

# MINERAL METABOLISM FEATURES IN TURKEYS

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**ABSTRACT**--Mineral substances are essential for the synthesis of vital compounds and are part of the molecules of complex organic structures. The aim of the research is to study mineral metabolism features of turkeys of different genotypes and age. It was established that the condition of calcium-phosphorus metabolism determined by the level of total calcium and inorganic phosphate in blood depends on the age and cross of birds. The content of macroelements of Heavy Cross Hybrid Converter turkeys exceeds its analogues by 3.21-14.72%. At the same time, the concentration of calcium during the growth of turkey organism increases, and phosphate - decreases, determining the increase of Ca : P - ratio in 60-day age from 1.44 - 1.49 conventional units to 1.74 - to 1.85 conventional units in 120-day age. The level of reserve alkalinity of blood is correlated with the age and genotype of birds. Its value decreases during the growth of the organism, reflecting the metabolic processes in cells of organs and tissues, during which a large number of acidic metabolites are formed. The volume of alkaline stocks decreases most strongly in the blood of Heavy Cross Hybrid Converter turkeys (group IV), indicating a higher level of metabolism in their bodies.

**Keywords**-- turkey, mineral metabolism, calcium, phosphorus, reserve alkalinity

## I. INTRODUCTION

Many factors affect the quality of poultry production (Igenbayev et al., 2019; Shukesheva et al., 2018; Sydykova et al., 2019). Mineral substances are a part of structural elements of poultry body (Goetting-Fuchs et al., 2012). Each cell contains certain mineral elements (Zhang et al., 2019). The formation of new cells in a growing organism is impossible without minerals (Bilal et al., 2015). Mineral depositions are mainly found in bones and other tissues of the body (Zhang et al., 2019, Kuramshina N et al., 2019).

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Mineral substances are essential for the synthesis of vital compounds and are part of the molecules of complex organic structures. For example, iron in the feed, together with copper and manganese, is used to build blood hemoglobin, which transfers oxygen and carbon dioxide (Chachaj et al., 2019; Czech et al., 2014; Dai et al., 2020; Ma et al., 2019; Sharipova et al., 2017). Phosphorus is a component of such organic compounds as nucleic acids, phosphides and others. Sulphur takes part in the synthesis of amino acids - methionine, cystine and cysteine - that are contained in body proteins. Iodine is an indispensable element in the formation of thyroid hormones. Chlorine is the main element in the creation of pepsin, a gastric juice enzyme (AL Homidan et al., 2019; Plumstead et al. 2007; Sobolev et al., 2019).

Minerals are important in the digestion, absorption and assimilation of feed nutrients in animals, contributing to the creation of an environment where enzymes and hormones are active (Fallah et al., 2020; Khabirov et al., 2020; Oikeh et al., 2019; Podolian, 2017; Sharipova et al., 2017). For example, the main pepsin enzyme that promotes digestion of feed protein only functions in the presence of hydrogen ions of hydrochloric acid, and alkaline salts facilitate digestion of fats. A certain interaction of a number of mineral ions determines the proper development of the young organism, heart function, transverse musculature, nervous system (Damaziak et al., 2017; Sobolev et al., 2019; Szabó et al., 2005; Tkachuk et al., 2018).

The full supply of minerals to animals during fattening contributes to faster feeding times and reduces feed consumption per body weight gain (Yakubchak et al., 2018).

Thus, the mineral proportion of the feed plays an important role in the complete feeding of animals. Only when the necessary amount of minerals is available in the diet, the animal organism uses nutrients of the feed to the fullest extent, maintains health and provides maximum productivity (Bilal et al., 2015; Khabirov et al., 2020; Sharipova et al., 2017).

Calcium and phosphorus play an important role in poultry by participating in the formation of skeleton and shell (Goetting-Fuchs et al., 2012). The calcium intake of chicks depends on the energy value of the feed and should be about 0.7-0.9% of the total feed (Fallah et al., 2020; Ren et al., 2020). The symptoms of calcium and phosphorus deficiency are lower appetite; delayed development and growth; and bone weight reduction (Oikeh et al., 2019).

Based on the above, the formation of productive qualities in birds is very strongly associated with the availability of minerals in their bodies, among which the main role is assigned to calcium and phosphorus. At the same time, most of these elements in the organism of growing birds are used in the processes of bone tissue formation. Therefore, calcium and phosphorus metabolism disorders initiate various pathologies of their organs and systems (Bilal et al., 2015; Majewska et al., 2016; Ren et al., 2020).

The work aims to study the mineral metabolism characteristics of turkeys of various genotypes and age.

## **II. MATERIAL AND METHODS**

For this purpose 4 groups of turkeys (30 head each) at the daily age were selected according to the analogue principle (Table 1).

**Table 1:** Experimental groups of turkeys

Group	Turkey breed	Slaughter age, days
I	Broad-Breasted White (middle cross)	120
II	Broad-Breasted White (heavy cross)	150
III	Hybrid Grade Maker (middle cross)	120
IV	Hybrid Converter (heavy cross)	150

Blood of turkeys was tested at ages 60 and 120 days from 5 heads from each group. The content of calcium, phosphorus, and reserve alkalinity in turkey blood serum were determined on a Stat Fax 3300 biochemical analyzer according to the approved technique of this device.

### III. RESULTS AND DISCUSSION

The results of calcium and phosphorus content in experimental groups of turkeys are presented in Table 2.

**Table 2:** Calcium-phosphorus metabolism rates in turkeys (n=30),  $\bar{X} \pm S_x$

Indicator	Age, days	Group			
		I	II	III	IV
Calcium total, mmole/l.	60	2.80±0.08	2.84±0.07	2.86±0.03	2.89±0.10
	120	3.02±0.13	3.04±0.17	3.18±0.13*	3.25±0.17*
Inorganic phosphorus, mmole/l.	60	1.88±0.22	1.92±0.19	1.98±0.16*	2.01±0.20
	120	1.63±0.12	1.67±0.06	1.82±0.06	1.87±0.10

$P \leq 0,05$  versus group I (control)

Calcium is an element that is used in the body to build skeletal bones, in the processes of neuromuscular excitation, muscle contraction and blood clotting. In addition, the mineral is an intracellular secondary mediator in the implementation of biological effects of series of hormones, regulates the permeability of cell membranes and the activity of several enzymes. The biological functions of calcium in the animal body determine its role in the conjugation of metabolic flows.

The concentration of calcium in the blood of turkeys depended on age and cross (genotype). The level of calcium in the body of 60-day-old birds varied between 2.80-2.89 mmol/l. The highest level was observed in the blood of the heavy cross turkeys Hybrid Converter (Table 2). During growing of turkeys the level of element increased by 7.04-12.45%. Thus the greatest variability of calcium concentration was observed for turkeys of middle cross Hybrid Grade Maker (III group) and heavy cross Hybrid Converter (IV group), in which it increased by 11.19 and 12.45%. The birds of these crosses, in comparison with the white broad-breasted crosses, had considerably higher live weight in the investigated age periods, which, accordingly, was reflected in the bone volume in their organism. This fact influenced the level of calcium in blood of turkeys, determining its dynamics in the course of bird growth depending on the speed of skeleton bones growth.

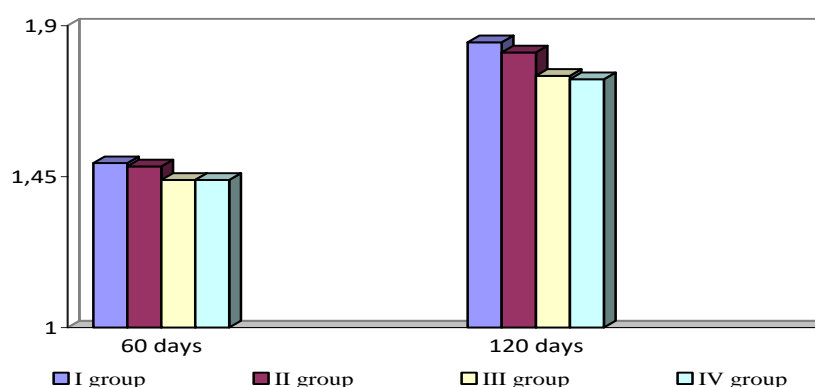
The higher level of calcium in the blood of turkeys of groups III and IV, as compared to groups I and II, also contributed to the growth rate of their bodies by increasing the efficiency of digestion of feeds. The exchange of calcium is closely related to inorganic phosphate. This is due to the fact that a significant part of macroelement cations form complex compounds with phosphorus, including in the bone tissue. In addition, phosphorus promotes absorption of calcium in the intestinal tract, formation of energy compounds such as ATP, phosphorus-containing proteins and lipids.

Analyzing the data on changes in the concentration of inorganic phosphate in the blood of turkeys, we found that its level decreased with age. The loss of the element from 60 to 120 days of age in turkeys of the middle cross of Broad-Breasted White (Group I) was 15.33%, in heavy cross of Broad-Breasted White (Group II) - 14.97%, in middle cross of Hybride Grade Maker (Group III) - 8.08% and in heavy cross of Hybride Converter (Group IV) - 6.97% (Table 1). This is caused by reduction of blood phosphatase activity as a result of functional activity decrease of osteoblasts along with reduction of skeleton bone growth rate.

Genotype of birds influenced the concentration of inorganic phosphate in blood. Thus, birds of the middle cross of the Hybrid Grade Maker (group III) and heavy cross of the Hybrid Converter (group IV) exceeded turkeys of the middle cross of the Broad-Breasted White (group I) and heavy cross of the Broad-Breasted White (group II) in 60 days of age in terms of biochemical parameters, respectively, by 3.12-5.33 and 4.69-6.91%, and by 8.98-11.66 and 11.97-14.72% in the 120-day period.

In assessing the state of calcium-phosphorus metabolism in the body of turkeys of experimental groups, it is necessary to take into account the value of their ratio (Ca : P), which should normally be 3 : 1.

At the age of 60 days, the turkeys of the experimental groups had no significant difference in the size of Ca : P - ratio (Fig. 1). It varied between 1.44-1.49 aud. units, showing the degree of prevalence of calcium over inorganic phosphate. This indicated the active use of minerals in the processes of building and restructuring of bone tissue in conditions of active bird growth. By the end of the growing period (120 days of age) the ratio of calcium to inorganic phosphate increased. In turkeys of the I and II experimental groups it varies in the range from 1.82 to 1.85 aud. units, and III and IV groups - from 1.74 to 1.75 aud. units. This ratio of macroelements is determined by the growth of calcium concentration against reduction of inorganic phosphate.

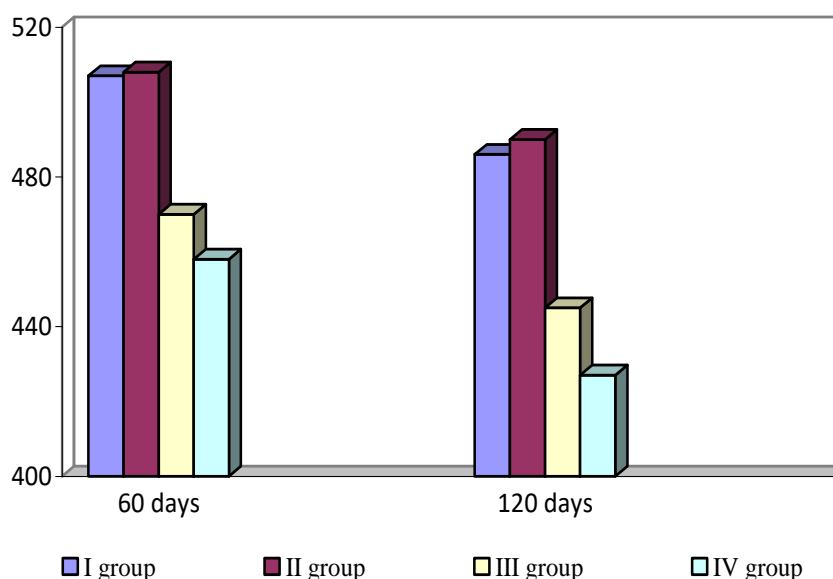


**Figure 1:** Ratio of calcium to phosphorus (Ca : P, conventional units) in birds

Calcium and inorganic phosphate ions, being one of the main blood minerals, have a significant impact on the amount of reserve alkalinity of blood. In this case, calcium is the main, and phosphorus is an acid element.

The value of the reserve alkalinity of blood indirectly reflects the ability of the organism to maintain the stability of the reaction of the blood medium in the conditions of inflow of various acidic and basic metabolites into it. Reserve alkalinity of blood is defined as a reserve of alkaline compounds in its buffer systems capable of maintaining pH value constancy due to neutralization of acidic products coming into it from organ and tissue cells. They are generated by the processes of cell respiration and metabolism. The main ones are carbonic, lactic and phosphoric acids.

The level of reserve alkalinity of blood depended on the age and cross of turkeys of experimental groups (Fig. 2). At the 60-day age the value of the parameter for turkeys of the middle cross of Broad-Breasted White (group I) and heavy cross of Broad-Breasted White (group II) were  $507.00 \pm 42.6$  and  $508.00 \pm 56.6$   $\mu\text{mol/l}$  respectively. The value of alkaline blood reserve was higher by 7,87-10,69 and 8,09-10,92% than that of analogues of Groups III and IV. Therefore, in the organism of middle-class Hybrid Grade Maker (Group III) and heavy cross Hybrid Converter (Group IV) the physiological processes, including metabolism, progressed more intensively.



**Figure 2:** Alkaline blood reserve ( $\mu\text{mol/l}$ ) in birds

During the growing period, the reserve alkalinity of blood decreased (Fig. 2). In 120-day age of turkeys the parameter value, in comparison with 60-day age, decreased in I, II, III and IV experimental groups by 4,14; 3,54; 5,32 and 6,77%. The volume of alkaline reserves decreased most strongly in the blood of Heavy Cross Hybrid Converter turkeys (group IV), which indirectly indicated a higher level of metabolic processes in their bodies.

#### IV. CONCLUSION

In summary, the assessment of the physiological state of turkeys in the growing process under industrial conditions on the variability of morphological and biochemical parameters of the blood showed that all of them

varied within the standard limits. At the same time the value of blood parameters depends on the age of the bird and genotype, determined by both breed and cross. The state of calcium-phosphorus metabolism, determined by the level of total calcium and inorganic phosphate in blood, depends on the age and cross of birds.

Heavy cross turkeys Hybrid Converter exceed their counterparts by 3.21-14.72% in terms of macroelement content. At the same time, the concentration of calcium increases during the growth of the turkeys' body, and phosphate decreases, resulting in an increase in the value of Ca : P - ratio in the 60-day age from 1.44 - 1.49 to 1.74 - to 1.85 in 120-day age. The level of reserve alkalinity of blood is correlated with the age and genotype of birds. Its value decreases during the growth of the organism, reflecting the tension of metabolic processes in cells of organs and tissues, during which a large number of acidic metabolites are formed. The amount of alkaline stocks decreases most strongly in the blood of Heavy Cross Hybrid Converter turkeys (group IV), indicating a higher level of metabolism in their bodies.

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