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Ontogenetic features of protein metabolism in hens of eggs production direction

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We have studied the dynamics of growth and development of chicken egg production of line cross “Hayseks brown” from day age to the age of peak performance. During the experiment, the study of the intensity of metabolic processes in the body of 6, 35, 90, 120, and 150 day-olds, i.e., in critical periods when there is intense growth of feathers and juvenile molten (30–60 days), the beginning of the oviposition (120 days) and the beginning of an intensive oviposition (150 days). In these age periods, the level of soluble proteins, amine nitrogen, and the activity of alanine and aspartate aminotransferases were determined in liver tissues, cuticles of the muscular stomach, gastrointestinal mucosa, gastrointestinal mucosa, 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 coincides with the recommended technology for hens of the cross “Hayseks Brown”. The results of biochemical studies are related to changes in the physiological state and magnitude of gains. During the growth of repair young poultry, 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 fodder and the sufficient introduction of free amino acids by the use of exogenous enzyme preparations.

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

Introduction

Ration balancing for poultry on 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 organism and the functions of individual organs and systems. It is known that the mass of newly hatched chicken in the first week of life increases by 4.4 times, and in 5 weeks by 5000% and reaches 2 kg (Carenko, 1988; Fisinin and Suray, 2013). These high rates are possible due to intensive selection of growth rates, optimal keeping conditions, and progress in feeding, which contribute to meeting the needs of 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 cultivation 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 250–280 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 prod-

ucts 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 and activity of hydrolytic enzymes.

Material and methods

In order to carry out the planned research, an experiment was carried out on repair young poultry of the hens-

eggs layers of the “Hayseks-Brown” cross from the day-old 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 heads 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 poultry 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.

Table 1

The content and nutritive value of forages for chickens

Components of forage	Chickens			
	0–35 days	35–70 days	70–100 days	120–150 days
Corn, %	44.00	36.20	22.00	40.00
Wheat, %	10.90	25.80	50.70	20.90
Sunflower shrot, %	15.00	18.70	16.50	20.00
Soybean shrot, %	22.30	13.50	6.00	11.00
Filtetroelite	3.00	1.00		1.50
Limestone, %	2.00	2.00	2.00	
Monocalciphosphate, %	1.00	1.00	1.00	1.00
Chalk, %				3.80
Salt, %	0.30	0.30	0.30	0.30
Premix, %	1.50	1.50	1.50	1.50
Total	100.00	100.00	100.00	
100 gr. of forage contain, g:				
Exchange energy, kcal	291.2	290.20	278.3	273.0
Raw protein	20.45	18.96	16.08	17.45
Crude fiber	4.93	5.07	4.92	4.99
Raw fat	4.62	4.20	3.14	4.08
Calcium	1.03	0.97	0.96	2.03
Phosphorus	0.70	0.60	0.64	0.65
Sodium	0.15	0.15	0.15	0.15
Lizin	1.21	1.05	0.80	0.86
Methionine + Cystine	0.78	0.66	0.53	0.68

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 molten (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 heads in each group and the liver tissues, cuticles of the muscular stomach, the mucous membranes of the gastrointestinal stomach, the mucous membranes of the duodenum, pancreas were taken (Vlizlo, 2004).

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.

Results and discussion

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 there-

fore 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 oviposition. 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.

Due to the results presented in the figure, we see that the average daily increments of chickens from 7 to 21-day-old age were gradually increasing, and already at 28-day-old age, the average daily gain of live weight of chickens was lower than in previous age periods. The decrease in the increments of live weight of chickens continued to 35-day-old age. According to the technology of growing chicks of the breed “Hayseks Brown” up to 35-day-old chickens received a diet containing 20.5% crude protein and 290.5 kcal of exchange energy or 1216.27 joules. In the 35-day-old age, according to the growing technology, the protein content was reduced to 19% and the exchange energy to 290 kcal or 1214.17

joules. However, despite the decrease in the amount of protein and exchange energy, the average daily increments in live weight have increased and reached the highest level in 63rd day of age. According to the recommended technological parameters of growing young chickens, intensive growth should be from 14 to 28 days. After 28 days, the daily increments of live weight should be at a more or less equal level to 84 days of cultivation. And starting from 84 days, they are reduced to 91 days and are at this level to 121 days, and then fall again for 126 days. In 119–126 days, the weight of the body grown

chickens practically coincides with the recommended technology. Perhaps the decrease in average daily increments in live weight from 21 to 35 daily genes is due to a change in dietary intake, in particular a decrease in the protein content and exchange energy. According to the recommended technology in these periods, average daily increments should be stable and 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.

Fig. 1. Average day increments of chickens, gr

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 exchange energy from 290.20 calories or 1215.01 g to 278.3 kcal or 1165.19 j, 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 begins to intensively develop reproductive organs in chickens, so a significant amount of nutrients and biologically active substances is used in these processes, and therefore decreases the intensity of body mass increments. Reducing the amount of protein and exchange energy prevents premature egg cells and better development of reproductive organs.

The results of biochemical studies 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 from daily to 6 days of age and then decreased to 30 days, then increased to 60-day-old age in all tissues, and until the 90-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 to 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 glandular gland, the level of amine nitrogen declined to 30 days of age, and then gradually increased to 120 days of age. The highest growth rate was for the period from 90 to 120 days of age.

In the mucosa of duodenum, the level of amine nitrogen 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; Cunningham, 1978;

Bender, 2012). 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).

Table 2

The indicators of protein change in chickens of egg productivity line

Indicators	Researched age periods						
	1 day	6 day	30 day	60 day	90 day	120 day	150 day
Mucous membrane of the glandular stomach							
Protein, mg/100 g	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	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
AlAt, μmol/h × g	0.024 ± 0.002	0.107 ± 0.01	0.110 ± 0.02	0.224 ± 0.005	0.20 ± 0.03	0.069 ± 0.05	0.079 ± 0.06
AsAT, μmol/h × 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							
Protein, mg/100 g	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	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
AlAt, μmol/h × 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
AsAT, μmol/h × 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							
Protein, mg/100 g	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	0.08 ± 0.008	0.24 ± 0.03	0.74 ± 0.048	1.50 ± 0.006	1.62 ± 0.06	1.65 ± 0.054	1.33 ± 0.12
AlAt, μmol/h × 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
AsAT, μmol/h × 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							
Protein, mg/100 g	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	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
AlAt, μmol/h × 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
AsAT, μmol/h × g	1.48 ± 0.03	1.550 ± 0.006	1.520 ± 0.02	1.420 ± 0.20	1.500 ± 0.02	2.462 ± 0.117	2.231 ± 0.018

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. 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 (Kyrlyliv and Hunchak, 2016).

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” cross, therefore it is expedient to use fodder products that allow to purposefully influence the processes of protein metabolism by enhancing the processes of digestion and assimilation of nutrients and biologically the active substances of feed and the sufficient entry of free amino acids necessary for the intensification of the synthesis of proteins in tissues.

References

- Fisinin, V.I., & Surai, P. (2013). Kishechnyj immunitet u ptic: fakty i razmyshlenija (obzor). Sel'skohozjajstvennaja biologija, 4, 3–25. doi: 10.15389/agrobiology.2013.4.3rus.
- Kochish, I.I., Petrash, M.G., & Smirnov, S.B. (2010). Belkovyj i uglevodnyj obmen veshhestv u nesuchek. Pticevodstvo. 4, 34–35 (in Russian).
- Grozina, A.A. (2014). Sostav mikroflory zheludochno-kishechnogo trakta u cypljat-brojlerv pri vozdejstvii probiotika i antibiotika (po dannym T-RFLP—RT-PCR). Sel'skohozjajstvennaja biologija, 6, 46–58. doi: 10.15389/agrobiology.2014.6.46rus (in Russian).
- Carenko, P.P. (1988). Povyshenie kachestva produkcii pticevodstva: pishhevye i inkubacionnye jajca. Leningrad, VO «Agro-promizdat» (in Russian).
- Bender, D. (2012). Amino Acid Metabolism Third Edition. John Wiley & Sons, Ltd doi: 10.1002/9781118357514.
- Cunningham, E.B. (1978). Biochemistry: Mechanisms of Metabolism, McGraw-Hill, New York. <https://onlinelibrary.wiley.com/doi/pdf/10.1016/0307-4412%2878%2990017-1>.
- Meister, A. (1965). Biochemistry of Amino Acids, 2nd Edition, Academic, New York. <https://www.elsevier.com/books/biochemistry-of-the-amino-acids/meister/978-0-12-395523-4>.
- Wen, C., Wang, L.C., Zhou, V.M., Jiang, Z.Y., & Wang, T. (2012). Effect of enzyme preparation on egg

- production, nutrient retention, digestive enzyme activities and pancreatic enzyme messenger RNA expression of late-phase laying hens. *Animal Feed Science and Technology*, 172(3), 180–186. doi: 10.1016/j.anifeedsci.2011.11.012.
- Filho, A.V., Geraldo, A., Machado, L.C., de Brito, J.A., Bertechini, A.G., & Muracami, E.S.F. (2015). Effect of protease supplementation on production performance of laying hens. *Acta Scientiarum*. 37(1), 29–33. doi: 10.4025/actascianimsci.v37i1.22830.
- Dong, X.Y., Azzam, M.M.M., & Zon, X.T. (2017). Effects of dietary threonine supplementation on intestinal barrier function and gut microbiota of laying hens. *Poultry Science*. 96(10), 3654–3663. doi: 10.3382/ps/pex185.
- Vlizio, V.V. (2004). *Dovidnyk: Fiziolo-ho-biokhimichni metody doslidzhen u biolo-hii, tvarynnystvi ta vetrynarnii medytsyni*. Lviv (in Ukrainian).
- Ratych, I.B. (1992). *Biolo-hichna rol sirky i metabolizm sulfatu u ptytsi*. Lviv (in Ukrainian).
- Kyryliv, B.Ya., Hunchak, A.V. (2016). The influence of alimentary factors on productivity hens. *Scientific Messenger LNUVMBT named after S.Z. Gzhytskyj*, 18, 2(67), 287–291. doi:10.15421/nvlvet6762.
- Sereda, T.I., & Derho, M.A. (2014). Ocenka roli aminotransferaz v formirovanii produktivnosti u kur-nesushek. *Sel'skoho-zhajstvennaja biologija*, 2, 72–77. doi: 10.15389/agrobiology.2014.2.72rus (in Russian).