Features of protein metabolism in turkeys of different genotypes and age

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Abstract. The study describes the characteristics of protein metabolism in turkeys of different genotypes and age. It is established that poultis during industrial cultivation were physiologically healthy, and the studied parameters fluctuated within normal limits. At the same time, the magnitude of the blood parameters depends on the age of the bird and the genotype determined by both the breed and crossing. The protein metabolism intensity determining the concentration of the total protein and its fractions in the blood of poultry, the activity of transamination enzymes (AlAT, AsAT) does not so much depend on age, but on the birds genotype. The highest level of protein parameters is found in the blood of heavy cross Hybrid Converter. At the same time, the rate of growth and development of their body is associated with the exchange of albumin and the ways of using free amino acids to cover its energy consumption. Therefore, turkey poultis of this cross are superior to their analogues in terms of albumin (by 9.54%), activity of AsAT (by 1.61–6.93%) and AlAT (by 2.77–5.23%).

1. Introduction

Knowing the specifics of physiological systems functional activity formation will allow us to create the technological conditions that will ensure the manifestation of desired qualities in birds during industrial cultivation and make poultry farming more profitable [1, 2, 3].

The rate of growth and development of turkeys is associated with their age. They most intensively increase their live weight to 60 days of age, and then reduce its growth rate until puberty [4, 5, 6]. The biological basis for the growth of turkeys is dynamic changes in functional systems, and biochemical processes in the cells of organs and tissues, the state of which can be judged by the key parameters of the blood [7, 8, 9, 10].
Proteins are a necessary building material of protoplasm of cells. They perform special functions in the body. They are mandatory components of all biological systems: organs, cells, subcellular elements. All enzymes, many hormones, optic retina, oxygen carriers, blood protective substances are protein bodies [11].

Proteins are complex in structure and very specific. In the cells, the synthesis of huge protein molecules consisting of chains of amino acids is continuously proceeding. Protein balance in the body is of great practical importance [11, 12].

Therefore, one of the main types of metabolism is protein. Its condition can be judged by the proteins concentration in the blood of birds, these integral parameters reflect the degree and speed of their use in metabolic processes [11, 13, 14]. Provision of the body with protein is determined not only by its intake with food, but also by a number of biochemical processes in the intestine [15].

Improving the efficiency of poultry and livestock farming requires researchers to study the characteristics of feeding and keeping farm animals and birds [17–19] for further development of new food products with specified properties that meet current consumer requirements and legislation [20–23]. So, the aim of the research was to study the characteristics of protein metabolism in turkeys of different genotypes and age.

2. Material and methods
4 groups of 30 turkey poults each were selected at a daily age. Group I – control turkey poultry of the middle cross-country of White broad-chest breed; Group II – turkey poultry of the heavy cross of White broad-chest breed; III group – turkey middle cross Hybrid Grade Maker; Group IV – Heavy Cross Hybrid Converter. The cultivation was carried out up to 120 days of age and heavy crosses up to 150 days. The blood was examined at the age of 60 and 120 days from 5 birds in each group.

The determination of total protein in serum was carried out by biuret reaction. Determination of various protein fractions – by nephelometric method. The optical density of solutions with certain protein fractions was measured with a KFK-3-01 photoelectric colorimeter. The content of calcium, phosphorus, the amount of intracellular enzymes (AsAT and AIAT) and reserve alkalinity in the blood serum of turkeys were determined on a Stat Fax 3300 biochemical analyzer according to the approved procedure for this device.

3. Results
An important indicator of protein metabolism in birds is the total protein, the concentration of which in the blood serum of turkeys increases with age (table 1).

| Indicator               | Age, day | Group I    | Group II   | Group III  | Group IV   |
|-------------------------|----------|------------|------------|------------|------------|
| Total protein, g/l      | 60       | 55.46±0.22 | 54.33±0.35 | 57.14±0.41 | 56.83±0.37 |
|                         | 120      | 56.61±0.35 | 57.17±0.26 | 58.26±0.29*| 60.29±0.27*|
| Albumin, g/l            | 60       | 25.42±0.28 | 24.91±0.26 | 26.17±0.24 | 25.54±0.29 |
|                         | 120      | 26.32±0.26 | 26.08±0.24 | 26.76±0.28 | 28.57±0.32*|
| Alpha - Globulins, g/l  | 60       | 10.78±0.18 | 10.78±0.17 | 11.81±0.14 | 11.62±0.19 |
|                         | 120      | 10.19±0.16 | 11.01±0.14 | 11.82±0.17*| 11.35±0.18*|
| Beta - Globulins, g/l   | 60       | 8.19±0.13  | 8.06±0.12  | 8.99±0.14  | 9.01±0.15  |
|                         | 120      | 8.59±0.12  | 8.64±0.15  | 9.92±0.17  | 9.16±0.19  |
| Gamma - globulins, g/l  | 60       | 11.07±0.15 | 10.58±0.14 | 10.67±0.18 | 10.66±0.16 |
|                         | 120      | 11.51±0.19 | 11.44±0.20 | 10.80±0.17 | 11.21±0.18 |

Note: * - P≤0.05 compared with the control
The increase in the parameter value was determined by both age and cross of birds. So, in the body of 120-day-old turkeys of group I, in comparison with 60-day-old age, the concentration of total protein increased only by 2.07%, and in groups II, III, and IV — by 4.69; 3.71 and 6.09%. Consequently, the blood proteins pool had a maximal change in the body of the heavy cross birds Hybrid Converter, creating the prerequisites for increasing the protein metabolism intensity in the cells of organs and tissues and contributing to an increase in their number in tissue depots. This provided a higher growth rate of these turkeys during the growing period, compared with other bird crosses.

Total blood protein is a complex indicator, which includes protein fractions that differ in speed in the external electric field. The main fractions of blood protein are albumins and globulins, the amount of which is directly related to the level of bird productivity. This is determined by the fact that they are directly involved in metabolic processes and their level is interconnected with the physiological state and body resistance.

The main protein fraction of the blood are albumins, which perform transport and plastic functions. The concentration of albumin in the blood of turkeys did not so much depend on their age, but on cross (genotype). During the growth and development of birds, the protein level most significantly increased in specimens of group IV. At 120 days of age, compared with 60 days of age, the albumin level in heavy cross turkeys Hybrid Converter increased by 11.86% (Tab. 1). In the same time, in turkey poult's of White broad-chest breed (group I) — by 3.54%, in the heavy cross of White broad-chest breed (group II) — by 5.16% and in the middle cross-breed Hybrid Grade Maker (group III) — by 2.25 %. It is logical to assume that in the body of group IV birds, the growth and development processes were associated with the most active use of albumin. This provided a higher growth rate of Hybrid Converter turkeys, compared with others. This conclusion is consistent with the results of assessing the growth rate of turkeys during the growing period under industrial conditions.

Globulins are a group of proteins with different structures and biological properties. They are divided into main groups: alpha, beta and gamma globulins.

The composition of alpha globulins includes both transport proteins that provide migration of vitamins and hormones with blood flow to the cells of organs and tissues, as well as acute phase proteins, the concentration of which is associated with the level of antigenic load on the body. The content of alpha-globulins in the blood of 60-day-old turkeys did not depend on age and cross and fluctuated in the range of 10.78–11.62 g/l, indicating the conformity of feeding conditions and biological capabilities of the body. However, at 120 days of age, the Hybrid crosses exceeded their analogues of the White broad-chest crosses by the alpha-globulins level. The most significant differences were with turkeys of the medium cross of the White broad-chest turkeys, which ranged from 11.38–15.99%, which in our opinion is explained by the increased need for proteins that transport hormones and fat-soluble vitamins in the bloodstream to the cells of organs and tissues.

The beta-globulin group includes proteins that provide transport of various lipids and lipoids throughout the body of birds. Therefore, their concentration is associated with lipid metabolism direction and activity.

Analysis of the results of beta-globulin variability in terms of age and cross of turkeys showed that their level did not depend on the above factors (Tab. 1). It ranged from 8.06 to 9.92 g/l. Therefore, the lipid metabolism intensity in the body of turkeys of different crosses was expressed approximately the same. This is explained by the fact that this bird species is not prone to excessive lipid accumulation in fat depots and the level of lipid metabolism is determined by the current demands of organ and tissue cells and lipid content in the feed components.

Gamma globulins are proteins that make up the chemical base of antibodies and, as a result, are involved in providing the body's immune defenses. The level of these proteins, as well as of beta-globulins, in the blood of turkeys did not depend on age and cross. In the blood of 60-day-old birds, it ranged from 10.58 to 11.07 g/l, and in 120-day-old birds — 10.80–11.51 g/l. The low variability of gamma globulins indicates the compliance of the technological conditions of their cultivation with the biological needs of the body; and turkeys have a high level of protective forces, which is a specific feature of this bird species.
To assess the direction of protein metabolism, we determined the protein coefficient value (Fig. 1), which reflects the ratio between albumins and globulins in the blood, as well as their level of demand in the biochemical reactions of cells. We should also consider that about half of the blood proteins are albumins, and due to this, the value of the protein coefficient tends to unity.

An analysis of age-related variability of the Alb/Gl coefficient showed that in turkey poult’s of medium (group I) and heavy (group II) crosses of the White broad-chested breed, the ratio between albumin and globulins did not depend on the birds age (figure 1). It shows that the metabolic state of the liver cells practically did not change with age, which was reflected both in their productivity level and in the quality of the products obtained. At the same time, in middle-cross birds of Hybrig Grade Maker (group III), the Alb/Gl coefficient decreased with age due to the predominant increase in the number of globulin proteins that perform transport and protective functions. In heavy cross turkeys of Hybrid Converter (group IV), on the contrary, the protein coefficient value during the growing period increased due to albumin, which is synthesized in the liver and is a direct participant in tissue protein metabolism. Accordingly, differences in the ratio of albumin and globulin in the blood of turkey poult’s of different crosses create the basis for the appearance of differences in the formation of productive qualities during the technological cycle.

The intensity of protein metabolism is directly related to the activity of aminotransferase enzymes, due to the catalytic action of which free amino acids undergo deamination. Aspartate aminotransferase (AsAT) and alanine aminotransferase (AlAT), with the participation of which the amino group is transferred from an amino acid to a keto acid, are the most common and demanded in metabolic processes. This feature of the biochemical reaction determines the presence of amphiobolic properties in these enzymes, as well as their participation in energy metabolism (table 2).

![Figure 1. Variability of the Alb/Gl coefficient (conventional units) in turkeys](image)

Table 2. Enzymes activity in turkey blood (n=30), X±Sx.

| Indicator | Age, day | Group |
|-----------|---------|-------|
|           | 60 days | I     | II   | III  | IV   |
|           | 120 days|       |      |      |      |
AsAT,

|       | 60     | 120     |
|-------|--------|---------|
| mmol/l| 1.87±0.05 | 2.03±0.07 |
|       | 1.86±0.04 | 2.02±0.08 |
|       | 1.86±0.08 | 2.06±0.07 |
|       | 1.89±0.05 | 2.16±0.07 |

AIAT,

|       | 60     | 120     |
|-------|--------|---------|
| mmol/l| 1.82±0.06 | 1.96±0.05 |
|       | 1.83±0.04 | 1.91±0.05 |
|       | 1.80±0.04 | 1.93±0.04 |
|       | 1.85±0.03 | 2.01±0.05 |

Note: * - P≤0.05 compared with the control

The activity of aminotransferases in the blood of turkeys of the experimental groups corresponded to the boundaries of the physiological norm, but depended mainly on age.

The concentration of aspartate aminotransferase (AsAT) in the blood of 60-day-old turkey poults ranged from 1.86 to 1.89 mmol/l. The enzyme activity in 120-day-old birds ranged from 2.02 to 2.16 mmol/l (Tab. 2). The increase in this parameter value during the cultivation of turkeys amounted to 8.56–14.28%. Moreover, the activity of AsAT increased to the maximum extent in the blood of heavy cross Hybrid Converter specimens (group IV) from 1.89 ± 0.05 to 2.16 ± 0.07 mmol/l. AsAT is known to be an enzyme that catalyzes transamination reactions, during which free amino acids are converted to keto acids - metabolites of the Krebs cycle. Therefore, they are involved in the biochemical cycle of the metabolic cycle, subjecting it to redox decomposition with the formation of an equivalent amount of energy. In the heavy cross Hybrid Converter turkeys, in comparison with other crosses, the higher catalytic activity of AsAT contributed to the production of additional energy during protein catabolism and was the basis for a higher bird growth rate.

A similar dependence was revealed in relation to the catalytic activity of AlAT. In the blood of 60-day-old turkey poults, the enzyme concentration ranged from 1.80–1.85 mmol/l, and in 120-day-olds from 1.91 to 2.01 mmol/l. The age-related enzymatic activity increase was 4.37–8.65%. At the same time, the maximum enzyme level increase was observed in heavy cross Hybrid Converter (group IV) – from 1.85 ± 0.03 to 2.01 ± 0.05 mmol/l (table 2).

The alanine aminotransferase enzyme catalyzes the transamination reaction, during which keto acid is formed from alanine, and is later used in glucose synthesis by gluconeogenesis. Glucose in the birds body is the main energy substrate, and its synthesis from amino acid residues serves as an additional energy source. In addition, glucose catabolism (in the apotomic way) is accompanied by the synthesis of reducing equivalents in the form of NADPH⁺, which are subsequently used in the synthesis of the body’s own biomolecules.

Basing on the biological role of AlAT in the body of birds, it can be assumed that heavy cross turkeys, compared to other crosses, are more adapted to receive an additional amount of energy during the protein molecules catabolism and formation of NADPH⁺, the amount of which determines the anabolic reactions intensity.

To verify this assumption, we calculated the ratio between AsAT and AlAT (de Ritis coefficient).

In the blood of turkeys, regardless of age and cross, AsAT activity prevailed over AlAT. Therefore, the value of de Ritis coefficient exceeded unity (figure 2). This reflects the ability of organ and tissue cells to primarily use the carbon residues of free amino acids formed in the transamination reactions in energy synthesis, oxidizing them in the Krebs cycle. Moreover, during the growth and development of birds, differences in the activity of AsAT and AlAT increased, providing an increase in the ratio of AsAT/AlAT. To the greatest extent, de Ritis coefficient increased in group IV, indicating the ability of the organism of heavy cross Hybrid Converter to use carbon residues of free amino acids in energy synthesis, both through the Krebs cycle and by gluconeogenesis.
4. Conclusion

Thus, an assessment of the physiological state of turkey poults during industrial cultivation showed that all of them were physiologically healthy, and the studied parameters fluctuated within normal limits. At the same time, the blood parameters values depends on the age of the bird and the genotype, determined by both the breed and the cross. The protein metabolism intensity, which determines the concentration in blood of turkeys of total protein and its fractions, the activity of transamination enzymes (AlAT, AsAT) does not so much depend on age, but on the genotype of birds. The highest level of protein parameters are in the blood of heavy cross Hybrid Converter. At the same time, the rate of growth and development of their body is associated with the exchange of albumin and the ways of using free amino acids to cover its energy consumption. Therefore, turkey poults of this cross are superior to their analogues in terms of albumin (by 9.54%), activity of AsAT (by 1.61–6.93%) and AlAT (by 2.77–5.23%).

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