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ONTOGENETIC FEATURES OF PROTEIN METABOLISM IN LAYING HENS DURING THE REARING AND EGG PRODUCTION PERIOD

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ABSTRACT

We have studied the dynamics of growth and development of Hayseks Brown layer hybrids, from day 1 of age to peak egg production. During the experiment, we analyzed the intensity of metabolic processes in the body at age 6, 35, 90, 120, and 150 days, i.e. in the critical periods of intense growth of feathers and juvenile molt (30–60 days), the beginning of the oviposition (120 days) and the beginning of intensive egg production (150 days). In these age periods, the level of soluble proteins, amine nitrogen, and the activity of alanine and aspartate aminotransferases were determined in the liver tissue, and the mucous membrane of the proventriculus, duodenum and pancreas. As a result of the research, it was found that the intensity of the growth of chickens is different from the recommendation for the Hayseks Brown cross. Only at the age of 119–126 days growing the body weight of the reared chickens coincided with the recommended technology for hens of the cross Hayseks Brown. During the growth of young birds, in the critical periods of growth and development, it is necessary to deliberately affect the processes of protein metabolism by enhancing the processes of digestion and assimilation of nutrients and biologically active substances of the diet.

Key words: hens, live weight, egg production, critical periods, soluble proteins, amine nitrogen, alanine transaminase, aspartate transaminase

INTRODUCTION

Ration balancing of poultry feeds, in terms of the content of the main nutrients and biologically active substances, is the basis of modern power systems, which is constantly being improved. However, the problems of improving the productivity of poultry and improving the quality of poultry production depends on many other factors, including compliance with the technology of growing young repair poultry and the intensity of the physiological and biological processes in their organisms and the functions of individual organs and systems. It is known that the body weight of a newly hatched chick increases 4.4 times over the first week of life, and 50 times at the end of the first 5 weeks of life, when it reaches 2 kg [Tsarenko 1988, Fisinin and Suray 2013]. These high rates are possible due to intensive selection for growth rates, optimal housing conditions, and the progress in nutrition technology, which contribute to meeting the needs for all major nutrients and bioactive substances, and effective disease prevention. As the growing season is steadily decreasing and feed conversion is improving, health support and nutrition optimization are among the priority tasks. At this stage, the details of the rearing technology are carried out at a high level, taking into account factors that previously scientists and practitioners did not pay attention. For example, microstructural changes in the intestine, in particular in the mucous membranes on which the assimilation of nutrients depends, the state and processes occurring in the intestine determine the health of the bird and the efficiency of the use of nutrients and biological active substances, which is associated with the intensity of growth and development, conversion of feed and other important economic indicators in poultry farming [Ratych 1992, Grozina 2014, Filho et al. 2014, Dong et al. 2017]. It is known that in the process poultry production about 70% of the cost goes to the value of forages. However, the assimilation of nutrients and biologically active substances from forage is different, and therefore the improvement of these indicators can reduce the cost of the product and increase its competitiveness of products. For a year, a hen bear on the productivity of 250–

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280 eggs allocates from 1.7–2.0 to 1.9–2.3 kg of proteins. That is, as much as the whole body is weighing. At the same time, the transformation of feed proteins into body protein and egg products in chickens is only 16.5–17.3% [Kochish et al. 2010]. In this regard, the intensity of protein synthesis in the body is decisive and it directly depends on the activity of the hydrolytic enzymes of the gastrointestinal tract. The purpose of our research was to study the age and organ-tissue features of protein metabolism, in particular concentration of soluble proteins, amino nitrogen and the activity of ALT and AST enzymes. The growth and the development of young chicken and egg productivity of chicken.

MATERIAL AND METHODS

The experiment was carried out on a repair flock of chickens of the Hayseks Brown crossbred laying hens , starting from the first day of age. For this purpose, in the conditions of the farm "Berkut" of the Drohobych district of the Lviv region, an industrial herd of hens in the amount of 10 thousand birds was formed. The bird was kept in cages with free access to feed and water. The temperature and light modes corresponded to the recommended standards, and the conditions met the requirements of the technology. All birds received a complete feed, balanced for all nutrients and biological active substances (Table 1). The research lasted for five months, that is, up to 150 days of age.

During the experiment, the study of the intensity of metabolic processes in the body of chickens of 1, 6, 35, 90, 120 and 150 days of age was carried out, i.e, during critical periods when there was intense growth of feathers (35 days) , juvenile molt (60 days), the beginning of the oviposition (120 days) and the peak of productivity (150 days). In these age periods, slaughter of poultry was carried out, 5 birds in each group and live tissues, the mucous membranes of the proventriculus, duodenum, pancreas were taken. The balance for weighing was used: SF-460; the accuracy of the balance is 0.01 gr. The weighing of chickens was conducted starting from March to July 2017.

In these tissues, the concentration of soluble proteins was determined by the Lowry method the content of amine nitrogen by the ninhydrin method, the activity of aminotransferases by the method of Reitman-Frenke. During the experiment, control was carried out on growth and development and egg productivity [Determination 1998, Methods 1998, Directory 2004].

RESULTS

The content of the main nutrients and biologically active substances in mixed fodders is the basis of balancing ration for poultry. However, the observance of all norms does not always provide the desired result and it is therefore important to control the intensity of the course of physiological and biological processes in their organism during the period of growth and development, and during the egg production. The digestive organs have a special role in these processes, because they play a decisive role in the processes of digestion and assimilation of nutrients of feed. Its functioning depends on numerous factors, including fodder ones. In order to control the growth of the young poultry, we conducted a weekly weighing of chickens in the process of their ontogenetic development. The weighing data is shown in Figure 1.

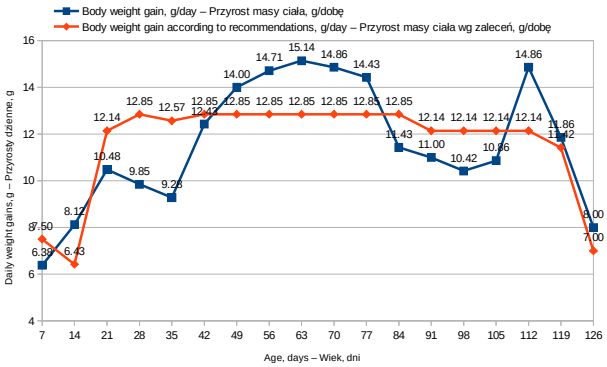

Fig. 1. Average daily weight gains of chickens, g

Rys. 1. Średnie dobowe przyrosty masy ciała kurcząt, g

The results presented in Figure 1 show that the average daily gains of chickens from 7 to 21 days of age were gradually increasing, and already at 28 days of age, the average daily gain of weight of chickens was lower than in previous life periods. The decrease in daily weight gains of chickens continued until the age of 35 days. According to the technology of growing chickens of the breed Hayseks Brown, chickens up to 35 days of age received a diet containing 20.5% crude protein and 2905 kcal ME · kg^{-1} of metabolizable energy, or 1216.27 joules. At 35 days of age, the protein content was reduced to 19% and the metabolizable energy to 2900 kcal ME · kg^{-1}, or 1214.17 joules, according to the technology. However, despite the decrease in the amount of protein and exchange energy, the average daily gains in live weight have increased and reached the highest level in the 63rd day of life. According to the recommended technological parameters of growing young chickens, intensive growth should occur from 14 to 28 days. Past 28 days, the daily gains of live weight should be at a more or less equal level, until 84 days of raising. And starting from 84 days, they are reduced to 91 days and remain at this level to 121 days, and then fall again until 126 days. In 119–126

Table 1. The ingredients and nutritive value of feeds for laying hens during the rearing and egg production period

Tabela 1. Skład i wartość odżywcza pasz dla kur niosek w okresie hodowli i nieśności

Ingredients – Składniki	Chickens – Kury			
	0–35 days/dni	35–70 days/dni	70–100 days/dni	120–150 days/dni
Corn, % – Kukurydza, %	44.00	36.20	22.00	40.00
Wheat, % – Pszenica, %	10.90	25.80	50.70	20.90
Sunflower meal, % – Śruta poekstrakcyjna słonecznikowa, %	15.00	18.70	16.50	20.00
Soybean meal, % – Śruta poekstrakcyjna sojowa, %	22.30	13.50	6.00	11.00
Filter perlite, %	3.00	1.00	–	1.50
Limestone, % – Wapień, %	2.00	2.00	2.00	–
Monocalcium phosphate, % – Fosforan jednowapniowy, %	1.00	1.00	1.00	1.00
Chalk, % – Kreda, %	–	–	–	–
Salt, % – Sól, %	0.30	0.30	0.30	0.30
Premix, % – Premiks, %	1.50	1.50	1.50	1.50
Total – Ogólem	100.00	100.00	100.00	100.00
Chemical composition, % – Skład chemiczny, %				
Metabolizable energy, kcal/kg feed – Energia metaboliczna paszy, kcal · kg^{-1}	2912	2902	2783	2730
Raw protein – Białko ogólne	20.45	18.96	16.08	17.45
Crude fiber – Włókno surowe	4.93	5.07	4.92	4.99
Raw fat – Tłuszcz surowy	4.62	4.20	3.14	4.08
Calcium – Wapń	1.03	0.97	0.96	2.03
Phosphorus – Fosfor	0.70	0.60	0.64	0.65
Sodium – Sód	0.15	0.15	0.15	0.15
Lizin – Lizyna	1.21	1.05	0.80	0.86
Methionine + Cystine – Metionina + cysteina	0.78	0.66	0.53	0.68

days, the live weight of the grown-up chickens practically coincides with the recommended technology parameter. Perhaps the decrease in average daily gains from 21 to 35 days is due to a change in dietary regime, in particular a decrease in the protein content and exchange energy. According to the recommended technology in these periods, average daily gains should be stable and remain at the highest level. In our case, these patterns do not coincide, which may be due to other factors, such as the violation of some unpredictable technology parameters. This decrease may also be due to the beginning of preparation for juvenile molt which the chickens have on 40–45 days of development. The next decline, which is not provided by cultivation technology, occurs between 63 and 98 days. In this period, namely from 70 to 100 days, according to the technology, the nutritional value of the diet changes again and the level of crude protein decreases from 18.96% to 16.08%, and the metabolizable from 2902 kcal or 2783 kcal, and from the diet the lipid additive perlite, which was a source of energy and a sort of sorbent, was excluded. It is known that from the age of 60 days, an intensive development of reproductive organs starts in chickens, so a significant amount of nutrients and biologically active substances is used in these processes, which affects the intensity of body weight gains. Reducing the amount of protein and metabolizable energy prevents premature egg cells and enhances better development of reproductive organs.

The results of biochemical anayses indicate that changes in the physiological state are related to the level of soluble proteins in the investigated digestive organs and the total content of free amino acids by the activity of enzyme reamination (AsAT, AlAt) (Table 2). We can see from the data of the table that changes in the concentration of soluble proteins in all investigated tissues were practically the same. Thus, the content of soluble proteins in all tissues increased to 6 days of age and then decreased to 30 days, then increased to 60 days of age in all tissues, and until the 90th day age somewhat decreased only in the liver tissue. Starting from the 90th day of age, the level of soluble proteins decreased in the tissues of the gastrointestinal mucosa and the mucous membranes of the duodenum, and increased in the pancreas and liver tissue until 120 days of age.

The content of amine nitrogen was similar in comparison with soluble proteins, with the exception of pancreatic and gastric mucosal tissues. Thus, in the pancreatic tissue, the level of amine nitrogen gradually increased from 1 day to 120 day old age and slightly decreased to 150 day age. In the proventriculus mucous membrane, the level of amine nitrogen declined to 30 days of age, and then gradually increased to 120 days of age. The hi-

Table 2. The indicators of protein metabolism during the rearing and egg production period in Hayseks Brown hybrids of laying hens

Tabela 2. Wskaźniki metabolizmu białek w okresie chowu i nieśności u niosek – mieszańców Hayseks Brown

Indicators Wyszczególnienie	Age, days – Wiek, dni						
	1	6	30	60	90	120	150
Mucous membrane of the glandular stomach – Błona śluzowa żołądka							
Protein, mg · 100 g^{-1} Białko, mg · 100 g^{-1}	4.66 ± 0.23	7.06 ± 0.07	2.80 ± 0.01	6.021 ± 0.41	6.87 ± 0.60	5.17 ± 0.47	4.17 ± 0.18
Amine nitrogen, mg · g^{-1} Azot aminowy, mg · g^{-1}	0.36 ± 0.01	0.26 ± 0.01	0.20 ± 0.001	0.36 ± 0.02	0.40 ± 0.08	1.36 ± 0.33	1.16 ± 0.24
ALT, μmol · h^{-1} × g	0.024 ± 0.002	0.107 ± 0.01	0.11 ± 0.02	0.224 ± 0.005	0.20 ± 0.03	0.069 ± 0.05	0.079 ± 0.06
AST, μmol · h^{-1} × g	1.126 ± 0.14	1.135 ± 0.27	0.974 ± 0.05	1.133 ± 0.09	1.070 ± 0.04	1.787 ± 0.33	1.538 ± 0.649
Mucous membranes of the duodenum – Błona śluzowa dwunastnicy							
Protein, mg · 100 g^{-1} Białko, mg · 100 g^{-1}	4.5 ± 0.18	6.54 ± 0.10	6.02 ± 0.32	6.87 ± 0.44	7.25 ± 0.04	6.03 ± 0.11	5.98 ± 0.68
Amine nitrogen, mg · g^{-1} Azot aminowy, mg · g^{-1}	0.21 ± 0.02	0.91 ± 0.02	0.53 ± 0.01	0.78 ± 0.10	1.08 ± 0.07	1.01 ± 0.08	0.76 ± 0.08
ALT, μmol · h^{-1} × g	0.158 ± 0.009	0.276 ± 0.016	0.114 ± 0.008	0.235 ± 0.01	0.285 ± 0.01	0.292 ± 0.031	0.176 ± 0.05
AST, μmol · h^{-1} × g	1.517 ± 0.01	1.396 ± 0.01	1.446 ± 0.06	1.267 ± 0.06	1.227 ± 0.06	1.467 ± 0.504	2.213 ± 0.081
Pancreas – Trzustka							
Protein, mg · 100 g^{-1} Białko, mg · 100 g^{-1}	8.05 ± 0.21	10.89 ± 0.11	8.08 ± 0.34	8.18 ± 0.07	8.58 ± 0.04	10.15 ± 1.26	9.97 ± 0.11
Amine nitrogen, mg · g^{-1} Azot aminowy, mg · g^{-1}	0.08 ± 0.008	0.24 ± 0.03	0.74 ± 0.048	1.50 ± 0.006	1.62 ± 0.06	1.65 ± 0.054	1.3 ± 0.12
ALT, μmol · h^{-1} × g	0.155 ± 0.01	0.121 ± 0.01	0.139 ± 0.04	0.181 ± 0.003	0.211 ± 0.001	0.262 ± 0.01	0.258 ± 0.01
AST, μmol · h^{-1} × g	1.212 ± 0.01	1.404 ± 0.02	1.345 ± 0.04	1.400 ± 0.06	1.563 ± 0.03	2.373 ± 0.062	2.018 ± 0.356
Liver – Wątroba							
Protein, mg · 100 g^{-1} Białko, mg · 100 g^{-1}	9.08 ± 0.17	11.00 ± 0.13	6.88 ± 0.32	8.97 ± 0.24	8.14 ± 0.06	9.79 ± 1.24	6.893 ± 0.39
Amine nitrogen, mg · g^{-1} Azot aminowy, mg · g^{-1}	0.36 ± 0.02	2.49 ± 1.46	1.71 ± 0.005	1.92 ± 0.04	2.61 ± 1.44	1.72 ± 0.04	1.76 ± 0.12
ALT, μmol · h^{-1} × g	0.38 ± 0.013	0.56 ± 0.01	0.54 ± 0.023	0.58 ± 0.04	0.479 ± 0.01	0.731 ± 0.08	0.628 ± 0.046
AST, μmol · h^{-1} × g	1.48 ± 0.03	1.55 ± 0,006	1.52 ± 0.02	1.420 ± 0.20	1.500 ± 0.02	2.462 ± 0.117	2.231 ± 0.018

ghest growth rate was for the period from 90 to 120 days of age.

The level of amine nitrogen in the duodenal mucosa increased to 6 days of age, then decreased to 30 days and again increased to 90 days. In the period from 90 days the level decreased in both, pancreas and liver.

Consequently, due to these changes, we see that the level of soluble proteins and amine nitrogen is associated with the growth and development of chickens.

If we analyze the activity of enzyme reamination, which characterizes the intensity of biosynthetic processes, then we could see that the change in the activity of alanine aminotransferases is more closely related to changes in the content of soluble proteins in tissues than the activity of aspartate aminotransferases. However, the activity of aspartate aminotransferases was higher in all tissues compared with the activity of aminotransferases in 3–11 times. It is believed that the AcAt-catalyzed Alanine-based transamination reactions in the exchange of amino acids in chickens play a less important role than those that occur with the use of AcAt.

It is not accidental, since the AcAt enzyme occupies a central place in the metabolism, providing substrates with a cycle of tricarboxylic acids and, accordingly, is involved in the regulation of energy formation in the processes of oxidative phosphorylation [Meister 1965, Bender 1975, Cunningham 1978]. In other words, AcAt is a peculiar indicator of the intensity of catabolic processes in metabolism The advantage of the activity of AcAt over AlAt manifests as much as possible during the period of decline in productivity when catabolism is dominant in amino acid exchange [Wen et al. 2012, Sereda and Derho 2014]. The minimum ratio between the activity of enzymes in the cells of organs is characteristic of the liver and it is approximately 3–4 to 1 activity units meaning the liver serves as the main a source of replenishment of aminotransferases in the blood [Lehninger 1985]. The catalytic activity and the ratio of enzymes in hepatocetals determines the intensity of the transformation of amino

acids in general, which affects productivity. At the age of 120 and 150 days in hens, the activity of enzyme reamination, as aminotransferases and aspartate aminotransferases, is significantly increased as compared to previous age periods, especially with 1 day-old chicks. It is known that at the age of 120 days, modern crosses of chickens begin eggplant. Thus, according to our previous studies, chicken of cross Hayseks Brown started egg production already since 122 days old, and the 140-day-old productivity reached 50% and reached the peak productivity of 89.9% at 170 days old [Kyryliv and Hunchak 2016].

CONCLUSIONS

Consequently, the results of the research indicate that during the growth of the repair young chicken there is a deviation from the recommended parameters for the Hayseks Brown breed, therefore it is expedient to use feed products that would allow us to control the processes of protein metabolism by enhancing the processes of digestion and assimilation of nutrients and biologically active substances of the feed and the sufficient intake of free amino acids necessary for the intensification of the synthesis of proteins in the tissues.

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ONTOGENETYCZNE CECHY METABOLIZMU BIAŁEK U KUR NIEŚNYCH W OKRESIE WYCHOWU I PRODUKCJI JAJ

STRESZCZENIE

Przeanalizowano dynamikę wzrostu i rozwoju mieszańców kur nieśnych Hayseks Brown od pierwszego dnia życia do osiągnięcia szczytu nieśności. W trakcie eksperymentu badano intensywność procesów metabolicznych w organizmie 6, 35, 90, 120 i 150-dniowych kur nieśnych tj. w krytycznych okresach intensywnego wzrostu piór i młodzieńczego pierzenia (30–60 dni), na początku nieśności (120 dni) i szczytu nieśności (150 dni). W tych terminach oceny oznaczono poziom rozpuszczalnych białek, azotu aminowego i aktywność aminotransferazy alaninowej i asparaginowej w tkankach wątroby, błonie śluzowej żołądka gruczołowego, dwunastnicy i trzustki. W wyniku badań stwierdzono, że intensywność wzrostu kur różni się od zaleceń producenta dla mieszańca Hayseks Brown. Dopiero w wieku 119–126 dni wzrost masy ciała kurcząt był zgodny z zaleceniami technologicznymi dla mieszańców kur Hayseks Brown. Podczas wzrostu młodego drobiu, w krytycznych okresach wzrostu i rozwoju, konieczne jest celowe oddziaływanie na procesy metabolizmu białka poprzez usprawnienie procesów trawienia i przyswajania substancji odżywczych i biologicznie czynnych substancji paszowych.

Słowa kluczowe: kura, masa ciała, nieśność, okres krytyczny, białka rozpuszczalne, azot aminowy, transaminaza alaninowa, transaminaza asparaginowa