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Comparative ultrastructure of skeletal muscles of broiler chickens and quails

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***Abstract*—The article presents the results of comparative ultramicroscopic studies of skeletal muscles of broiler chickens and quails (39-40 days old). Uneven maturation of striated muscles of the pectoral muscle fibers of broiler chickens was revealed during ultramicroscopic studies. Destruction of cristae and enlightenment of mitochondrial matrix were noted, while in the muscular tissue of the pectoral and femur of quails even distribution of mitochondria with apoptosis of some of them was noted. Unlike striated muscles of broiler chickens the even maturation of the striated muscles was visualized in the pectoral and femoral muscles of quails.**

Keywords—chickens, broilers, quails, skeletal muscles, ultrastructure, ultramicroscopy

I. Introduction

One of the most important problems nowadays is the production and supply of environmentally safe food of high quality. The poultry industry takes one of the leading places in this issue. This is the most dynamically developing branch of agriculture [3].

Experience of Russia and other countries confirms that industrial poultry farming in short terms can increase the production of much-needed food products, in order to ensure the optimal protein balance of diet of population. The reasons of the profitability of poultry production compared to other industries are quick growth of birds, little consumption of chicken food, energy, human labor; all this makes this priority area of agricultural production worth developing. Works by G. Bobyleva [2], B. Bessarabov [1], R. Gadiev [4] are devoted to modern researches of the industry of poultry farming in market conditions. In recent years scientific works related to the intensification of industrial poultry farming and improvement of its efficiency [8] are considered to be especially important.

In recent years the poultry industry is in the process of transformation, as one of the bases that can ensure the food security of the country. The State program of agricultural development for 2008-2012, the Doctrine of food security of the Russian Federation and the Concept of industry development until 2020 were adopted.

The successful solution of the problem of increasing the meat productivity of broiler chickens mostly depends on knowledge of the features of skeletal muscles development in the age and breed aspects. Swatland H., 2006, exploring the growth and development of muscles, was confident in the discovery of cellular mechanisms, which in the future can be manipulated with the aim of creating sustainable production of high quality poultry meat [11].

Poultry provides the population with high-value dietary food (eggs, meat, offal), and industrial raw materials for processing (feather, down, dung, etc.) [9].

The quality and veterinary and sanitary condition of poultry products entering the consumer market is considered to be one of the most important factors that determine the health of the population. In most countries of the world the safety of food programs is considered a priority area of national public policy and scientific researches [7].

One of the main reasons for the deterioration of public health is malnutrition, consumption of substandard, adulterated and hazardous products [7].

Organoleptic indicators of poultry meat are determined during veterinary and sanitary examination, including look and color of carcass surface, subcutaneous and internal adipose tissue, serous membrane of thoracic cavity, determining the condition of muscles in the section, their consistency, smell, as well as transparency and aroma of broth during cooking, in doubtful cases, physical and chemical studies are carried out, including a qualitative reaction to the activity of the enzyme peroxidase. In addition to organoleptic and physico-chemical studies in recent decades there is a fairly intensive study of meat and meat products using various methods of analysis, including histological ones. For morphological study pieces of muscle tissue of birds are fixed in a 10% solution of neutral formalin. To study the microstructure researches prepare total paraffin sections with a thickness of 5-6 microns by conventional methods on a sliding microtome, followed by differential staining with hematoxylin (according to the formula of Mayer) and eosin. Hematoxilin and eosin staining is used for the general assessment of development, condition and interaction of the studied tissues, as well as the structural and functional condition of connective tissue structures.

During our veterinary and sanitary examination of broiler and quail meat (39-40 days old), the meat in all respects corresponded to the normative documents. Nevertheless, during the detailed examination of the

morphological structure of skeletal muscle tissue of the studied birds we found out a number of changes that go beyond physiological ones [5, 6], so we set a goal – to consider at the ultramicroscopic level the changes occurring in the skeletal muscles of broiler chickens and quails.

II. Materials and methods

The studies were carried out at the Department of Morphology, Examination and Surgery of the Ural State Agrarian University and in the laboratory of electron microscopy of the Clinical Diagnostic center (2018-2019). The object of the study was the muscle tissue of the pectoral and femoral muscles of broiler chickens (n=10) and quails (n=10) of 39-40 days old.

The material for ultramicroscopic studies was selected with a razor blade in the form of 0.1 cm thick plates and placed in a pre-purified 2.5% solution of glutaraldehyde. In this solution the plates were cut into pieces of 0.1 mm^3 and fixed in a fresh portion of this solution for 4-6 hours. Then the pieces were washed in a phosphate buffer and treated with an osmium fixative for 1.5-2 hours at a temperature +4 °C. Araldite and Epon of identical firms were used for filling. Sections were obtained with LKB Ultratome III, contrasted with 2% alcoholic solution of uranyl acetate for 15 minutes and lead citrate according to Reynolds [6]. Zoom from 1800 to 44000 was used to visualize the processes using the electron microscope Morgagni 280D (Japan).

III. Results

Broiler chickens of 38 days old at the end of the technological cycle have in their thigh muscle striated myofibrils, that are located more loosely (Fig. 1), in the pectoral muscle they are located close to each other (Fig. 2). The striation of myofibrils is more distinct in the femoral muscle. Between myofibrils in the thigh muscle the single ribosomes are visible, or they form small clusters. In the pectoral muscle an abundance of ribosomes is revealed, forming large clusters between myofibrils (Fig. 2). Mitochondria are small in both muscle types. The destruction of cristae and the enlightenment of the mitochondrial matirix are observed. Visually there is a slightly larger number of mitochondria in the pectoral muscle.

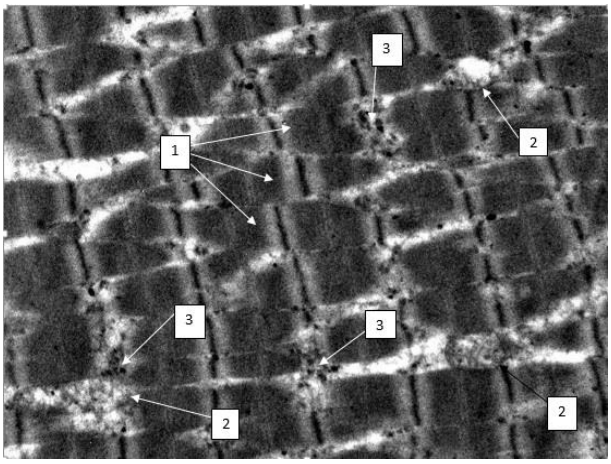

Fig. 1. A fragment of the femoral muscle of a broiler chicken. Striated myofibrils (1), mitochondria (2), ribosomes (3). Zoom x7100

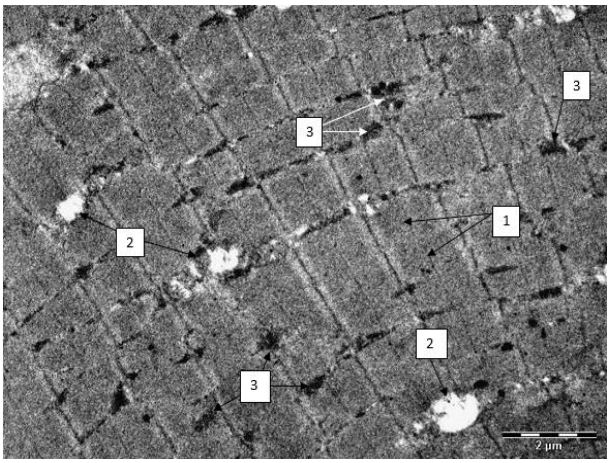

Fig. 2. A fragment of the pectoral muscle of a chicken broiler. Striated myofibrils (1), mitochondria (2), ribosomes (3). Zoom x7100

In the striated myofibrils of the thigh muscle of broiler chickens, the sarcomere visually looks larger. There is a high electronic density of the disk-A, T-strip. Disk-E also looks larger. The boundaries between the disks are clearer. In the structure of the strip-M 3 zones are clearly visible: dark zone between two light zones (Fig. 3).

In the striated myofibrils of the pectoral muscle of broiler chickens there are disc-A and T-strip of low electron density. The size of disk-E is smaller, the boundaries between discs are blurry. The zones in the M-strip are not clearly visible (Fig. 4).

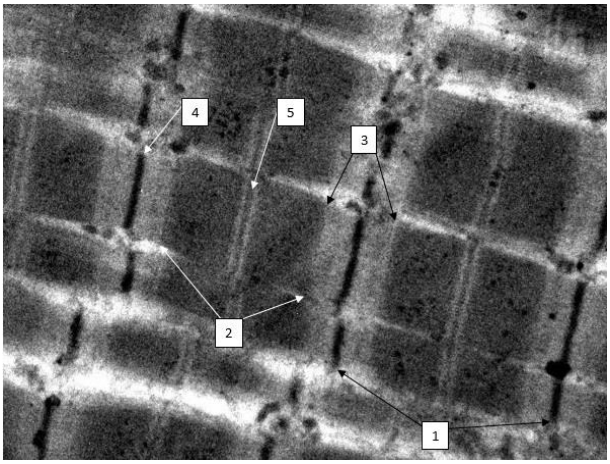

Fig. 3. A fragment of the femoral muscle of a broiler chicken. Striated myofibrils. Sarcomere (1), A-disk (2), E-disk (3), T-strip (4), M-strip (5). Zoom x18000

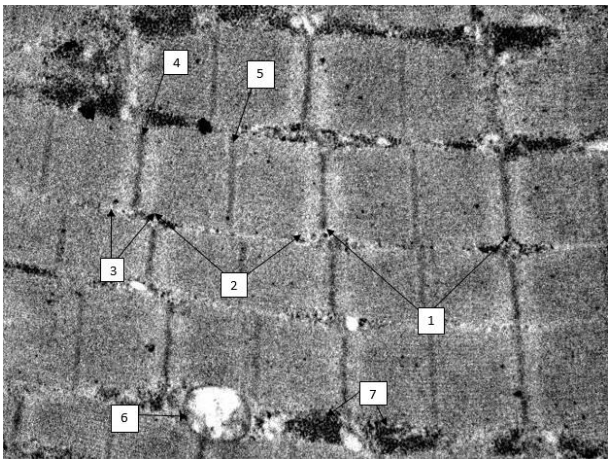

Fig. 4. A fragment of the pectoral muscle of a chicken broiler. Striated myofibrils. Sarcomere (1), A-disk (2), E-disk (3), T-strip (4), M-strip (5), mitochondria (6), ribosomes (7). Zoom x18000

In the sample of quail thigh muscle striated myofibrils are visible, in which the sarcomeres, discs A, E, strips T, M (according to Gilev) are clearly visualized. The layers of connective tissue are rather loosened. A large number of mitochondria are seen between myofibrils. There is an uneven distribution of mitochondria. In some areas single mitochondria are visible. In some areas clusters of mitochondria are found. Single mitochondria have a typical structure. Most mitochondria are swollen, with destroyed cristae, an enlightened matrix, blurry contours. The inclusion of lipids are identified in moderate amounts, they are small, located between myofibrils, in the layers of the connective tissue in close proximity to mitochondria (Fig. 5, Fig. 6).

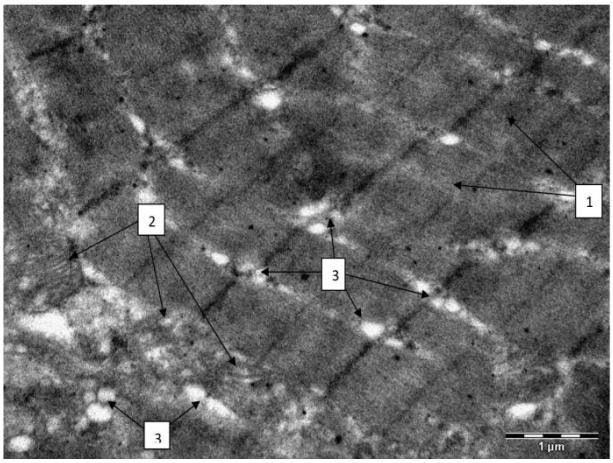

Fig. 5. A fragment of quail femoral muscle. Striated myofibrils (1), mitochondria (2), lipid inclusions (3). Zoom x14000

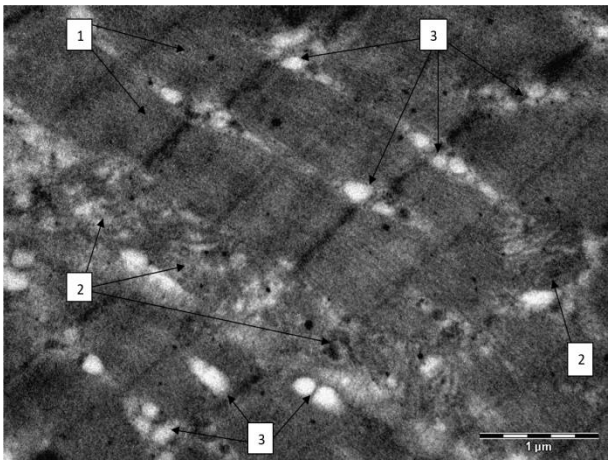

Fig. 6. A fragment of quail femoral muscle. Striated myofibrils (1), mitochondria (2), lipid inclusions (3). x 18000

In the sample of quail pectoral muscle striated myofibrils are visible, in which the sarcomeres, discs A, E, strips T, M (according to Gilev) are clearly visualized. The layers of connective tissue are rather loosened. A moderate number of mitochondria are seen between myofibrils. Mitochondria are mostly swollen, with partially destroyed cristae, enlightened matrix, blurry contours. The distribution of mitochondria is even, the clusters are small. The inclusion of lipids are in moderate amounts, they are small, located between myofibrils, in the layers of the connective tissue in close proximity to mitochondria (Fig. 7, Fig. 8).

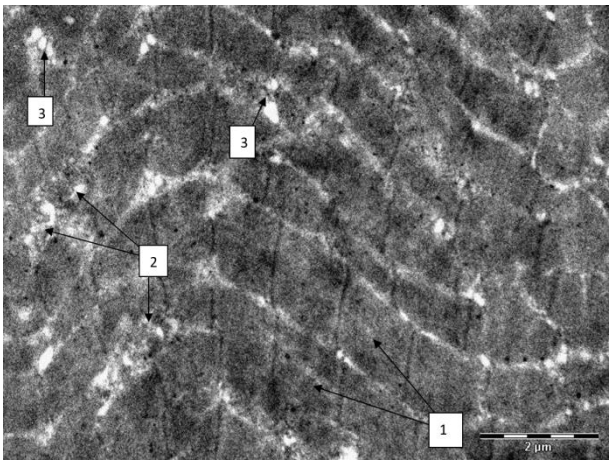

Fig. 7. A fragment of the pectoral muscle of a quail. Striated myofibrils (1), mitochondria (2), lipid inclusions (3). Zoom x8900

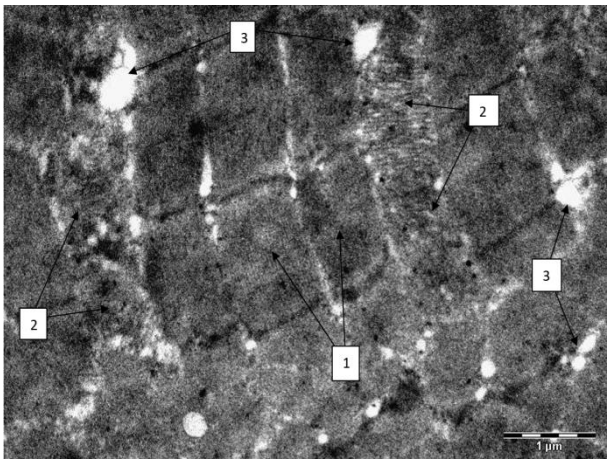

Fig. 8. A fragment of the pectoral muscle of a quail. Striated myofibrils (1), mitochondria (2), lipid inclusions (3). Zoom x14000

A comparative ultramicroscopic study of skeletal muscles of 38-days-old broiler chickens at the end of the technological cycle and 40-days-old quails revealed uneven maturation of striated muscles of the pectoral muscle fibers of broiler chickens. Destruction of cristae and enlightenment of mitochondrial matrix were noted, while in the muscular tissue of the pectoral and femur muscles of quails even distribution of mitochondria with apoptosis of some of them was noted. Unlike striated muscles of broiler chickens the even maturation of the striated muscles was visualized in the pectoral and femoral muscles of quails.

IV. Conclusion

Organoleptic, physical and biochemical, structural, technological and microbiological indicators play the main role in assessing the quality of raw meat and meat products. These indicators should be considered as an integrated system and only in some cases the quality of the products is assessed by a single indicator, which in this case is the main one.

These methods of research (chemical, biochemical and others) allow to obtain only part of the necessary information about the quality and composition of meat products. Another not less valuable part of the information about them is provided with the method of microstructural analysis. Microstructural studies allow to judge both about the structure of the product as a whole, and about the changes occurring in certain areas of the studied objects.

Thus, microstructural studies in combination with data from other methods of analysis allow to assess objectively the quality of poultry meat.

References

[1] B. Bessarabov, E. Bondarev, T. Stolyar “Poultry and technology of eggs and poultry meat production”, Saint-Petersburg: Lan, 352 p., 2005.

[2] G. Bobyleva “Strategy for sustainable development of poultry farming”, APK: Economica, management, No. 8, P. 8-11, 2007.

[3] V. Buyarov, A. Buyarov, I. Kleymenov, O. Shalimova “Status and prospects of poultry meat”, Vestnik OrelGAU, No.1., 2012, URL: https://cyberleninka.ru/article/n/sostoyanie-i-perspektivy-razvitiya-myasnogo-ptitsevodstva (accessed: 01.04.2019).

[4] R. Gadiev “Reserves of industrial poultry in Russia”, Sergiev Posad: Ed. BSAU, 323 p., 2002.

[5] U. Kundryukova, L. Drozdova “Veterinary and sanitary examination of quail meat and its morphological structure”, Scientific and industrial magazine NAUKA : materials of the VIII International scientific-practical conference: "Industrialization is the basis of the new economic growth of the state", special issue, "Biological Sciences and Sciences on technology of production and processing of agricultural products", Kostanai, P. 79-83, 2016.

[6] U. Kundryukova, L. Drozdova “Veterinary-sanitary and morphological assessment of muscles of femoral and pectoral muscle groups of broiler chickens with the lowest category of fatness”, "Scientific life", Moscow: Publishing house Science Of Education, № 12, P. 217-225, 2018.

[7] E. Malysheva “Morphological characteristics of striated muscle tissue of cattle, horses, marals, rabbits and cats in the normal contition and in the process of autolysis” : thesis ...of PhD in Veterinary Sciences : 06.02.01, Barnaul, 157 p., 2013.

[8] V. Nechaev, S. Fetisov “The economy of the poultry industry: monograph”, Krasnodar, 150 p., 2010.

[9] N. Smirnova “Veterinary and sanitary assessment of poultry meat when using diarinum”: thesis ...of PhD in Veterinary Sciences : 16.00.06, St. Petersburg, 134 p., 2007.

[10] B. Weekly “Electron microscopy for beginners”, Moscow: Mir, 336 p., 1975.

[11] N. Swatland “Physiology of bird growth and development”, Bio., №11, P. 2-7, 2006.