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Performance of laying hens fed diets incorporated with feather-based feed additive

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Abstract

A comprehensive and in-depth understanding of modern industrial poultry production technology is a vital condition for the development of poultry enterprises. Among the factors that determine poultry farming's development, the state and development of the feed base are of paramount importance. One of the promising directions for organizing rational poultry feeding based on self-produced feed is the use of new feed sources in compound feeds that have a multifaceted positive impact on poultry health. This study aimed to determine whether feeding feather meal induces changes in the body weight of laying hens, feed consumption, and egg production. The experiment was conducted on laying hens of the Hy-Line Brown W-36 breed without beak trimming, aged from 21 to 34 weeks at an industrial poultry farm. The chickens were placed in standard cages arranged in 6 tiers (with eight chickens per cage) and were distributed into five randomized groups. Four diets were formulated with the inclusion of feather-based feed additives in the base diet at levels of 2.0, 2.5, 3.0, or 3.5 kg per ton, while the control group was maintained on the standard diet. Research results using feather meal as part of the compound feed for laying hens have revealed that the inclusion of this additive had a positive impact on the live weight dynamics of Hy-Line Brown laying hens. Positive trends in absolute live weight gains were observed in the experimental groups compared to the control group, with EG1 showing an increase of 56.78 g (4.8%), EG2 with 43.66 g (3.7%), EG3 with 33.26 g (2.8%), and EG4 with 25.75 g (2.1%). The highest retention rate of laying hens was recorded in the first (EG 1) and second (EG 2) experimental groups: 98.9% and 97.9% respectively. The difference in retention between the first experimental group and the control group was 4.1%, while between the second experimental and control groups, it was 3.1%. The feather meal feed additive is an effective protein supplement, and research has revealed its positive influence on live weight gains and the survival of laying hens. The most effective level is 2 kg per ton of compound feed, which can be explained by the data observed in EG1.

Keywords: Laying hens, Feeding, Feather-based feed additive, Live weight

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1. Introduction

Poultry production ranks first in the world among all livestock sectors in terms of annual growth rate of meat production, and second (36%) after pork (38%) in terms of gross meat production. Beyond the nature of this continuity hides the significant role of poultry farming in the production of meat products. In addition, it is worth considering that eggs are an important component in the world food basket. In total, more than 74 million tons of eggs are produced, which corresponds to more than 1 trillion 360 billion eggs. This fact emphasizes the importance of poultry production as the most successfully developing branch of agriculture capable of providing consumers with biologically nutritious food products.

The feeding ration plays a crucial role in the structure and development of poultry production. Particularly critical is the deficiency of protein and minerals in poultry diets.

The understanding of the importance of protein feeds in diets for farm animals and poultry is very high. Protein feeds are not only scarce but also financially demanding components in diets. Therefore, research to address the problem of protein deficiency continues to evolve and remain relevant (Gavrilova, 2004).

The integration of non-traditional feed ingredients is an innovative approach in poultry production that can significantly improve sustainability and production efficiency. This method offers the opportunity to expand the range of feed ingredients, which not only diversifies poultry diets, but also reduces dependence on expensive protein feeds. This is particularly important in the context of price volatility of classical feeds. The use of non-traditional feeds can help to strengthen the feed base and thus increase productivity in the poultry industry.

In the modern context, when the feed industry is faced with an acute shortage of raw materials, primarily protein, ensuring high quality products and competitiveness of poultry farming becomes an urgent task. Lack of protein in feed entails a decrease in the productivity of poultry and an increase in the cost of production (Egorov et al., 2010).

Therefore, it is now strategically important to look for alternative sources of protein that can compensate for protein deficiency. In this context, the use of non-traditional feed ingredients, such as feather meal, is of great importance

Given the increasing need to reduce dependence on grain in feed production, we are seeing significant interest in researching and implementing alternative sources of nutrients, such as by-products from various industrial sectors. This approach not only enables feed to be enriched with essential nutrients, but also reduces pressure on grain resources, which is relevant when grain reserves are limited.

There are several strategies to address feed protein deficiencies. First and foremost, researchers and the poultry industry are actively seeking alternative sources of protein to supplement or replace conventional feedstuffs. This includes exploring the use of non-traditional feed ingredients, such as feather meal, which can provide a high-protein supplement to poultry diets (Fisinin and Egorov, 2011)

The extraction of protein from poultry feathers represents an important development in the poultry industry. Feathers, previously considered waste, are now becoming a valuable resource. The process of processing feathers, while respecting the technological parameters, allows the protein to be preserved in its most useful form, namely keratin. This keratin is rich in protein, making it highly valuable for poultry feed (Chikov and Kononenko, 2009; Fisinin et al., 2012).

Studies show that when feather meal is introduced into poultry diets, there is an improvement in their overall performance. This includes higher body weight gain and increased protein production. Importantly, this protein has a high biological value and is easily digested by the poultry body.

In recent years, new technologies for feather processing have been actively developed, allowing to obtain a high-protein feed additive from it. Large poultry feathers and waste from feather and down production facilities contain up to 85-88% protein-keratin. Poultry feather processed using the new technology is converted into a feather product (with feather temperature treatment not exceeding 60 °C), which is effectively used by the poultry organism (Caisin et al., 2019).

The study of non-traditional feed ingredients provides unique opportunities to develop more efficient animal diets, including processing technologies that maximize their biological value. This area of research helps to develop strategies for more efficient use of resources and to reduce the environmental impact of agriculture.

Thus, research on non-traditional feed additives not only improves animal performance, but also contributes to a more sustainable and environmentally friendly agriculture, which is an important challenge in today's environment.

In this regard, this study aimed to evaluate the possibility of integrating feathers processed using new technologies into poultry diets. Subjecting the feather to a temperature treatment that did not exceed 60 °C produced a feather product. Our task was to determine the optimal doses of this feather supplementation for poultry diets. We sought to identify doses that would maximize the growth and development of the poultry. This approach is aimed at more efficient utilization of available resources and increasing the productivity of poultry, ultimately contributing to increased production of quality products.

2. Material and Methods

To evaluate the effectiveness of feather meal in the feeding of laying hens, a scientific and economic experiment was conducted. The object of research was laying hens of one-age industrial flock of cross “Hai-Lan-brown”, kept in production buildings equipped with battery type cages. Experiments were conducted by the method of analogues; five groups of laying hens were formed (control and four experimental groups, Table 1) with 96 heads in each (Imangulov et al., 2004).

During the experiment feeding of laying hens was carried out with the same composition of mixed fodder in accordance with the recommended feeding norms (Nadtochiy, 2016), the control group received the main mixed fodder, and the birds of the experimental groups were fed feather meal (FMP) in the diet.

The use of feather feed additive, as investigated in this paper, is a promising solution to strengthen the feeding ration of poultry production. Modern feather processing technologies allow it to maximize its high-protein

potential. Waste from feather processing and large poultry feathers, containing up to 85-88% protein, become a source of valuable nutrients.

During the experiment, we carried out the following: determination of optimal doses of feed meal from feathers in diets of laying hens; studied the dynamics of live weight at the introduction of feed additive from feathers in the diet; determination of average daily gains in live weight of hens laying; accounting of safety of birds throughout the experiment. This made it possible to determine how the supplement affected the growth rate of laying hens. Monitoring the safety of poultry in all groups throughout the experiment. This aspect is important to ensure animal health and welfare. In addition, it should be emphasized that the diets of all groups were carefully balanced in terms of nutrients, which contributed to the objective results of the study.

Table 1. Experimental groups

Group	Specific feeding characteristics
Control (CG)	Basic compound feed (OC)
Experimental 1 (EG 1)	OC + KMP* 2.0 kg/ton
Experimental 2 (EG 2)	OC + KMP* 2.5 kg/ton
Experimental 3 (EG 3)	OC + KMP* 3.0 kg/ton
Experimental 4 (EG 4)	OC + KMP* 3.5 kg/ton

**KMP: Feed meal from feathers*

The experimental part of the work was carried out on the basis of the poultry farm of "Floreni" JSC and in the laboratory of the Department of Animal Resources and Quality Control, Technical University of Moldova in 2022.

3. Results and Discussion

The results of the study indicate the intensity of growth and development processes at the introduction of feather additive in the diets of laying hens (Table 2).

The results of our research allow us to identify the optimal dosage range of feather feed additive for laying hens in order to achieve maximum growth intensity. This range is from 2% to 3.5% of the total feed weight. At this dosage, the highest weight gain in poultry was observed. This indicates that feather supplementation has the potential to improve the performance of laying hens.

However, it is important to note that even within the optimum dosage range, the level of feather supplementation should be strictly controlled so as not to lead to overconsumption. It is always necessary to consider the balance of feed components and the poultry's requirements for various nutrients. Nevertheless, our research provides important data for the development of effective strategies for the use of non-conventional feed additives such as feather meal to optimize poultry production.

At the initial oviposition stage at 17 weeks of age, the first experimental group of laying hens showed a significant increase in live weight compared to the control group, by 62 g or 4.4%. The second experimental group showed an increase of 53.86 g or 3.8%. The third experimental group showed an increase of 48.82 g, equal to 3.4% and the fourth group showed an increase of 40.8 g, equal to 2.9%. It is important to note that the initial live weight was almost the same in all groups, with a difference of no more than 1.4 %, which did not exceed the permissible deviation for live weight in the formation of the group, set at 3%.

At the end of the experiment, at the age of 34 weeks, the highest gains were also obtained from laying hens of the experimental groups. Compared to the control, this difference in the 1st, 2nd, 3rd, 4th groups were 61.25;50.46;42.36 and 35.15g, or 3.3; 2.7;2.3 and 1.9%, respectively, which indicates the most intensive growth rate of laying hens from the experimental groups.

Table 2. Dynamics of live weight of laying hens

Age, weeks	Group of laying hens				
	CG	EG1	EG2	EG3	EG4
8	665.00±1.00	669.47±0.57	671.80±1.04	673.87±1.41	674.40±1.01
12	1144.40±2.16	1181.20±1.75	1172.67±3.15	1166.93±3.16	1158.20±3.09
17	1400.80±2.56	1462.80±2.00	1454.66±3.61	1449.62±5.20	1441.60±2.12
22	1710.43±1.47	1773.55±2.40	1761.90±2.36	1752.09±3.31	1747.03±2.03
26	1772.27±4.28	1841.20±0.78	1834.88±4.66	1826.34±8.02	1818.36±4.44
34	1835.87±4.98	1897.12±7.05	1886.33±2.04	1878.23±1.50	1871.02±0.62
Absolute growth, g	1170.87	1227.65	1214.53	1204.13	1196.62
Average daily gain, g	6.43	6.75	6.67	6.62	6.58
Relative growth, %	176.07	183.37	180.79	178.72	177.43
Weight of experimental hens at the end of the experiment in % of the control group	100	103.34	102.75	102.31	101.92

The birds of the first experimental group, which were provided with feather feed supplement in the amount of 2% of the feed weight, achieved the highest live weight gain. In comparison with the control group, the difference was very noticeable: absolute weight gain was 56.78 g (or 4.8%), average daily gain was 0.32 g (or 4.9%), and relative gain reached 7.63%. These data indicate high growth activity and activation of metabolic processes in laying hens receiving the studied supplement.

The increase in live weight gains observed during the study may be attributed to the properties of the feather feed supplement. These properties include normalization of digestive processes, improved conversion of feed intake to body weight and immune support. Together, these factors have a positive effect on the metabolism of laying hens. For a better visualization of the dynamics of poultry growth, we present a diagram illustrating the change in live weight during the whole period of the experiment (Figure 1).

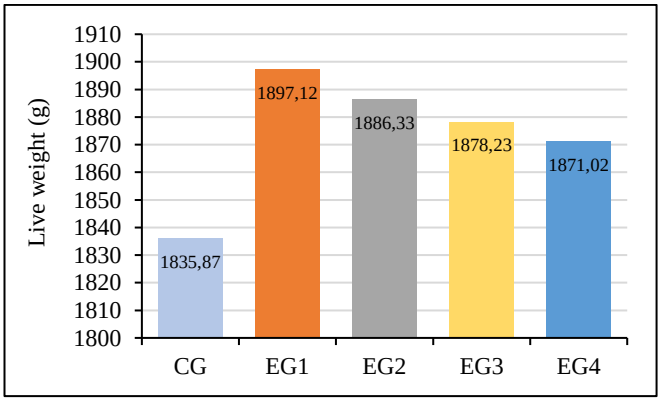

Figure 1. Dynamics of live weight of laying hens at 34 weeks of age

According to the diagram in Figure 1, it can be seen that from weeks 8 to 34 of the study, there are marked differences in the rate of live weight gain of laying hens. These observations can be interpreted as a response of the poultry organism to the inclusion of the investigated supplement, which emphasizes the importance of its effect on the processes of growth and development of poultry.

In spite of similar conditions for poultry in control and experimental groups, significant differences in live weight indicate a profound effect of protein components present in the feather supplement on biochemical and physiological processes in the poultry organism. This may indicate a pronounced biological activity of this supplement, affecting the absorption of nutrients, metabolism, and, as a consequence, the intensity of poultry growth.

Retention is an important indicator characterizing the nutritional adequacy of poultry under optimal housing conditions. To determine the safety of chickens during the experimental period, we recorded the number of fallen stock during the whole period of research (Table 3).

It should be noted that herd safety is a key indicator that evaluates the effectiveness of the studied feather feed additive. The analysis of the livestock safety during the experiment also allows us to identify the optimal dosage of feather feed additive. The greatest increase in safety was observed in the first experimental group, where the dosage was 2% of the feed weight. The difference in safety between this group and the control group was 4.1%, emphasizing the effectiveness of this dosage. The second experimental group, which received 2.5% of feather supplementation, also showed high retention, although slightly lower than the first experimental group.

The difference in preservation between the control group and the second group was 3%. These results suggest that a dosage of 2% to 2.5% of feed weight is optimal to maximize the retention of laying hens. Representation of the percentage of safety during the experiment is given in Figure 2.

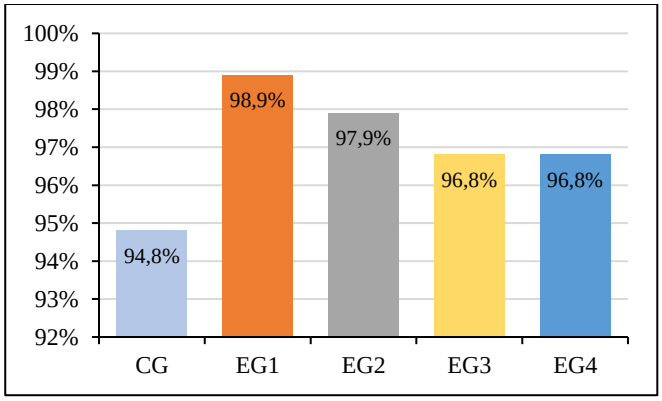

Figure 2. Conservation of laying hens during the experiment period

Table 3. Safety of laying hens for the period of experience

Indicator	Group of laying hens				
	CG	EG1	EG2	EG3	EG4
At the beginning of the experiment, heads	96	96	96	96	96
At the end of the experiment, heads	91	95	94	93	93
Safety, %	94,8	98,9	97,9	96,8	96,8

4. Conclusion

The results of our research provide valuable practical recommendations for poultry farmers and poultry enterprises. In particular, identification of the optimal dosage of feather meal at 2% per 1 ton of mixed feed is important. This dosage has the greatest positive effect on the growth and development of poultry, and also contributes to increasing their productivity.

In addition, this feed additive represents a potential solution for agricultural enterprises facing the problem of protein deficiency in compound feeds. Its use can lead to improved quality of mixed fodder, reduced costs of feeding poultry and, as a consequence, increased economic efficiency of poultry farming.

Thus, it is recommended to widely implement this practice at the enterprises of poultry farming, taking into account the optimal dosage. This not only helps to increase egg and meat production, but also helps to solve important agricultural problems related to providing consumers with high-quality food products and reducing economic costs.

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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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