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Hematological Parameters in Broiler Chickens using Feather Meal as Part of Compound Feed

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***Abstract*:** *Modern technology of industrial poultry farming causes a significant functional load on the poultry organism. In intensive poultry farming, biologically complete feeding is a decisive factor in obtaining high productivity. The production of feed for poultry is constrained by the lack of protein feed of plant and animal origin. In the researches, the protein feather concentrate was tested on the Cobb 500 cross hybrid. The poultry feather-based feed additive used in the experiment was made according to the special technology of the Terafix company.*

As a result of the experiment on the use of feather protein concentrate in different concentrations to broiler chickens and the study of its effect on the health of chickens, of their clinical-hematological, physiological-metabolic status and productivity indicators, it was found out that for the chickens of all experimental groups average indicators for the level of erythrocytes, hemoglobin, hematocrit and lymphocytes were within the physiological norm. The indicators of leukocytes are lower in the experimental groups than in the control group, which confirms the positive effect of feather concentrate on hematopoietic functions, as well as on their nonspecific resistance.

The obtained results of the use of protein feather concentrate in determining the total protein in the experimental groups showed a slight increase in comparison with the control group, which confirms a positive effect on protein metabolism and nonspecific resistance of broiler chickens.

According to experimental data, under production conditions, the optimal concentration of feather meal in the diet of broiler chickens was 1.5%.

Keywords: *broiler chickens, feather protein meal, hematological parameters*

1. Introduction

In ensuring the country's food security, the production of cost-effective and high-quality environmentally friendly poultry products is of great importance. A sustainable increase in poultry production is possible on the basis of rational nutrition, taking into account all the necessary factors. Currently, one of the main directions of increasing productivity in poultry farming is the search for and use of biologically active additives in the diets. The high productivity of animals, the maintenance of the productive functions of the body, the effective use of feed is now impossible without the inclusion of feed additives in the diet that provide the necessary level of good nutrition [8, 9, 10, 3].

The growing demand for protein feed can be met by maximizing the use of non-food waste, which is an unconventional source of increasing feed protein resources.

A fundamentally new approach towards the effective use of new feed additives is the development of bioconversion technologies based on the use of effective complexes and ensuring the conversion process of

complex organic compounds that make up the waste, as well as suppressing the growth and development of pathogenic microflora of waste.

The search for ways of rational processing of chicken feather waste into feed additives that increase the protein value of nutrition is of great economic importance. The development of a feed additive from feather waste is an urgent and demanded task.

In terms of chemical composition (amino acid content, balance of micro- and macroelements), chicken feather raw materials are a valuable source of nutrients and promising raw materials for the feed industry. Existing technologies for the processing of feather waste into protein components are based on the processes of high-temperature hydrothermal treatment or acid (alkaline) hydrolysis. Such methods often lead to the loss and racemization of essential amino acids, the formation of cyclopeptides and a significant decrease in the overall biological value of the final products.

Due to their biological characteristics, broilers compare favourably with poultry of other species by their growth rate, maintenance, feed costs per unit of production. Roughly, the efficiency of broiler production depends on the genetic potential - by 24%, growing conditions - by 17% and balanced feeding - by 59% [7].

Adequate feeding accelerates the growth and development of chickens, increases productivity, reduces feed costs and provides them with good health [12, 11].

An important interior indicator necessary for organizing the relationship with redox processes, metabolic rate, growth and development of a chicken is blood. Having a relatively constant composition, it creates a special environment for the transfer of nutrients to the organs and tissues of an animal or chicken, it participates in the synthesis of structural tissues, metabolic products [4].

2. Material and Method

The objective of the study was to determine the optimal level of introduction of the feed additive from feather meal into feed for broiler chickens and to determine its effect on the productive hematological parameters of poultry.

The research was carried out at the Technical University of Moldova in the laboratory of the Department of Management of livestock products and agri-food safety. For the experiment, chickens of broiler-cross COOB 500 were selected and distributed into 5 groups of 20 heads each. The chickens were kept under the same conditions (in special cages) and were individualized by marking with rings. Keeping conditions - light and temperature conditions, humidity, stocking density - corresponded to the standard indicators.

During the rearing period, zootechnical parameters were monitored, such as the dynamics of body weight of chickens (by means of individual weighing), average daily gain, feed consumption (g/head) (by daily registration of feed intake), as well as the health of chickens (by assessing hematological parameters). All the studies were carried out in accordance with the recommendations and according to the methodology for conducting scientific and industrial research on poultry feeding [2]. The health status of the chickens was monitored by morphological and biochemical parameters of blood and its serum.

Compound feed recipes and feed rations have been balanced in strict accordance with detailed poultry feeding guidelines. Feather meal was added to the composition of mixed fodder for the chickens of the experimental groups at different levels (tab. I).

TABLE I: Scheme of Experience

Groups	Number of heads	Feeding features
CG	20	Basic compound feed (BCF)
EG_1	20	BCF + 1,5% feather meal
EG_2	20	BCF + 2,5% feather meal
EG_3	20	BCF + 3,5% feather meal
EG_4	20	BCF + 4,5% feather meal

Drinking water and rations were given to the birds was ad libitum. Weighing the feed given is done every day. Besides, we also weighed the remaining feed to determine the consumption of poultry every day as well as weighing the body weight of broiler chicken carried out on days 7, 14, 21, 28, and 35.

Feather meal is a fodder product with a high protein content produced from feathers. For the manufacture of feather meal fodder, raw materials (feathers) are used, obtained during the processing at poultry enterprises. The feathers are subjected to a special technological fermentation treatment (according to the new low-temperature technology developed by the Terafix Ltd) to increase the digestibility of the proteins that contains.

The research material was processed by the method of variation statistics according to [6] using a personal computer and Microsoft Excel.

3. Results and Discussions

The experiment lasted three periods: the initiation, the growing and the finish period, as well as the feeding of the chicks was divided into three periods.

During the rearing of broiler chickens, based on the results of weekly individual control weighing, it was found out that the registered body weight in the five batches during the initiation period was 287.04g in CG and 292.41, 292.00, 285.75 and 284.79 g corresponding to EG_1, EG_2, EG_3 and EG_4; during the growing period - 661.22, 660.07, 652.77, 640.85 and 638.53g, and at the end of the finish period it was 1869.70g in CG and 1927.55, 1893.75, 1819.10 and 1812.50g in EG_1, EG_2, EG_3 and EG_4 according. The inclusion of the feather meal in the ration has favored an increase in the live mass of chickens. At the end of the experiment, the chicks that were fed with fodder flour supplemented with 2.5% feather meal had a similar weight to the CG chicks. According to the body mass, it was established that the average weight of broiler chicks at the end of the experiment in the control group was 1869.70g, while in the experimental groups the average weight of the chicks varied from 1812.50 to 1927.55g (tab. II).

Thus, during the whole experiment, the weight of broiler chickens in EG_1 and EG_2, which were fed with compound fodder, supplemented with feather meal at the level of 1.5% and 2.5%, was higher by 3.21% and respectively by 1.29%, compared to CG chicks. The experimental data indicate that as chickens in EG_3 and EG_4 were fed with compound feed supplemented with feather meal at 3.5 and 4.5% levels, their weight decreased compared to chickens in the control group.

The absolute weight gain of broilers over the experimental period increased from 1820.70g in CG to 1879.05g and 1844.25g in the corresponding EG_1 and EG_2 groups.

TABLE II: Dynamics of the Body Mass of Broiler Chicks by Periods, ($\overline{X} \pm S\overline{x}$)

Groups	Growth period/ WG, g				Absolute weight gain, g
	at the beginning	*initiation*	*growing*	*finish*	
CG	49.00±0.93	287.04±7.37	661.22±16.12	1869.70±44.57	1820.70
EG_1	48.50±0.82	292.41±9.06	660.07±16.92	1927.55±39.20	1879.05
EG_2	49.50±0.95	292.00±7.57	652.77±16.97	1893.75±28.77	1844.25
EG_3	47.00±1.05	285.75±4.31	640.85±12.41	1819.10±36.91	1772.10
EG_4	48.00±0.92	284.79±5.33	638.53±17.58	1812.50±27.21	1764.50

The average daily gain increased by growing periods, as well as by the entire experimental period was higher in the chicks from EG1 and EG2 compared to CG, EG3 and EG4 (tab. III). The increases achieved by the experimental groups on average during the experimental period (CG - 44.41 g and respectively in EG_1, EG_2, EG_3, EG_4 - 45.83, 44.74, 43.22 and 43.04g) also reflect the nutritional value of the used 5 combined feeds that allowed the expression of this desideratum.

TABLE III: The Evolution of the Body Weight Gain of Broiler Chicks, ($\overline{X} \pm S\overline{x}$)

Groups	The average body weight gain of broiler chicks, g			
	Initiation period	Growing period	Finish period	total per experiment
CG	23.80±0.71	31.18±1.00	60.42±2.18	44.41±1.08
EG_1	24.39±0.92	30.60±1.05	63.37±1.71	45.83±0.96
EG_2	24.25±0.78	30.06±1.38	61.55±1.51	44.74±0.71
EG_3	23.88±0.48	29.59±0.87	58.91±1.81	43.22±0.90
EG_4	23.68±0.52	29.48±1.18	58.70±1.65	43.04±0.66

In the course of scientific and economic experience, according to the research methodology, the consumption of feed was constantly recorded. It should be noted that the chickens of all experimental groups eagerly ate the feed mixture.

Feed consumption shows the same trend in the experimental groups EG_1 and EG_2, being lower compared to CG over the entire growth period by 72.6 and 179.4 g, and the specific consumption per 1kg weight gain ranged from 1.55 to 1.70kg (tab. IV).

TABLE IV: Specific Consumption per 1 kg Weight Gain of Broiler Chickens

Indicators	Groups				
	CG	EG_1	EG_2	EG_3	EG_4
Absolute increase over the experimental period, g / head	1820,70	1879,05	1834,25	1772,10	1764,50
Combined feed consumption over the whole period, g/head	3034,00	2962,30	2855,50	2967,35	3005,35
Specific consumption per 1 kg weight gain, kg	1,67	1,58	1,56	1,67	1,70
Difference in specific consumption compared to CG, kg	-	-0,09	-0,11	-	+0,03
Difference in specific consumption compared to CG, %	-	-5,39	-6,59	-	+1,80

Based on the results of accounting for consumed feed and on the dynamics of growth in live weight, the cost of feed per unit of production was calculated. Specific consumption (feed conversion rate in increase) was higher in EG_4 by 1.80% compared to CG; a good feed conversion was demonstrated by the two groups EG_1 and EG_2 in total during the experimental period at the level of 1.58 and 1.55 kg combined fodder per 1 kg weight gain, which is 5.39 and 7.19% less than in the chickens from CG. For each kilogram of increase in live weight the broilers that received feather concentrate in the diet on average consumed 0.03-0.12kg less than the control group.

The results of the scientific and economic experience are consistent with the research.

When raising poultry, special attention is paid to the provision of diets with protein. This is due to the fact that broiler chickens are characterized by high growth rate and are extremely sensitive to the quality and quantity of protein consumed.

Intermediate metabolism includes not only metabolic pathways for the transformation of individual nutrients, but also takes into account their relationship with each other, and its research involves elucidating the mechanism of pathways in order to regulate metabolite flows for the whole body [1].

An important interior indicator necessary for organizing the relationship with redox processes, metabolic rate, growth and development of an animal is blood. Having a relatively constant composition, it creates a special environment for the transfer of nutrients to the organs and tissues of an animal or chicken, it participates in the synthesis of structural tissues and metabolic products [5].

For the analysis of blood morphological and biochemical indices, blood samples were collected from each group at the end of the experimental period (3 chicks in group). There were determined the following biochemical indices: total protein, serum proteins, non-nitrogenous organic substances, enzymatic substances, mineral substances as well as hematological values.

Analyzing the values of the protein profile rendered by the total protein, an increase is observed in group EG_1 and EG_2 by 8.69 and 3.14% compared to the values in CG, in the experimental group EG_3 practically there were observed the same values as in CG (27,667g/l) (tab. V, fig. 1).

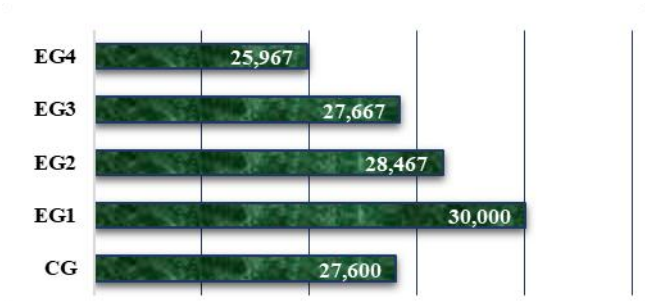

Fig. 1: Total protein in the blood sample, g/l

The mineral profile was studied by the mineral elements essential to sustain life: calcium and phosphorus. Although the Ca / P ratio in chick feed is optimal, a reduction in Ca uptake was observed in the experimental groups (EG_1-EG_4) compared to CG by 1.04; 8.77; 6.80 and 7.73 respectively and vice versa an increase in phosphorus absorption by 10.96; 23.76 and 13.31 was observed in groups EG_1, EG_2 and EG_3.

TABLE V: Blood Morphological and Biochemical Indices in Broiler Chickens

Parametres		Experimental groups				
		CG	EG_1	EG_2	EG_3	EG_4
Morphological						
Hemoglobin	g/dl	146,333±21,3	117,33±6,17	104,33±0,88	168,67±10,33	135,67±18,67
Erythrocytes	10^{12}/l	3,27±0,54	2,80±0,10	2,47±0,09	4,00±0,35	3,23±0,33
Color index	un.	1,30±0,06	1,24±0,06	1,21±0,02	1,27±0,04	1,25±0,04
Hematocrit	%	44,90±7,00	36,70±1,01	34,03±0	52,43±3,37	43,83±5,44
Leukocytes	10^9/l	292,33±7,62	289,00±3,51	272,67±2,19	304,67±4,81	301,67±16,67
Erythrocyte sedimentation rate	mm/hour	2,67±0,88	3,67±0,88	2,67±0,33	1,67±0,33	2,67±0,88
Mean corpuscular volume (MCV)	fl	135,60±2,61	131,83±4,69	133,67±0,64	131,30±3,60	135,40±1,00
Mean Corpuscular Hemoglobin (MCH)	pg	44,27±1,21	42,10±2,02	41,00±0,95	42,27±1,27	41,57±0,97
Mean Corpuscular Hemoglobin Concentration (MCHC)	g/l	326,67±11,17	319,33±10,40	306,67±6,57	322,00±1,0	306,67±4,67
PLT	10^9/l	0,33±0,33	0,00±0	0,00±0	4,67±2,33	0,00±0
RDW	fl	39,30±2,85	36,27±3,03	34,53±0,73	38,07±0,37	11,37±11,37
Biochemical						
Alanine Aminotransferase	un/l	6,00±0	6,00±0	6,00±0	6,00±0	6,00±0
Aspartate Aminotransferase	un/l	257,33±21,40	341,33±34,83	247,33±14,52	245,67±7,31	246,00±5,57
Alkaline phosphatase	un/l	1281,3±184,19	1397,3±159,99	1219,3±136,95	933,0±194,63	1692,0±118,74
Total protein	g/l	27,60±1,59	30,00±2,65	28,47±1,37	27,67±2,22	25,97±0,97
ALB	g/l	11,57±0,43	12,80±0,61	12,03±0,64	11,90±0,68	11,10±0,26
Ca	mmol/l	2,90±0,09	2,87±0,14	2,64±0,08	2,70±0,07	2,67±0,08
P	mmol/l	1,95±0,21	2,17±0,02	2,42±0,05	2,21±0,09	1,94±0,20
albumin	%	45,67±2,16	48,37±2,01	46,73±0,22	47,53±1,13	44,13±0,83
alpha 1	%	4,87±0,41	4,23±0,85	4,63±0,27	3,67±0,18	4,40±0,25
alpha 2	%	22,97±0,26	19,83±1,54	19,67±0,44	23,10±0,40	24,30±0,64
Beta	%	7,23±0,43	10,07±2,17	11,23±0,91	9,13±0,96	8,13±0,58
Gamma	%	19,26±1,64	17,50±0,99	17,73±0,95	16,50±0,55	17,03±0,78
A/G ratio		0,85±0,07	0,94±0,07	0,87±0,01	0,91±0,04	0,86±0,06

Alanine aminotransferase being an endogenous enzyme is included in the transferase group. The increase of this parameter indicates the appearance of some complications in the body, which is not observed in the chicks from the experimental groups, the value of this index being identical in all groups.

Aspartate aminotransferase is also an endogenous enzyme whose variation indicates liver damage and an increase in alanine aminotransferase indicates a weakening of the heart muscle. The value of this blood parameter is lower in groups EG_2, EG_3 and EG_4 by 3.88; 4.53 and 4.40% respectively compared to CG.

Alkaline phosphatase is also an endogenous enzyme that belongs to the group of hydrolases representing an indicator of liver disease or bone system. The highest index is indicated in the blood obtained from chickens in EG_4 at the level of 1692.0 un /l, which is 32.05% higher compared to CG.

The morphological elements determined in the blood of broiler chicks are: hemoglobin, erythrocytes, leukocytes, average erythrocyte volume, hematocrit, average erythrocyte hemoglobin concentration.

Leukocytes are created by the spinal cord to fight infections. The found average values vary between $299.333x10^9$/l in CG and $272.667x10^9$/1 in EG_2, as well as 304.667 and $301.667x10^9$/l in EG_3 and EG_4. The variation in plus or minus indicates the appearance of pathological conditions.

Hemoglobin is the main component of red blood cells giving the cells a red color. In CG it is at the level of 146.333g/dl, while in chickens from EG_1 and EG_2 this blood parameter is decreasing by 29.0 and 42.0g/dl. The highest amount was observed in chickens from EG_3 at the level of 168.667g/dl or 15.26% more compared to CG.

The values of the erythrocytes indicated by the control group (CG) are $3.267x10^{12}$/l. In groups EG_1 and EG_2 there is a decrease of 14.29 and 24.49% compared to CG. The highest value is in chickens from EG_3 in comparison with CG by 22.44% respectively. Only the parameters indicated by EG_3 and EG_4 are within the permissible limit (3-4 x 10^{12}/l).

Hematocrit represents the mass of red blood cells in a certain volume of blood. The found values were between 44.90% in the control group and 34.033-52.433% in the experimental groups being within the limits of the physiological norm.

Replacing fishmeal with feather protein meal in the compound broilers' feed is becoming necessary, in general it can be an optimal alternative. The replacement of fishmeal with feather meal at 1.5 and 2.5% (EG1 and EG2) allowed to obtain a body mass during the starter period by 1.87 and 1.73% and during the finish period by 3.09 and 0.75% higher compared to CG chicks.

There was an absolute increase both over periods and over the experiment: it was higher in chickens from EG_1 and EG_2 by 3.20 and 0.74% respectively compared to CG. The average daily gain was found to be higher in the experimental groups EG_1 and EG_2, respectively, in the growth period it was higher by 2.48 and 1.89% and in the finish period by 4.88 and 1.87%. During the experimental period the highest daily gain was found in the chickens from EG_1 by 3, 20% more compared to CG chicks.

4. Conclusions

The results of the research showed that the use of protein feather meal as part of compound feed of broiler chickens increased the weight gain, organ immunity, blood profile and confirmed a positive effect on protein metabolism and nonspecific resistance of broiler chickens. According to experimental data, under production conditions, the optimal concentration of feather meal in the diet of broiler chickens was 1.5%.

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