

Age-related features of the manifestation of non-contagious pathology and metabolic disorders of liver in broiler chickens

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Abstract. The article presents the data on the study of age-related features of non-contagious pathology in broiler chickens, as well as the level of metabolic processes in liver of healthy poultry and poultry with diseases. The results of the studies indicate that in the conditions of an industrial enterprise specializing in meat poultry rearing, poultry mortality in different age periods ranged from 3 to 5 % of the total population. In the structure of the causes of mortality of broiler chickens from the 8th to the 15th day, an increase in mortality from hepatopathies was registered, and by the 25th day of life hepatitis was recorded in the bulk of the dead poultry. Biochemical monitoring of blood serum in poultry with signs of liver pathology revealed an increase in the level of ALAT, β -globulins, and the “inflammation syndrome” of the hepatic parenchyma was confirmed by a positive thymol test. Long-term consumption of feed contaminated with mycotoxins by broilers led to the deterioration in the health of the poultry, an imbalance in liver and the development of general metabolic disorders of the poultry organism.

1 Introduction

In modern conditions of intensive farming, a huge poultry population is concentrated in industrial poultry farming in Russia. At the same time, the technology for the production of broiler meat is based on the use of highly productive poultry, full feed rations, regulation of the maintenance regime, mechanization and automation of production processes, as well as effective methods of veterinary and sanitary preventive measures [1–3].

However, in pursuit of maximum productivity, the realization of the poultry genetic capabilities often takes place on the verge of wear and tear of their body because of the deep metabolic disturbances of various genesis, which are based on imbalance or nutritional deficiency of poultry diets, discrepancy of living conditions, conveyor system of technology leading to stress situations which cause an increased sensitivity of the poultry organism to various diseases. Moreover, a significant number of poultry die in the postnatal period, when the requirements for their feeding and keeping conditions are the highest. In certain age periods, cases of mass diseases with clearly expressed or latent pathological signs are observed, which causes significant damage in the poultry industry [4, 5].

Moreover, up to 95–98 % of poultry mortality occurs in diseases of non-contagious etiology, since timely vaccination against the most frequently occurring infectious diseases, such as infectious bursal disease (IBD), Newcastle disease, infectious bronchitis (IB), Marek’s disease and others, provides persistent

veterinary well-being for the development of infectious diseases in poultry farms, which reduces the likelihood of infectious diseases almost to zero [6].

The variety of negative factors acting on the poultry organism leads to the development of edogenic and exogenous toxicosis in the body, which becomes the trigger for the emergence of many diseases, and, first of all, liver pathologies, with which most of the body’s metabolic processes are directly or indirectly associated [7, 8].

Liver is the largest gland of the body, performing many functions, which are necessary for maintaining life, playing a major role in the metabolism (biosynthesis, secretion, detoxification and excretion) of various substances. In poultry, liver is the dominant organ in the abdominal cavity. In proportion to the size of the poultry, their liver is much larger than that in mammals. Due to its size and the small size of the poultry, liver is in direct contact with many organs (e.g. lungs, heart, air sacs).

Liver has great functional abilities; however, being a highly aerobic, oxygen-dependent tissue, it determines the high sensitivity of hepatocytes to any metabolic disturbances, which, ultimately, leads to the development of various pathological conditions in the poultry organism [9].

In connection with the foregoing, the purpose of our research was to study the age-related characteristics of non-infectious pathology in broiler chickens, as well as the level of metabolic processes in the liver of a healthy poultry and poultry with diseases.

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2 Materials and methods

The studies were conducted on broiler chickens of the ROSS 308 cross in the conditions of the poultry-rearing enterprise of CJSC Kurganinsky Meat Poultry Plant in the Kurganinsky District of the Krasnodar region in autumn. The company specializes in rearing of meat poultry.

The main zootechnical indicators of poultry rearing in the enterprise:

- the average growing age is 36 days;
- the average safety of poultry is 97.16 %;
- the average weight at the time of slaughter is 2.320 kg;
- the average daily weight gain is 63.3 g;
- the average feed conversion is 1.665 kg;
- the average productivity index (EPIF) is 369.

The poultry was kept in buildings with a capacity of up to 40000 broiler heads each. The poultry was kept on the floor, on the mat of rice husk. Feeding was systematized by means of screw distribution. The fodder was granulated with complete ration. Watering was made through nipple drinkers. The first 10 days of the life chickens were kept on the starter ration, from the 11th day they were transferred to the “growth” diet, which was fed until the 25th day of rearing and then the young poultry was transferred to the “finish” compound feed.

The microclimate in the room was created using a control unit that regulates the basic criteria of the environment – temperature, humidity, air exchange. Lighting was carried out by LED lamps with a regulator of the number of suites and the frequency of light output. The ventilation system had the shaft type of ventilation.

Before the 16th day of age, broiler chickens were subjected to compulsory vaccination.

The level of metabolic processes in the poultry was determined by biochemical blood parameters. Blood sampling for research was carried out from the veins of the inner surface of the wing of chickens.

Biochemical blood tests were made on an automatic analyzer Vitalab Selectra Junior with software version 1.0. (open system for conducting photometric tests, manufactured by Vital Scientific N. V. Netherlands) using reagents from ELITech Clinical Systems (France) and Analyticon biotechnologies AG (Germany).

Statistical processing of the results was carried out using the statistical software packages ARCADA, Microsoft Excel XP and Statistical for Windows. The study of quantitative traits was evaluated by comparing the average values of two sample sets with the determination of Student’s criterion and significance level (p).

3 Results

The analysis of the safety of broilers over five years showed that poultry mortality, the so-called technological mortality, in different age periods ranged from 3 to 5 % of the total population. Moreover, the clinical picture of the disease was often erased and had no obvious signs of one or another pathology; therefore

an important diagnostic criteria was a comprehensive diagnostic examination of broilers with disease, including clinical, pathomorphological studies of dead poultry, as well as laboratory studies of broiler feed and blood serum, which allowed revealing the age and technological dependence of the manifestation of metabolic disorders and the development of non-communicable pathology.

At autopsy of the dead poultry in the first 7 days of life, omphalitis was found (blood vessels were stretched on the yolk sac, it was inflamed, the skin area around the navel was discoloured), as well as dystrophic changes in organs and tissues, vitelline peritonitis, uric acid diathesis, hemorrhages and erosion in the muscle stomach. Almost always we observed changes in liver, characterized by a yellow-brown colour of the organ, which could be mistaken for pathology. However, these changes were caused by reversible embryonic jaundice.

The development of these diseases is confirmed by the fact that violations of technology during the incubation period are manifested by deviations in the normal life of chickens and the emergence of various pathologies. In the future, fodder stresses are added, associated not only with the transition of the chicken from yolk nutrition (in the last week of incubation) to dry feed, which differs in composition from the yolk, but also with an unbalanced ration on nutrient and biologically active substances [9].

From the 7th to the 12th days of the chickens' life, muscular dystrophies, an unresolved yolk, and gout, which are characteristic for weak and non-viable individuals, were observed.

In the structure of the causes of mortality of broiler chickens from the 8th to the 15th day, the decrease in mortality from diseases of the respiratory system and an increase in it from liver diseases were determined. The decreasing mortality caused by damage of the organs of the respiratory system was because of the fact that weak hypotrophic chickens died earlier. However, even in this age period, pathology of the respiratory organs was determined caused by drafts and temperature changes in the room where broilers were kept.

From the 13th to the 20th day, post-vaccination reactions of the organism (pulmonary edema, tracheitis, rhinitis) were manifested. At autopsy, hyperemia and swelling of the lung tissue with areas of catarrhal inflammation were observed. In some cases, the heart was enlarged. In kidney, the nephrosis was observed, manifested by the increase in kidneys and a change in their colour to light brown.

During this period, an increase in poultry mortality was recorded (about 5–6 % of the average value), caused by the weakening of resistance against the background of drafts and temperature changes in the room where broilers were kept.

From the 21st to the 30th day of life, deviations from the normal functioning of the musculoskeletal system were determined, associated with excess muscle gain in broilers. At pathological autopsy of broiler chickens, we observed various bone deformations such as an increase in volume, inactivity of the joints, and curvature.

From the 15th day, cases of liver damage were noted in dead chickens, and by the 25th day of life hepatitis was recorded in the bulk of the dead poultry; it was characterized by the development of toxic liver dystrophy, areactive hepatocyte micronecrosis in the absence of a demarcation line at their border. An autopsy and examination revealed the change in the boundaries of liver; the organ had a flabby texture, yellow-brown in colour, in some cases with spot hemorrhages. At pathomorphological study, a violation of the beam structure, plasmolysis of hepatocytes, venous hyperemia was recorded. Such disorders indicate a protein-fatty liver dystrophy (Fig. 1).

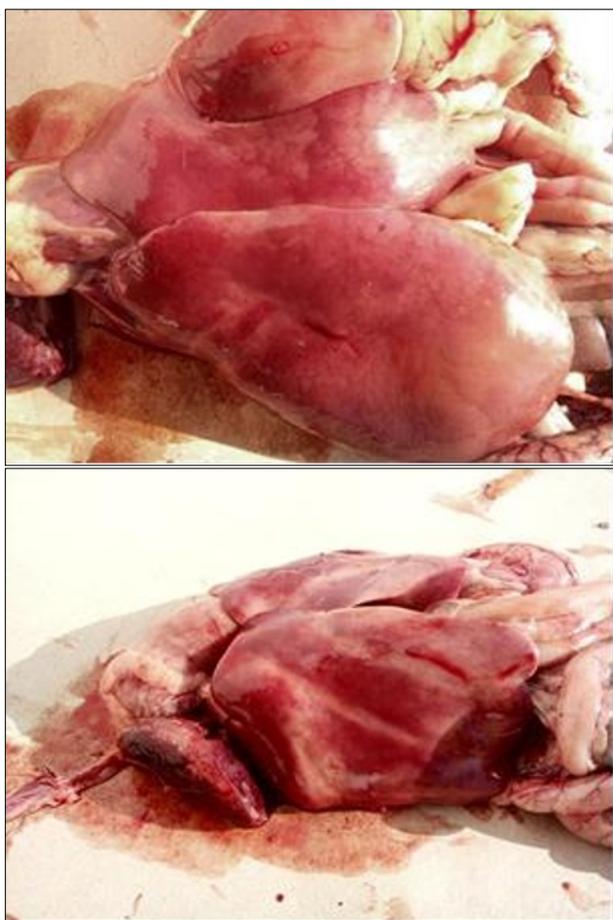


Fig. 1. Indicators of liver hepatitis in poultry

From the digestive system, damage of the organs of the gastrointestinal tract was determined, which was mainly represented by acute gastroenteritis. Characteristic changes occurred in the glandular stomach, manifested by inflammation and hemorrhage.

During the biochemical monitoring of blood serum, which was carried out during this period in poultry with signs of liver pathology, an increase in the level of alanine aminotransferase was found in 90 % of the samples (2–5 times from the upper values of the species norm). ALAT refers to cytoplasmic enzymes and its increase in the bloodstream is evidence of the violation of the integrity of the liver hepatocytes. In addition, in 45 % of the samples the “inflammation syndrome” of the

hepatic parenchyma was confirmed by a positive thymol test.

When analysing broiler proteinograms, it was found out that in 35 % of cases an increase in the level of α -globulins was recorded. A similar shift of α -globulins, which are also called “reactant proteins”, is characteristic of an acute inflammatory process or is caused by external stimuli that exhibit a toxic effect in the live organism (exo- and endotoxicoeses, allergic and stressful conditions).

The concentration of β -globulins increased in 60 % of samples. The beta fraction is mainly formed by lipoproteins (the most lipid-rich protein group), and therefore, the level of β -globulins always increases with hyperlipoproteinemia, as well as with toxic damages of the liver parenchyma.

It should be noted that any errors in poultry feeding are primarily reflected in the morphofunctional state of liver. The violations of the functional activity of liver in poultry can occur when feeding high-calorie feed, which predispose to fat deposition, increased intake of carbohydrates, inadequate nutrition of vitamins and lipotropic amino acids, stimulating the transport of fats and phospholipids from liver to various organs. In addition, liver damage can be caused by the presence in the feed of microsporidic fungi and mycotoxins produced by them [5].

Therefore, taking into account the technological cycle of poultry rearing, we examined samples of compound feed used to feed broilers at different age periods – starter, growth and finish.

The organoleptic evaluation of feed samples allowed them being classified as benign, but as a result of mycological and mycotoxicological studies, microscopic fungi of the genera *Fusarium* and *Penicillium* were determined in the samples, the number of spores of which varied from $0.6 \cdot 10^4$ to $1.6 \cdot 10^4$, as well as the toxins produced by them, such as aflatoxin – 0.01–0.15 mg /kg, T-2 toxin – 0.05–0.08 mg /kg and DON – 0.5–1.2 mg /kg were determined.

In addition, during the bacteriological study of feed samples, in some cases, opportunistic microflora – *Cluyvera cryocrescens* (α -hemolysis) and *Staphylococcus aureus* (α -hemolysis) were determined.

According to A. Nassif and Grigoriev D.Yu. [10], prolonged feeding of feed with low and medium levels of mycotoxin contamination, when their concentration under control may be lower than the level of maximum available level, can cause chronic mycotoxicoses in poultry, which are manifested primarily by the liver damage. Long-term consumption of diets poorly contaminated with mycotoxins over a long period of time leads to poor health caused by the additional effect of accumulation and increased exposure to several mycotoxins [5].

The target for the damaging effect is ultimately liver, the organ with which most of the body's metabolic processes are directly or indirectly associated. Moreover, the functionality of liver is not unlimited. Under the influence of toxicants, destructive and inflammatory processes inevitably develop in liver, which ultimately leads to the development of the common metabolic

pathology, the decrease in the level of natural resistance and immunological reactivity, and the development of diseases of various geneses.

Moreover, the symptoms of chronic mycotoxicosis are often not pronounced and appear clinically only after a certain period of time from the moment the pathological process actually begins in its morphological “design”. Therefore, to assess the severity of the development of hepatopathies in the early stages of the disease is possible only with the help of a biochemical study of blood serum, which, being the most mobile medium of the body, is able to reflect pathological changes in the homeostasis of the poultry organism.

The level of metabolic processes in poultry was determined by a number of biochemical blood

parameters characterizing the functional activity of the hepatocytes of liver, in order to identify the dynamics of the physiological systems of poultry under conditions of industrial rearing. For this purpose, in the process of broilers growing, blood was sampled three times – on the 7th, 20th and 35th days of the study (Table 1).

As the research results show, the level of total protein during all periods of studies had a steady increase, and in the final period of feeding – 35 days, its concentration from the growth period increased by 19.6 %, which can be explained by the use of high protein feed and active proteosynthesis in liver. At the same time, the concentration of urea by 35 day decreased relative to the previous indicators (4.3±0.05 mmol/l) by 11.6 %, remaining at the level of weekly values.

Table 1. Dynamics of biochemical indicators of blood serum of broiler chickens (M ± m; n = 20)

Indicators	Days of study		
	7	20	35
Total protein, g / l	32.4±1.8	35.8±0.69	42.8±1.23
Urea, mmol / l	3.7±0.3	4.3±0.05	3.8±0.7
Glucose, mmol / l	12.3±0.69	11.8±0.5	8.9±0.36
Cholesterol, mmol / l	3.8±0.05	3.7±0.14	3.1±0.08
Triglycerides, mmol / l	1.16±0.07	0.78±0.03	0.68±0.02
Total bilirubin, μmol / l	5.13±0.24	4.39±0.06	4.25±0.04
Aspartate aminotransferase, unit / l	195.8±12.6	261.6±11.2	329.5±8.4
Alanine aminotransferase, unit / l	11.6±0.74	18.2±0.8	21.4±1.16

This happened despite the fact that in the final period of poultry feeding, broilers had intensify metabolic processes, leading to a physiological increase in a number of biochemical parameters of blood serum. In this case, we observed the opposite picture. The presence of mycotoxins in the feed diet had a depressing effect on the synthesis of urea in the liver of chickens and led to the possible accumulation of its decomposition products – potassium ions, guanidane derivatives, medium mass molecular peptides, etc.

By the level of glucose, a picture was slightly different from the dynamics of protein metabolism. At the beginning of the study, the experimental poultry had a high level of energy supply, but by the end of the experiment, the concentration of sugar in the blood of broiler chickens significantly decreased (by 38.2 %). A similar effect may indicate a more intensive use of liver energy reserves as broiler body weight increases during the final feeding period.

The cholesterol level in the experimental poultry decreased with age. Moreover, on the 20th day of the study, its concentration decreased slightly, at the level of the trend, while by the 35th day the cholesterol values decreased by 22.6 %. A similar pattern was observed for triglycerides and bilirubin. The dynamics of the decrease in these indicators shows that in the process of physiological growth, poultry has an increase in the toxic load on liver, leading to a weakening of the functional activity of hepatocytes.

Certain changes in the biochemical blood homeostasis of the experimental poultry by the level of enzyme activity were also determined. With a comparative content of liver transaminases in poultry on

the 20th day of the experiment, a significant increase by 33.6 % in the level of aspartate aminotransferase was noted. Since broilers showed intense growth during this period, an increase in ASAT occurs due to the growth of muscle tissue, and is not a marker of toxicosis. However, by the 35th day of the study, the process of increasing ASAT in the blood serum continued (by 25.9 %), reaching the level of the upper normal limits.

The concentration of ALAT by the end of the experimental period increased by 1.84 times compared with the initial values. Since alanine aminotransferase belongs to cytoplasmic enzymes, its increase within such limits may indicate damage of the walls of hepatocytes with subsequent release into the blood.

Thus, a high level of metabolic processes in broilers leads to naturally intense liver function and increased susceptibility to stress factors.

4 Conclusion

The results of our research indicate that in an industrial enterprise specializing in the rearing of meat poultry, poultry mortality in different age periods ranged from 3 to 5 % of the total population. In the structure of the causes of broiler chickens mortality from the 8th to the 15th day, an increase in mortality from hepatopathies was determined, and by the 25th day of life hepatitis was recorded in the bulk of the dead poultry. The biochemical monitoring of blood serum in poultry with signs of liver pathology revealed an increase in the level of ALAT, β-globulins, and the “inflammation syndrome” of the hepatic parenchyma was confirmed by a positive

thymol test. Long-term consumption by broilers of feed contaminated with mycotoxins led to the deterioration in the health of the poultry, an imbalance in the liver and the development of general metabolic disorders of the poultry organism.

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