.17 ^{***}

*** $p<0,001$

Table 5. Economic efficiency of using peat feed additive in feeding laying hens

Parameters	Group				
	CG	EG1	EG2	EG3	EG4
Number of poultry, head:					
Start of the experiment	96	96	96	96	96
The end of the experiment	92	94	96	96	95
Safety, %	93.3	96.7	100.0	100.0	96.7
Eggs produced, pcs.	7236	8737	9623	10502	10338
Revenue from sales of eggs, lei	14471.6	17474.6	19246.7	21003.8	20676.4
Feed consumption, kg	1342.4	1243.5	1210.9	1165.2	1136.4
Total costs, lei (MD)	13324.4	15810.7	17194.5	18125.30	19115.20
Profit, lei (MD)	1447.2	1963.9	2352.2	3178.6	1861.1

The analysis of egg flavour characteristics showed that laying hens of the third and fourth experimental groups showed an increased quality of production, while in laying hens of the second experimental group this quality was slightly lower. The exception is eggs from laying hens of the first experimental group, which slightly exceeded the eggs of the control group in flavour characteristics.

Tasting analysis of laying hens' products shows that the addition of additional feed peat additive to their diet contributes to a significant improvement in egg quality. The most significant impact on product quality is observed when using peat feed additive at a dose of 1.0 kg/t of mixed feed, which is reflected in the results of the third experimental group.

When studying the cost-effectiveness of organic bioregulators in laying hens' diets, a significant increase in egg production was observed in hens of experimental groups, which were supplemented with peat supplement in addition to the main feed (Table 5). In comparison with the control group, the experimental groups showed higher productivity indices. These data confirm the feasibility of using peat additive in the composition of compound feed for industrial laying hens.

The use of peat feed additive in the main compound feed for laying hens of Hy-Leni cross resulted in a significant economic effect. In the experimental groups there was an increase in profit ranging from 300.2 to 620 lei. This

indicates that the introduction of peat additive not only increases the productivity of chickens, but also contributes to significant economic gain. The additional income indicates a reduction in egg production costs and an increase in egg profitability.

The conducted studies confirmed the effectiveness of using a peat feed additive to increase productivity and improve the economic performance of laying hens. The additive had a positive effect on egg production in all experimental groups, which demonstrates its potential as a means of optimizing feeding. However, the increase in total feed costs in the experimental groups, due to the cost of the additive, requires a detailed analysis of the economic return from its use. The highest economic efficiency was achieved in the third experimental group with a dosage of 1 kg/t of compound feed, where the profitability level was 17.8%, which is 6.7% higher than in the control group (Figure 1). This indicates that this dosage is optimal for achieving the maximum balance between costs and production results. A significant increase in profitability in this group is associated with an increase in egg production, which ensured maximum net profit against the background of a moderate increase in costs. The second experimental group (0.75 kg/t) showed a moderate improvement in profitability to 13.9%, which is 2.8% higher than in the control group. Despite the positive effect, the economic indicators of this group are inferior to the third, which indicates that increasing the dosage to the optimal level

allows achieving higher returns. The first experimental group, where the additive was used in a minimum dosage of 0.5 kg/t, demonstrated the lowest level of profitability among the experimental groups - 12.7%, which is 1.6% higher than in the control group. This result indicates that such a dosage is insufficient to realize the full potential of the additive, and its use in minimal quantities is not economically feasible. Exceeding the optimal dosage, as shown in the example of the fourth experimental group (1.25 kg/t), led to a decrease in profitability to 9.9%, which was lower than the level of the control group. This supports the hypothesis that excessive dosages lead to increased feed costs that are not offset by a corresponding increase in productivity.

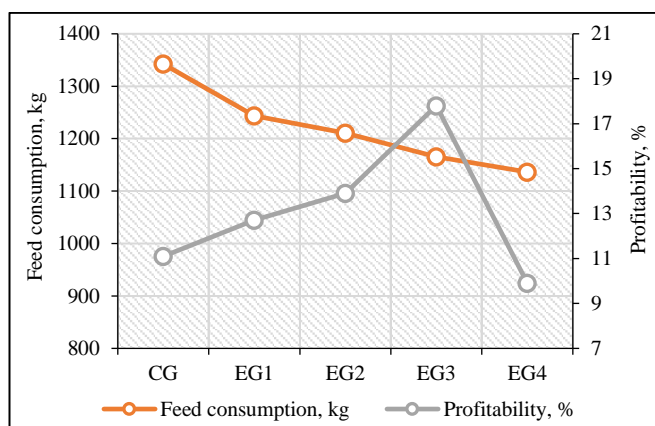


Figure 1. Dynamics of feed consumption and profitability level when using peat feed additive in laying hen diets

4. Conclusion and Suggestions

The results obtained confirm that the use of organic bioregulators in laying hens' diets not only represents an innovative approach, but is also an economically beneficial solution. Profit gains show a significant improvement in financial performance, which makes this method particularly attractive for industrial poultry farms. Thus, the introduction of feed peat additive into the main compound feed contributes to the sustainable development of poultry farming, providing both increased productivity and increased profitability of production. The addition of organic peat feed additive to the diet of laying hens, especially at a dosage of 1 kg/t (EG3), contributes to a significant increase in the productive performance of poultry. The increase in egg production by 39% and the increase in egg weight by 43.2% confirm the effectiveness of this approach. The economic benefit, expressed as an increase in profitability by 6.7%, makes the use of the additive a promising solution for increasing productivity and profitability of poultry farms.

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Conflict of interest

The authors declare that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required.

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