ISBN 978-989-9121-13-3
31st ISTANBUL International Conference on "Chemical, Agriculture, Biological and Environmental Sciences" (ICBEN-22)
Nov. 23-25, 2022 Istanbul (Turkey)

Egg Quality of Laying Hens Fed Different Levels of Feather Meal

[1]Larisa Caisin, [1]Alla Cara

[1]Department of Management of livestock products and agri-food security,

Technical University of Moldova

***Abstract*:** *Poultry farming in Moldova is one of the most important branches of agriculture. Conducting poultry farming on an industrial basis makes it possible to obtain high-quality products with high efficiency of feed payment. Modern industrial poultry farming uses highly productive hybrid poultry for the production of eggs and meat, which makes high demands on complete feeding.*

The present study was conducted in a commercial poultry farm to investigate the effect of feather meal added to the diet on the performance and quality of eggs of laying hens between 21 and 34 weeks of age. A total of 1,000 Hy-Line brown laying hens were housed in 6-tiered cages.

According to the results of studies on the use of feed flour from feathers as part of compound feed for egg-laying hens, it was revealed that its use contributed to an increase in the productive qualities of poultry. The results showed that performance in terms of egg production, egg weight and protein mass depended on the inclusion of feather meal at levels of 2 or 3.5% of the diet. The use of feather meal in the diets of chickens at the beginning of oviposition affected the increase in the mass of eggs in EG1 by 1.3 g (2.6%; P<0.05), in EG2 by 0.5 g (1.0%, P<0.05) in EG3 0.63 g (1.2%, P<0.05). In all experimental groups, an increase in shell thickness and weight was observed, which varied from 6.01g (EG2) to 6.28g (EG1) in comparison with the control group, where the shell weight was 5.91g. Indicators were obtained by the production of chickens EG1 (29.75 points) in terms of such indicators as the aroma and taste of protein. In terms of taste, the experimental groups were superior to the control group, respectively. Thus, it was found that the addition of feather meal had a significant improvement in some indicators of the quality of eggs and their organoleptic indicators in the experimental groups compared to the control.

Keywords: *laying hens, egg productivity, feather meal*

1. Introduction

Poultry farming in the food market has become one of the main sources of meat and the only source of food eggs. Due to the high dynamism, the annual increase in egg production in the world amounted to 1.5 - 2%. Changes in egg quality observed in conditions of intensive poultry farming indicate the possibility of regulating these parameters without compromising their high nutritional values. Morphological features, such as the weight and shape of the egg, the weight of the yolk, albumen, shell, its strength, and others, are determined mainly by genetic factors and conditions of keeping and feeding [1]. Evaluation of the morphological qualities of eggs is not limited to external examination. Opening the eggs makes it possible to more objectively judge the quality of the protein, yolk and shell [2].

For the manifestation of a significant genetic reserve of modern chicken crosses, a constant supply of a whole range of nutrients with feed is necessary, therefore, the solution to the problem of balanced feeding of

poultry is possible using cheap feed from processing enterprises, which would not be inferior to expensive feed in terms of set and nutritional value.

The high cost of fish and meat and bone meal is explained by the lack of available energy sources, and its low level in the feed causes an excess of deficient protein [3, 4].

Feather meal is a good source of protein. In recent years, new technologies for processing feathers have been actively developed, making it possible to obtain a high-protein feed additive from it. Large bird feathers and feather and down production wastes contain up to 85 - 88% of protein - keratin. The bird feather processed according to the new technology is transformed into a feather product (when the temperature treatment of the feather is not higher than 60^0C), which is effectively used by the bird's body [5, p. 6].

In this regard, of great interest are studies on the study of egg productivity, indicators of the quality of food eggs obtained from laying hens of the Hy-Line brown cross with the introduction of a new feather feed additive into their diet.

2. Material and research methods

The experimental part of the work was carried out on the basis of the poultry farm JSC "Florenı" and in the laboratory of the Department of Management of Livestock Products and Quality Control of the Technical University of Moldova in 2022. The object of research was chickens-laying hens of the same-aged industrial flock of the Hy-Line brown cross during the laying period, which were kept in the main production buildings equipped with cage batteries. According to the recommendations for working with this cross, the necessary microclimate parameters were maintained in the premises.

Studies of physical and morphological parameters and indicators of egg quality were carried out. For this purpose, 20 eggs were selected by random sampling during the laying period of 21, 34 weeks and were analyzed on the second day after laying. Eggs were evaluated according to physical and morphological indicators: the mass of eggs, protein, yolk and shell by weighing with an accuracy of 0.1 g; formula index, shell thickness - using a caliper; the protein and yolk index was calculated by dividing its height by the average diameter; to calculate the protein and yolk index (I), the formula $I = [2H/(D+d)]*100$ was used, where H is the height, mm; D, d - respectively large and small diameter, mm; the ratio of protein mass to yolk mass was established by dividing the protein mass by the yolk mass; Howe units according to the table, using the value of the mass of the egg (g) and the standing height of the outer dense protein (mm) when pouring the contents of the egg onto a flat glass [6].

Feeding of laying hens was carried out with compound feeds of the same composition in accordance with the recommended feeding norms [7, p. 223], the control group received the main compound feed, and the birds of the experimental groups were fed with feather meal (FM) (Table 1).

TABLE I: Scheme of the experiment

Group	Features of feeding
Control (CG)	Basic compound feed (BCF)
Experimental 1 (EG1)	BCF + FM* 2,0 kg/ton
Experimental 2 (EG2)	BCF + FM* 2,5 kg/ton
Experimental 3 (EG3)	BCF + FM* 3,0 kg/ton
Experimental 4 (EG4)	BCF + FM* 3,5 kg/ton

**FM - feather meal*

Feed and water were provided ad libitum throughout the experimental period. The experimental period lasted for 34 weeks.

Biometric processing of digital data and assessment of their reliability were carried out according to generally accepted methods [8, p. 63].

3. Research results

The edible egg has a complex structure and is an unfertilized egg. Changes in egg quality observed under intensive poultry farming conditions indicate the possibility of regulating these parameters without violating

their inherent high nutritional benefits. Morphological characteristics, such as the weight and shape of the egg, the weight of the yolk, protein, shell, its strength and others are determined mainly by genetic factors and conditions of keeping and feeding.

Poultry corporations point out that unbalanced rations in any respect to feeding become inferior, and significantly significant productivity and feed efficiency [8]. Therefore, we conducted a study on the statistics of various dosages of feed concentrate from feathers in the diets of laying hens of the Hai-Lan cross of brown color on the morphological parameters of the egg.

Egg weight is the most important physical indicator of nutritional and commercial value that determines the productivity of a hens.

When conducting a morphological analysis of eggs, an increase in the weight of eggs during the laying period in the experimental groups was noted in comparison with the control: at 21 weeks of age (beginning of egg-laying), the eggs in groups EG1, EG2 and EG3 exceeded the weight of eggs from control group by 1.3, 0.5 and 0.16g respectively. Thus, the use of feather meal in the diets of chickens at the beginning of oviposition affected the increase in egg weight in EG1 by 1.3 g (2.6%; P <0.05), in EG2 by 0.5 g (1.0% P <0.05) and in EG3 by 0.63g (1.2% P<0.05) (Fig. 1).

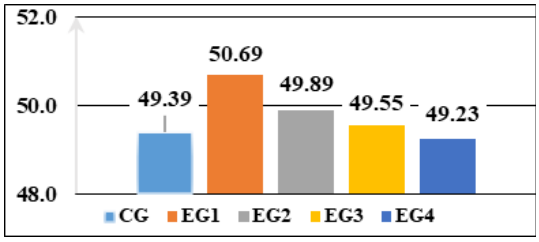

Fig.1. Average weight eggs (g), at the beginning of laying, JSC «Floren», 2022

Egg weight is in direct proportion to albumen, yolk and shell. The albumen is a major indicator of internal egg quality; air cell size, albumen and yolk quality and the presence of blood or meat spots in the eggs are the parameters, which determine the internal egg quality [9, 10].

In the experiment, the use of feather meal affected the increase the egg protein mass in EG1 by 0.40 (P <0.05) and in EG2 by 0.25 g (P<0.05) (Table II).

Other indicators characterizing the quality of eggs is the ratio of the mass of the constituent parts of the egg. For a qualitative assessment of the biological usefulness of food eggs, the shape of the eggs, the white and yolk indices, and the strength of the shell are determined.

TABLE II: Effect of feed additive on egg composition ratio
at the beginning of lay (21 weeks), n = 20 ($\overline{X} \pm S\overline{x}$)

Indicators	Group				
	Control	EG 1	EG 2	EG 3	EG 4
The mass of the components of the egg, g					
Protein	29,61±0,81	30,01±0,77*	29,86±0,79*	29,53±0,73	29,52±0,72
Yolk	13,87±0,31	14,40±0,56	14,15±0,29	13,96±0,27	13,49±0,23
Shell	5,91±0,27	6,28±0,17	6,01±0,19	6,06±0,12	6,22±0,24
The ratio of the components of the egg to the mass of the egg, %					
Protein	59,95±0,22	59,20±0,29	59,65±0,32	59,59±0,26	59,96±0,31
Yolk	28,08±0,11	28,40±0,31	28,28±0,18	28,10±0,22	27,40±0,29
Shell	11,96±0,22	12,38±0,19	12,01±0,15	12,23±0,25	12,63±0,24
The ratio of the mass of protein to the mass of the yolk	2,13±0,17	2,08±0,30	2,10±0,22	2,12±0,28	2,18±0,32

*Note: * P<0.05; **P<0.01, **P<0.001*

Egg yolk is still an important source of nutrients a source of biologically active substances [11].

During this period of oviposition, a slight decrease in the mass of egg yolk was noted in all experimental groups in comparison with the control; with an increase in the mass of eggs and the mass of the protein. According to Stele A.L. and Filatova A.I. an increase in the mass of eggs from 45 to 75g and increase in their calorie content is observed [12].

A direct impact on the quality of food eggs is exerted by the strength of the shell, the value of which determines the amount of breakage and notches and the preservation of the nutritional properties of eggs during storage [13]. During the 21th week of the experiment laying hens in all experimental groups showed an increase in shell thickness and shell weight, which varied from 6.01g (EG2) to 6.28g (EG1) in comparison with the control group, where the shell weight was 5.91g (Table III).

TABLE III: Egg morphology at start of lay (21 weeks), n = 20 ($\overline{X} \pm S\overline{x}$)

Indicators	Group				
	Control	EG 1	EG 2	EG 3	EG 4
Average protein diameter, cm	8,3±0,17	8,7±0,15	8,0±0,44	8,2±0,61	8,4±0,55
Protein height, mm	7,1±0,20	7,7±0,12	7,5±0,33	7,5±0,90	7,2±0,52
Protein index, %	9,2±0,65	8,8±0,48	9,4±0,14	9,1±0,81	8,5±0,06
Yolk height, mm	14,4±0,19	15,4±0,19	17,3±0,20	17,97±0,03	14,8±0,19
Yolk diameter, cm	3,9±0,33	3,6±0,83	3,5±0,15	3,6±0,29	4,0±0,32
Yolk index, %	37,0±0,29	42,7±0,19	49,4±0,23	49,9±0,77	37,0±0,29
Shell thickness, mm	0,33±0,44	0,34±0,72	0,34±0,04	0,34±0,32	0,34±0,26
Howe units	73,41	74,41	74,21	73,52	73,41

When assessing the effect of the studied feed additive on the weight of eggs at 34 weeks of age, it was found that, on average, the egg weight of laying hens in the first experimental group exceeded the control values by 1.29 g, while in other groups it was slightly lower (Fig. 2).

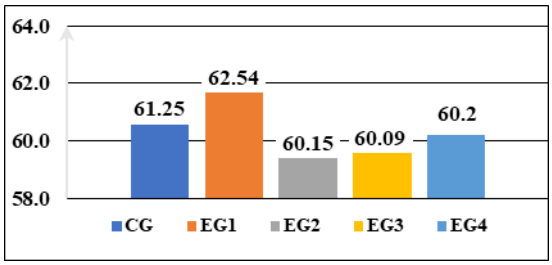

Fig. 2. Average weight of eggs (g)
during the reproductive period of 34 weeks, JSC «Floren», 2022

When analyzing the data on the ratio of the components of the eggs of laying hens at 34 weeks of age, an increase in the mass of protein in the experimental groups was also noted in comparison with the control with a slightly larger mass of yolk in EG1 (16.88g) (Table IV). Nutritional value level eggs increase during the reproductive period, but the proportion of protein and yolk in its maintenance is determined by the laying period.

The difference between the indicators at the beginning and end of oviposition in terms of yolk weight was 7.2 and 7.4% and in protein weight - 8.4 and 9.4%, respectively, in the first and second experimental groups.

The egg shell is a kind of natural packaging that contains the contents of the egg. It consists of 95% inorganic compounds, mainly calcium salts. The quality of the shell is determined by its thickness, relative weight and density of the egg. The thickness of the shell mainly determines its strength and, consequently, resistance to mechanical destruction [14].

Against the background of the use of feed flour from the feather, an increase in both the absolute and relative mass of the shell was noted. Eggs of laying hens at the age of (34 weeks) had a high indicator of shell thickness and its percentage in relation to eggs obtained from laying hens at the beginning of laying (21 weeks).

TABLE IV: Influence of feed additive on the ratio of egg constituents in the age of laying hens (34 weeks), n = 20 ($\overline{X} \pm S\overline{x}$)

Indicators	Group				
	Control	EG 1	EG 2	EG 3	EG 4
The mass of the components of the egg, g					
Protein	36,63±0,86	37,52±0,67	36,86±0,79	36,95±0,72	36,77±1,22
Yolk	16,75±0,37	16,88±0,26	15,80±0,29	15,78±0,33	15,85±1,12
Shell	7,87±0,29	8,14±0,15	7,49±0,19	7,36±0,24	7,58±0,19
The ratio of the components of the egg to the mass of the egg, %					
Protein	59,80±0,22	59,99±0,21	61,28±0,32	61,41±0,29	61,07±0,33
Yolk	27,34±0,11	26,99±0,31	26,26±0,18	26,26±0,14	26,32±0,19
Shell	12,84±0,22	13,01±0,23	12,45±0,21	12,24±0,22	12,59±0,24
The ratio of the mass of protein to the mass of the yolk	2,18±0,47	2,22±0,32	2,33±0,28	2,34±0,36	2,31±0,34

So, during this period, the shell thickness in the groups increased from 0.34 mm to 0.36-0.37 mm, while at the end of the experiment a difference was found in EG 1 (0.37 mm), which is 0.01 mm more in contrast to the control. Based on objective data, the highest shell weight was 8.14g. 3.43% higher compared to the control, respectively. The ratio of the mass of protein and the mass of the yolk shows that in the experimental groups the egg contains more protein than in the control group, and in the second experimental group its amount exceeds that in the first experimental group (Table V).

TABLE V: Morphological characteristics of eggs at the age of laying hens (34 weeks), n = 20 ($\overline{X} \pm S\overline{x}$)

Indicators	Group				
	Control	EG 1	EG 2	EG 3	EG 4
Number of eggs, pcs.	20	20	20	20	20
Average protein diameter, cm	7,6±0,27	7,7±0,15	7,6±0,44	7,9±0,51	7,5±0,47
Protein height, mm	7,2±0,20	7,8±0,12	7,5±0,33	7,7±0,90	7,14±0,35
Protein index, %	9,4±0,65	9,8±0,38	9,8±0,14	9,7±0,81	9,5±0,16
Yolk height, mm	14,5±0,10	16,9±0,19	17,0±0,20	15,8±0,03	14,38±0,40
Yolk diameter, cm	3,9±0,33	4,2±0,65	4,00±0,15	4,18±0,29	4,25±0,32
Yolk index, %	37,0±0,29	40,2±0,19	42,4±0,23	37,7±0,77	33,8±0,29
Shell thickness, mm	0,36±0,44	0,37±0,72	0,36±0,04	0,36±0,32	0,36±0,56
Howe units	81,22	82,41	80,87	81,00	80,22

As a result of scientific research, an increase in the mass of protein and, accordingly, a decrease in the specific gravity of the yolk of eggs obtained from birds of experimental groups that received fodder meal from feathers was established.

One of the indicators of the quality of food eggs is the protein index, which decreases slightly with the age of the bird. This indicator at the 21st and 34th weeks varied from 8.2 to 9.2%, which corresponds to the normative indicators.

The yolk index of food eggs was in the range of 33-42% and remained practically unchanged during the study period.

Howe units have the highest relationship with the protein index, since both of these indicators are determined based on the measurement of the height of a dense protein. The optimal values of the Howe units for chicken eggs are 65-87. Analyzing the data obtained from our studies, it was found that the indicator of the Howe unit at 34 weeks of age in all groups was almost the same and amounted to 82.41 in EG1, 80.87 in EG2, while in CG it was 81.22. It should be noted that the indicators of the protein index and the Howe unit decrease with the age of the bird. This is due to an increase in the time the egg stays in the laying oviduct, namely in the uterus, where the shell is formed and water enters the protein [15].

TABLE VI: Results of the organoleptic evaluation of eggs, according to a 5-point system (n=10)

Indicators	Group				
	Control	EG 1	EG 2	EG 3	EG 4
Squirrel flavor	4,25±0,19	5,00±0,19	4,50±0,16	4,50±0,16	4,50±0,16
Yolk flavor	4,25±0,26	4,5±0,26	4,35±0,16	4,38±0,18	4,38±0,16
Squirrel color	4,50±0,19	5,00±0,19	4,50±0,19	4,63±0,18	4,63±0,19
Yolk color	4,35±0,18	4,5±0,18	4,38±0,18	4,38±0,18	4,38±0,18
protein taste	4,38±0,19	5,00±0,19	4,50±0,19	4,50±0,19	4,50±0,19
Yolk flavor	4,25±0,19	4,50±0,19	4,50±0,19	4,50±0,19	4,38±0,19
The degree of separation of the protein from the yolk	2,13±0,16	1,250±0,16	1,63±0,16	1,38±0,18	1,38±0,16
Overall rating	28,11	29,75	28,36	28,27	28,15

The characteristic taste of a chicken egg is given by yolk lipids, which stimulate appetite - a prerequisite for normal digestion. Protein and yolk represent a single system of egg contents, forming a complex of essential amino acids and complete protein, lipids and saturated fatty acids, other nutrients and biologically active substances.

In the tests carried out, the highest overall score in terms of organoleptic indicators was received by the products of chickens EG1 (29.75 points) in terms of such indicators as the aroma and taste of protein. In terms of taste, the experimental groups were superior to the control group, respectively.

4. Acknowledgements

The authors would like to acknowledge their gratitude to TUBITAC (Turkey) and our partner Yozgat Bozok University (Turkey), Dean of the Faculty of Agriculture and Natural Sciences Prof., Dr. Yavuz GÜRBÜZ for the opportunity to implement research under the bilateral project “Innovative Strategies for Improving the Biological Effectiveness o (Some Unused and Environmentally Polluting Wastes and Developing Thein as Poultry Alternative Feed and Additive”, contract № 21.80013.8007.3B.

5. Conclusions

The use of feed additives from feathers as part of the main diet of laying hens during the productive period showed that all morphological parameters of eggs corresponded to optimal values. Based on the foregoing, it follows that the assessment of the quality of edible eggs of the Hy-Line brown hens during the productive period showed that all morphological and physicochemical parameters corresponded to the optimal values: increase egg weight by 1.29 g or 2.1%, which was manifested in the improvement of morphological parameters and egg quality, protein index from 8.2 to 9.2%, yolk index from 33.0 to 42.0%, shell thickness from 0.34 to 0.37 mm, Howe units from 74.41 to 82.41. Based on the data we have obtained, we believe that the optimal rate of feed additive from feathers for laying hens is a dose of 2% per 1 ton of feed, and can serve as an alternative to the use of expensive feed additives.

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