Comparative characteristics of metabolism in stress-sensitive and stress-resistant broiler chickens

Sergey Smolentsev[1*], *Lyudmila* Holodova[1], *Alexey* Rozhentsov[1], *Snezhana* Bryukhacheva[1], *Kseniya* Belyakova[1], *Olga* Gracheva[2], *Alizade* Gasanov[2], *Fazil* Medetkhanov[2], *Dina* Mukhutdinova[2], *Bulat* Tamimdarov[2], *Nadezhda* Isupova[3], and *Vyacheslav* Milaev[3]

[1] Mari State University, Lenin Square 1, Yoshkar-Ola city, 424000, Russia
[2] Kazan State Academy of Veterinary Medicine by N.E. Bauman, Sibirsky tract 35, Kazan city, 420029, Russia
[3] Udmurt State Agricultural University, Studencheskaya street 11, Izhevsk city, 426069, Russia

Abstract. The metabolic processes in ISA F 15 cross broiler chickens with different stress sensitivity in industrial technology have characteristic differences. The content of total protein in the blood serum of stress-sensitive poultry is 3.46% higher, β-lipoproteins - 8.8; glucose - 8.3; alkaline phosphatase activity - 42.6% higher than in stress-resistant chickens; total lipids (2.83 g/l) and inorganic phosphorus (2.6 mmol/l) are set at the same level Cholesterol is 11.5% higher; alkaline reserve is 14.5% higher in stress-resistant than in stress-sensitive birds. Key words: stress, broilers, stressful sensitivity, metabolism.

1 Introduction

Industrial poultry farming is based on the use of highly productive and environmentally resistant chicken hybrids [1,2]. Despite the stability of modern crosses, very often there is a discrepancy between biological characteristics and industrial technologies, which become the causes of contradictions between the adaptive capabilities of chickens and environmental factors [3,4]. In such conditions, certain difficulties arise associated with the occurrence of stressful situations leading to additional energy costs, accompanied by a decrease in productivity and safety of poultry, a decrease in resistance, impaired metabolic processes, high morbidity and a shortage of products [5,6,7]. In this regard, the issue of studying the level of metabolic processes in the body of stress-resistant and stress-sensitive birds in a technological habitat remains particularly relevant, and this has become the goal of our research.

2 Materials and methods

The experiment was carried out on the basis of CJSC Ural-Broiler Argayash Poultry Farm at an industrial site located in the village of Derbyshevo. The poultry farm uses a cellular

* Corresponding author: smolentsev82@mail.ru

 https://doi.org/10.1051/bioconf/202413007011

content system. Broiler chickens are housed in a three-tiered cage "EGS-CARRE", which is equipped with all necessary systems to ensure comfortable poultry keeping. The coordination of all systems in poultry houses is carried out by the computer system "Viper", which monitors the state of the microclimate parameters (ambient temperature, humidity, lighting, provision of all production processes (filling of feed bins and their consumption, water consumption, poultry weight control, etc.). Feeding and maintenance of broiler chickens is carried out in accordance with the zoohygienic standards developed by VNITIP and the Methodological recommendations of the manufacturer of the cross – the Hubbard company. Hubbard ISA F15 cross broiler chickens were used in the experiment, 5 cells were tested for stress sensitivity – 246 heads at the age of 32 days. To determine the level of stress sensitivity of the experimental bird, a method developed by A.I.Kuznetsov et al. was used [8,9]. Based on the evaluation criteria, experimental groups of broiler chickens were formed for further research. Blood collection was carried out by the conventional method (from the axillary vein). The study of biochemical parameters of chicken blood was carried out using standardized methods [10,11]. Thus, the determination of total protein was performed by the biuretic method using a crophotoelectrocolorimeter (type MMF-1); total lipids – by the calorimetric method; β-lipoproteins cholesterol, AsAT, AlAT, glucose, total calcium, inorganic phosphorus, alkaline phosphatase, alkaline reserve – by Eco-service clinical tests. All experimental data obtained were statistically processed using the Biometrics computer program.

3 Results and discussion

As a result of the turpentine test of ISA F15 cross broiler chickens in the conditions of an industrial site, 11% were stress-sensitive, 13% were stress–sensitive and 76% were stress–resistant individuals. To study metabolic processes, we selected 10 heads from a group of stress-sensitive and stress-resistant chickens for blood collection and biochemical studies.

As is known, proteins play an important physiological role in the body, performing a plastic function, they are part of hormones, enzymes, vitamins, therefore, a change in their content in the blood leads to a violation of homeostasis. As a result of the conducted studies, it was found that the total serum protein content in stress-sensitive poultry was 34.7 g/l and was 3.46% higher than in stress-resistant chickens.

It is known that with the participation of aminotransferases, transamination processes are carried out, which play a huge role in intermediate metabolism, they ensure the synthesis and destruction of individual amino acids in the body, convert amino acids (glutamic, aspartic, alanine) into corresponding alpha-keto acids, which are components of the tricarboxylic acid cycle, and serve as energy sources during oxidation. We were interested in determining the level of amintransferases in birds with different stress sensitivity. As a result of the conducted studies, it was found that the content of AsAT in the group of stress-sensitive poultry was 10.8% lower compared with stress-resistant broilers (Table 1). In contrast, AlAT levels were 30% higher in stress-sensitive chickens.

Table 1 - The level of aminotransferases in poultry with different stress sensitivity, mmol/ml

Group	AsAT	AlAT
Stress sensitive	1,82±0,03	0,1±0,01
Stress-resistant	2,04±0,04	0,07±0,01

 https://doi.org/10.1051/bioconf/202413007011

The intensity of the course of fat metabolism can be judged by the content of total lipids, β-lipoproteins, and cholesterol in the blood serum. Lipids are chemically diverse substances that perform vital functions in a living organism. Some of them serve as a form of deposition (triacylglycerols, triglycerides), others (free fatty acids) – transport of substances, when they decompose, a large amount of energy is released, and others represent the most important structural components of cell membranes (free cholesterol, phospholipids).

During the determination of the level of total lipids, we found that in the blood serum of the compared broiler groups, the content of total lipids practically did not differ and amounted to 2.83-2.84 g/l (Table 2). The level of β-lipoproteins was higher in the group of stress-sensitive chickens. The indicator was 161.96 mg%, which is 8.8% higher compared to stress-resistant broilers. The cholesterol content, on the contrary, was 11.5% higher in the stress-resistant group compared to the stress-sensitive bird.

Table 2 - Indicators of fat metabolism in broilers with different stress sensitivity

Group	Total lipids, g/l	β-lipoproteins, mg%	Cholesterol, mmol/l
Stress sensitive	2,83±0,35	161,96±5,12	3,47±0,14
Stress-resistant	2,84±0,30	147,69±8,52	4,00±0,02

The next stage of our experiments was to study the level of carbohydrate metabolism. According to the literature data, carbohydrates perform energy, protective, structural, mechanical and other functions in the body of animals. In particular, glucose is a valuable nutrient for most cells (especially brain cells). The glucose content depends on the characteristics of its metabolism, which consists of the processes of carbohydrate intake into the body, their metabolism at the level of cells and tissues, as well as excretion from it. During the study of blood glucose, it was found that in stress-sensitive chickens, the analyzed indicator was noted at the level of 7.07 mmol/l, which is 8.3% higher compared with the results obtained in the group of stress-resistant broilers (6.84±0.50 mmol/l).

The state of health and the level of productivity of poultry is largely determined by the quality of mineral nutrition during the growing period. Any deviations in the content of chemical elements can lead to a wide range of disorders in the functioning of the body. Thus, calcium plays a very important role in the implementation of vital processes. It affects the permeability of biological membranes, regulates the excitability of nerves and muscles, participates in neuromuscular conduction, contraction and relaxation of muscles, formation of bones and cartilage tissue, regulates metabolism in cells, participates in the formation of hormones, enzymes, is a coagulation factor. In a stress-sensitive bird, the level of total serum calcium was noted at 3.69 mmol/l. This is 8.9% lower than in stress-resistant chickens (Table 3).

 https://doi.org/10.1051/bioconf/202413007011

Table 3 Indicators of mineral metabolism in broilers with different stress sensitivity

Group	Total calcium, mmol/l	Inorganic phosphorus, mmol/l	Alkaline phosphatase, Unit/l	Alkaline reserve, vol%CO2
Stress sensitive	3,69±0,21	2,69±0,14	709,01±14,27	26,69±1,32
Stress-resistant	4,02±0,16	2,58±0,16	407,17±3,22	31,37±1,84

The concentration of inorganic phosphorus in the blood serum largely depends on the function of the parathyroid and thyroid glands, the functional state of the kidneys, the presence of vitamin D. The mineral element performs many vital functions in the body, is part of cell membranes, ensures the growth and development of bone and cartilage tissues, regulates metabolism in cells, participates in the formation of biologically active substances. It was found that the content of inorganic phosphorus in the blood serum of an experimental bird with varying degrees of stress sensitivity was approximately at the same level.

The next step in our research algorithm was to determine the level of alkaline phosphatase. It is an enzyme that is found in almost all tissues of the body (bone and lung tissues, kidneys, intestinal mucosa, but especially a lot of it in growing bones). Localized in the cell membrane, the enzyme participates in the process of transport of biologically important compounds. During the clinical test, a significant difference in the content of alkaline phosphatase in the blood serum of stress-sensitive and stress-resistant birds was established. Thus, in stress-sensitive chickens, alkaline phosphatase was registered at the level of 709.01 u/ l, which is 42.6% higher than in the group of stress-resistant broilers (407.17 u/ l) (at normal - 316 u/ l).

The state of metabolic processes, the work of blood buffer systems, acid-base balance in the body can be judged by the level of alkaline reserve in the body. During the determination of this indicator in experimental groups, a decrease in the alkaline reserve in the blood serum of the observed birds was found. In stress-sensitive chickens, the alkaline reserve was 26.69 Vol%CO2, which is 14.5% lower than in the group of stress-resistant broilers.

4 Conclusion

Based on the results obtained, we made the following conclusions: Metabolic processes in ISA F 15 cross broiler chickens with different stress sensitivity in industrial technology have characteristic differences:

1. the content of total protein in the blood serum of stress-sensitive poultry is 3.46% higher, β-lipoproteins - 8.8; glucose - 8.3; alkaline phosphatase activity - 42.6% higher than in stress-resistant chickens;
2. The content of total lipids (2.83 g/l) and inorganic phosphorus (2.6 mmol/l) is set at the same level;
3. The cholesterol content is 11.5% higher; the alkaline reserve is 14.5% in stress-resistant birds than in stress-sensitive birds.

https://doi.org/10.1051/bioconf/202413007011

References

1. Potekhina, R.M., Tarasova, E.Yu., Matrosova L.E., Khammadov N.I., Saifutdinov A.M., Ermolaeva O.K., Tanaseva S.A., Mishina N.N., Nigmatulin G.N., Mukharlyamova A.Z., Smolentsev S.Yu. and Semenov E.I., Veterinary Medicine International, **2023**, 5281260 (2023)
2. Sufyanova L., Smolentsev S., Kislitsyna N., Aleev D., Malanev A., Khalikov K., Yamalova G., Gabitova G., Valiev A., E3S Web of Conferences, **381**, 01031 (2023)
3. Gaynutdinov T., Idrisov A., Vagin K., Kurbangaleev Ya., Zakirova G., Ishmukhametov K., Kalimullin F., Nizamov R., Guryanova V., Smolentsev S., E3S Web of Conferences **371**, 02046 (2023)
4. Smolentsev S.Yu., Gertman A.M., Samsonova T.S., Kalyuzhny I.I., Strogov V.V., Loschinin S.O., Semivolos A.M., Bryukhanova A.A., Lecture Notes in Networks and Systems, **706**, 65–71 (2023)
5. Smolentsev S.Yu., Strelnikova I.I., Kislitsyna N.A., Burova N.O., Gugkaeva M.S., Kornaeva A.K., Milaev V.B., Babintseva T.V., Deryusheva A.D., Lecture Notes in Networks and Systems, **706**, 58-64 (2023)
6. Smolentsev S.Yu., Strelnikova I.I., Kislitsyna N.A., Burova N.O., Gugkaeva M.S., Kornaeva A.K., Shkaeva N.A., Abduramanova T.D., Lecture Notes in Networks and Systems, **706**, 72-78 (2023)
7. Smolentsev S.Yu., Bogomolova O.A., Fedorov Yu.N., Markova E.V., Neminuschaya L.A., Skotnikova T.A., Eremets V.I., Melnik R.N., Melnik N.V., Lyulkova L.S., Matveeva I.N., Popova V.M., Burova N.O., Lecture Notes in Networks and Systems **706**, 85-91 (2023)
8. Zinnatov F.F., Yakupov T.R., Fayzrakhmanov R.N., Zinnatova F.F., Smolentsev S.Yu., Hairullin D.D., Khisamov R.R., Bikchantaev I.T., Hardina E.V., Krasnova O.A., Bass S.P., Vasileva M.I., Achkasova E.V., Lecture Notes in Networks and Systems **706**, 102-108 (2023)
9. Smolentsev S.Yu., Smirnov A.S., Kislitsyna N.A., Papunidi E.K.,Makarov A.S., Garafutdinova N.Yu., Nikolaev N.V., Abdullina L.V., Beloglazova O.A., BIO Web of Conferences **65**, 02004 (2023)
10. Smolentsev S.Yu., Holodova L.V., Kislitsyna N.A., Kislitsyna E.I., Volkov A.H., Papunidi E.K., Yusupova G.R., Yakupova L.F., Volkov R.A., BIO of Conferences **65**, 02003 (2023)
11. Sufyanova L.M., Smolentsev S.Yu., Holodova L.V., Kislitsyna N.A., Zagidullin L.R., Khisamov R.R., Zakirov T.M., Gorshenina K.A., Larina Y.V., BIO Web of Conferences **65**, 02002 (2023)