

MICROSCOPIC DIFFERENCES BETWEEN MUSCLE TISSUE IN BIRDS RAISED IN HOUSEHOLD VS. INTENSIVE SYSTEM

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Abstract

Following numerous pieces of research that highlighted the value of histological techniques applied in assessing the quality and safety of meat food products, a histological examination has become mandatory in many countries. This paper describes in detail the quality characteristics of poultry meat from two different rearing systems. Fragments were taken from the breast of chickens raised in a household system and an intensive industrial system. The fragments taken were processed using the usual histological techniques and stained by the H & E (Hematoxylin & eosin) and Mallory staining methods. After analyzing the permanent histological preparations, numerous differences were observed between the two growth systems. In the household system, the muscle fibers are more developed, which shows that they do a lot of movement, at the same time, the white adipose tissue is less represented. In the industrial system, the muscle fibers show a smaller number of striations, which indicates that they do no movement, a large amount of white adipose tissue being observed. Through the histological evaluation of the chicken muscle tissue from the two different growth systems, a series of differences resulted.

Key words: intensive system, household system, chicken meat.

INTRODUCTION

Chicken meat is a healthy source of animal protein. It has lower rearing costs and higher efficiency than other meat species (Dalle Zotte et al., 2020). Chicken comes mainly from fast-growing (FG) broilers (e.g., Ross 308 broilers) and slow-growing (SG) broilers (e.g., Rouge label).

Slow-growing broilers complete their life cycle at a more mature age (usually at least 81 days) than conventional fast-growing lines (between 35 and 42 days) (Chabault et al., 2012). Muscle fibers are directly related to poultry growth rate and meat quality traits (Joo et al., 2013).

The number of muscle fibers formed before birth and the size of these fibers after birth determine final muscle mass, while muscle fiber characteristics affect both appearance and feed quality traits in poultry (Ismail and Joo, 2017). Fiber characteristics include fiber type composition and fiber morphological features.

For birds, skeletal muscles comprise mainly glycolytic fibers (type II, fast twitch) and oxidative fibers (type I, slow twitch). However, compared to animals, the skeletal muscles of

poultry contain a relatively small number of oxidative fibers. Several studies have reported that the chicken breast in broilers consists entirely of 100% glycolytic fibers, regardless of breed (Roy et al., 2006; Verdiglione and Cassandro, 2013).

MATERIALS AND METHODS

Fragments of chicken breast raised in a household system but also raised in an intensive system were taken.

From a histological point of view, the collection of samples was carried out to preserve and fix them with formalin solution, at 10% concentration.

The duration of fixation was 24 hours, varying depending on the size of the extracted tissue. Afterward, the fixed piece was washed with distilled water to remove the fixing solution.

We integrated the sections into the coverslips by applying a thin layer of Mayer's ovalbumin, then they were placed in the thermostat for a very short time to achieve adequate adhesion.

To create a contrast between tissue and cellular elements, we stained the sections using the H&E

(hematoxylin-eosin) and Mallory staining methods.

The staining process was preceded by deparaffinization (by taking the slides in 3 successive baths of benzene for 2-5 minutes) and hydration (in 3 baths of ethyl alcohol in decreasing concentration from 90°, 80° and 70° for 5 -6 minutes).

Over 30 permanent histological slides were obtained which were studied with the help of the Motic Panthera microscope which has a video camera.

The examination of the microscopic slides was carried out in the laboratory of the discipline of Histology and Embryology within the Faculty of Veterinary Medicine of Bucharest.

RESULTS AND DISCUSSIONS

The present article does show the differences that can appear at the level of muscle fibers originating from the growth passage in two different growth systems.

In the case of chickens raised in the extensive system, the muscle fibres have a compact structure compared to the muscle fibres from chickens raised in the intensive system.

For chickens raised in the extensive system, reduced content of adipose tissue could be remarked, and skeletal striated muscle fibers show numerous striations at the level of the sarcolemma, the endomysium, which normally contains an abundant connective tissue that forms the sheath that envelops each muscle fiber is inadequately developed, which does not indicate that the birds raised in the extensive system have enough space for movement, which can lead to developed musculature and reduced adipose tissue.

Chicken breast - extensive system

Skeletal striated muscle fiber has a cylindrical shape, unbranched, with slightly rounded ends. It has a particularly long length that can reach up to 35-40 centimeters (Figure 1).

The endomysium is represented by the connective tissue that forms a thin sheath that envelops each muscle fiber.

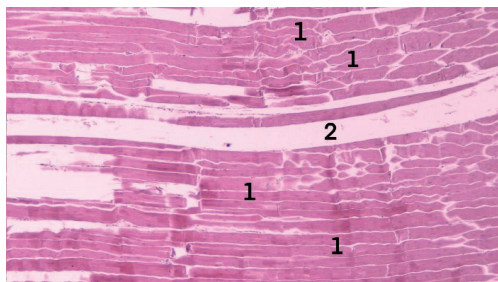


Figure 1. Chicken breast grew in an extensive system, H & E stain, obj. 10X: 1. Skeletal striated muscle fibers in the longitudinal section; 2. Endomysium - loose connective tissue

It includes a network of reticulin fibers, collagen fibers, and fibroblasts. The endomysium is inadequately developed in chicken breasts raised in the extensive system (Figure 2).

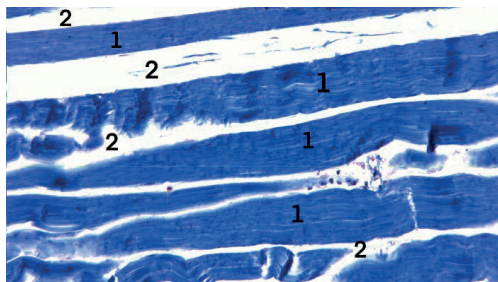


Figure 2. Chicken breast grew in the extensive system, Mallory stain, Obj. 10X: 1. Skeletal striated muscle fibers in the longitudinal section; 2. Endomysium

The endomysium is inadequately developed (Figure 3), and the sheaths formed by it are hardly visible.

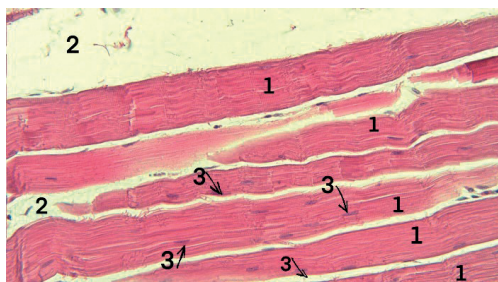


Figure 3. Chicken breast grew in an extensive system, H & E stain, obj. 40X: 1. Skeletal striated muscle fibers in the longitudinal section; 2. Endomysium; 3. Fiber nuclei muscles located on the periphery

The muscle fibers are well developed (Figure 4), the striations are accentuated and can be seen along the entire length of the fiber.

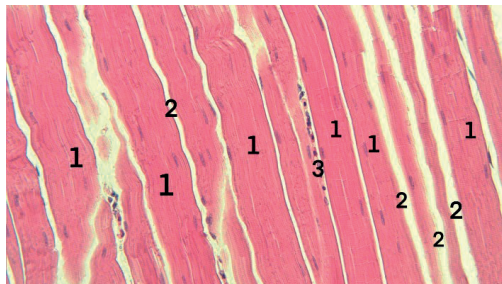


Figure 4. Chicken breast grew in an extensive system, H & E stain, obj. 40X: 1. Skeletal striated muscle fibers in the longitudinal section; 2. Nuclei of muscle fibers located at the periphery; 3. Capillary from the endomysium

The thickness of the fiber and the striations are well developed, and the nuclei are evident (Figure 5).



Figure 5. Chicken breast grew in an extensive system, H & E stain, obj. 100X: 1. Skeletal striated muscle fibers in the longitudinal section - the transverse and longitudinal striations at the level of the sarcoplasm; 2. The nuclei of the muscle fibers are located at the periphery; 3. Capillary from the endomysium

The thickness of skeletal striated muscle fibers is uniform at birth, but it increases with age, differentiated according to the degree and type of stress on different muscle groups. Skeletal striated muscle fibers are well developed in chickens raised in the extensive system, being very thick and the striations very obvious (Figure 6).

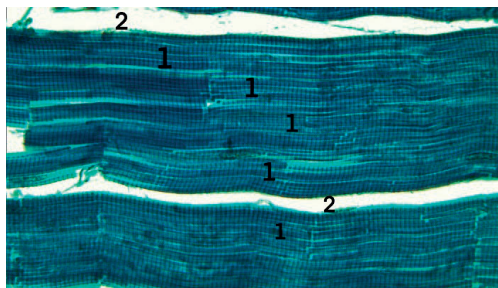


Figure 6. Chicken breast grew in an extensive system, Mallory stain, Obj. 100X: 1. Skeletal striated muscle fibers in the longitudinal section - the transverse and longitudinal striations can be observed at the level of the sarcoplasm; 2. Endomysium

For the chicken raised in the intensive system, a significantly reduced number of striations were observed at the level of the sarcoplasm, nuclei are not very evident, the endomysium forms a thick sheath that covers the muscle fiber, adipose tissue is found in large quantities and is predominant along the entire length of the fiber. This shows us the fact that birds do not have much space to move, they are raised in battery cage system. Another result that could be observed microscopically was the epimysium, which is the tissue that envelops the muscle, is highly developed and predominant (Figure 4).

Chicken breast - intensive system

The epimysium or external perimysium is a connective tissue that wraps the muscle, as an anatomical organ, anchoring it to the fascia.

In chickens raised in the intensive system, the epimysium is highly developed, it infiltrates between the muscle fibers and predominates along the entire length of the muscle fiber (Figure 7).

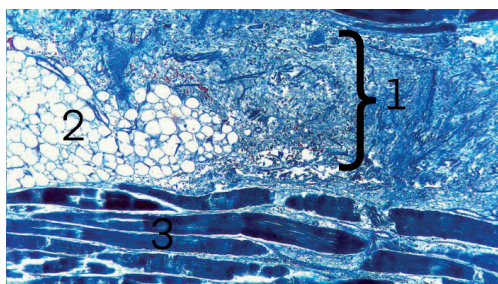


Figure 7. Chicken breast grew in an intensive system, Mallory stain, Obj. 10X: 1. Epimysium; 2. White adipose connective tissue; 3. Skeletal sciatic muscle fibers in the oblique section

The adipose cell has a spherical or ovoid shape, rarely appearing polyhedral (Figure 8). The semilunar nucleus is eccentrically. The cytoplasm is quantitatively reduced, being mostly replaced by a single drop of fat.

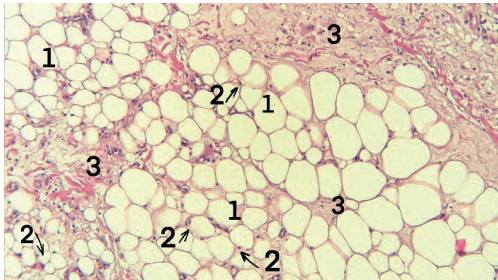


Figure 8. Chicken breast grew in an intensive system, H & E stain, obj. 10X: 1. White adipose connective tissue - adipocytes; 2. Adipocyte nuclei located at the periphery; 3. Connective matrix

Tunica media at the level of the muscular artery consists mainly of leukocytes, arranged between 2 and 20 concentric circular layers. Elastic and collagen fibers are found among the muscle cells (Figure 9). The two elastic limits (internal and external) appear obvious, strongly wavy, rich in glycosaminoglycans (Figure 9).

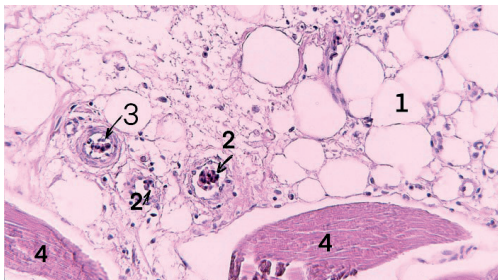


Figure 9. Chicken breast raised in an intensive system, H & E stain, obj. 40X: 1. White adipose connective tissue – adipocytes; 2. Blood vessel - vein; 3. Blood vessel - artery; 4. Striated muscle fibers - in the oblique section

Adipocytes have an eccentrically located nucleus, the cytoplasm is discoloured due to the lipids that have been washed due to organic solvents. The adipose tissue is very well developed, and the muscle tissue is barely visible (Figure 10)

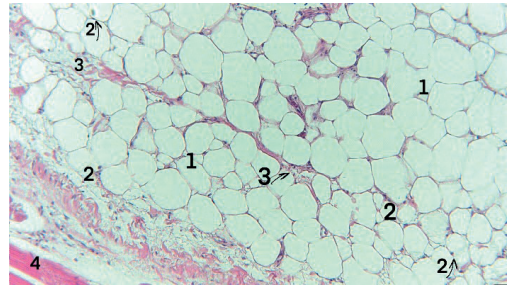


Figure 10. Chicken breast raised in an intensive system, H & E stain, obj. 40X: 1. White adipose connective tissue - adipocytes; 2. Adipocyte nuclei located at the periphery; 3. Connective matrix; 4. Striated muscle fibers - in the longitudinal section

The endomysium is well developed, envelops each muscle fiber, and presents a large thickness of the sheath that surrounds the muscle fiber (Figure 11).

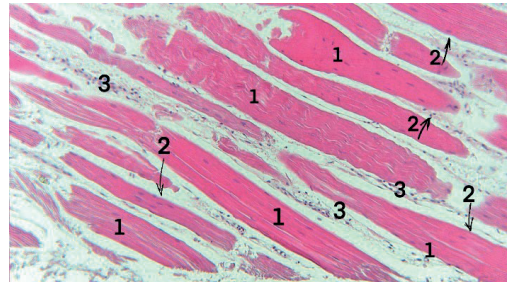


Figure 11. Chicken breast grew in an intensive system, H&E stain, obj. 40X: 1. Skeletal striated muscle fibers in the longitudinal section; 2. Nuclei of muscle fibers located at the periphery; 3. Capillary from the endomysium

The endomysium is visible, surrounding each fiber if capillaries and connective fibers are present (Figure 12).

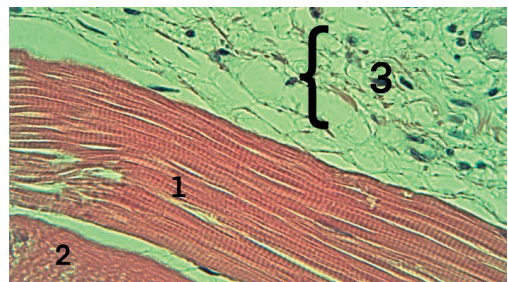


Figure 12. Chicken breast grew in an intensive system, H & E stain, obj. 100X: 1. Skeletal striated muscle fibers in the longitudinal section; 2 Skeletal striated muscle fibers in the oblique section; 3. Endomysium

CONCLUSIONS

Examining the 30 slides with the 4x, 10x, 40x and 100x objectives with the usual stains and H & E and Mallory, we were able to observe clear differences at the level of the chicken breasts from the two rearing systems, respectively the extensive system and the intensive chicken rearing system.

In conclusion, we can highlight that birds which have been raised in the extensive system, present many striations at the level of skeletal striated muscle fibers, the muscle fiber is better developed, the endomysium is hardly visible, and the adipose tissue is almost absent.

This was since the birds raised in the extensive system had enough space for movement, which led to a better development of the muscles.

For chicken raised in an intensive system, the muscle fiber is inadequately developed, with a reduced number of striations, the endomysium is rich in connective tissue, the sheath formed for each muscle fiber is thick, adipose tissue is abundant, the epimysium predominates in muscle fibers and all this indicates that the birds do not have enough space to move, which is due to the fact that the birds are raised in battery cages system.

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