


## Histological studies of the muscle tissue of the bactrian camel meat in the process of autolysis

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### Abstract

The purpose of the study is to conduct targeted histological examination on the processing of camel meat to create technologies for new meat products. The objects of the examination were samples of the quadriceps femoris from three male Bactrian camels at the age of 5 years, obtained during slaughter at a meat processing enterprise in the Almaty region of the Republic of Kazakhstan. Selected muscle tissue samples were fixed in 10% solution of neutral formalin. Conducted microstructural studies allowed to establish the patterns of morphological changes in the muscle tissue of camel after slaughter. It was established: the absence of transverse striation, slit-like violations of the integrity of muscle fibres, as well as nuclear lysis. It was concluded that in order to develop the technology of quality meat products from camel meat, scientifically-based methods and modes of processing, the use of intensive methods of mechanical processing and effective methods of salting are necessary.

**Keywords:** camel meat; histological changes; aging; nutrition.

**Practical Application:** Improving the structural and mechanical parameters of camel meat and to develop a technology of high-quality meat products.

### 1 Introduction

According to dietitians, nutrition is one of the main factors determining the state of human health. Food can become a powerful treatment, carrying a charge of vigour, maintaining the constancy of the internal milieu of individuals. To date, the efficiency of food treatment is considered to be on par with medicine. Food products satisfy, on the one hand, physiological needs, and on the other hand, perform preventive functions. It is possible to satisfy these requirements when creating combined products using animal and vegetable raw materials enriched with certain vitamins and biologically active additives, the undoubted healthiness of which lies in the fact that they can balance and improve the diet through the introduction of proteins, amino acids, vitamins, micro and macro elements, food fibres and other beneficial substances.

The main sources of nutrients necessary to maintain the normal functioning of the human body are meat and their processed products. The development of new types of products, the main components of which are animal raw materials and processed products, provides for the maximum possible involvement of local regional raw materials – camel meat (Uzakov & Chernukha, 2014; Raiymbek et al., 2018; Kenenbai & Adilbek, 2015). Kazakhstan has created a legislative framework for the intensive development and increase in the number of highly productive gene pool of purebred Kazakh Bactrian camels. From these positions, camel meat is one of the promising resources of non-traditional high-quality domestic

raw materials for meat processing industries. However, currently the industrial processing of camel meat and production of meat products is not performed in the republic (Uzakov & Chernukha, 2014; Kenenbai & Adilbek, 2015).

One of the methods for determining the quality of meat and meat products is histological examination. Histological examination of meat is performed to determine the degree of aging and freshness by detecting changes in the microstructure of muscle tissue. A number of authors conducted histological examinations to study the process of autolysis during the aging of meat of sheep, red deer, horses and cattle. Thus, microstructural studies of the morphology of different muscles of sheep were performed at the Almaty Technological University. The meat was examined using a scanning electron microscope. The microstructure of a longitudinal section of the longest muscle of the back of a sheep is presented. It was noted that the microstructural examination of the morphology of different muscles of sheep demonstrated the fine structure of the muscle tissue of the musculus longissimus and musculus semitendinosus of sheep (Uzakov & Ospanova, 2013; Uzakov, 2009).

Articles (Uzakov & Kaimbaeva, 2016) study the indicators characterizing the process of autolysis (pH, water-binding power, activity of tissue enzymes, microstructural changes) to select the optimal exposure time for red deer meat before using it in the production of meat products. Samples of muscle tissue were

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isolated from the quadriceps femoris of female red deer at the age of 2.5-4 years immediately after dressing.

Studies established that the nature of the change in protein substances in the process of autolysis is determined by the pH of the meat and the intensity of glycolysis. Studies of the water-binding power and structural-mechanical properties of red deer meat in the process of autolysis are consistent with the results of histological examination. Proceeding from the data obtained, it was noted that postmortem changes are characterized by multiple destruction and disengagement of muscle fibres, lysis of nuclei and their structures. All this subsequently leads to irreversible destructive changes in muscle tissue. Thus, the mechanisms of autolytic processes affect both the morphological composition of muscle tissue and the shelf life of red deer meat.

With regard to camel meat, it was found that it has a high content of connective tissue, a coarse-fibered structure, which determines the toughness of meat – the main obstacle to its widespread use (Uzakov & Chernukha, 2014; Raiymbek et al., 2018; Kenenbai & Adilbek, 2015). One of the indicators of meat quality is its histological (microstructural) analysis. The increased toughness of the camel meat conditions the necessity of targeted histological examination regarding its processing in order to create technologies for new meat products. Scientists conducted experimental research on the study of nutritional and biological value and processing of camel meat (Kaimbayeva et al., 2018; Taeva et al., 2016, 2017, 2019; Uzakov et al., 2016a, b; Taeva, 2016). Thus, the purpose of the article is to study the indicators characterizing the process of autolysis (microstructural changes) to select the optimal exposure time for camel meat before using it in the fabrication of meat products.

## 2 Materials and methods

Slaughter of animals was performed by bleeding after stunning with electric current (50 Hz) in accordance with the “Rules for the work using experimental animals No. 755 dated 12.08.1977” (Soviet Union, 1977). During anatomical and topographic examination, thorough layered preparation, photographing, weighing, and morphometry were performed. To measure the length, width and thickness of muscle tissue, we used: a flexible ruler, a sliding calliper, a micrometre with a graduation value of 0.01 mm, model 1003, accuracy class 2, used to measure linear measurements of the muscle head.

The objects of the study were samples of the quadriceps femoris from three male Bactrian camels at the age of 5 years, obtained during slaughter at a meat processing enterprise in the Almaty region of the Republic of Kazakhstan. For the experiment, samples were taken 30 minutes, 24 hours, 48 hours, 72 hours, 96 hours, 120 hours after slaughter and stored at a temperature of 2-4 °C.

Histological examination was performed in accordance with GOST R 19496-93 “Meat. The method of histological examination” (Euro-Asian Council for Standardization, Metrology and Certification, 1993). A meat sample 30×30×30 mm in size is taken for analysis, cutting it in the direction perpendicular to the surface of the carcass from the areas least durable upon storage: the neck, at the site of the carcass cut in the chest or floor of pelvis, or at the discretion of the veterinarian from other areas.

To prepare a histological specimen, a piece of meat 30×15×4 mm in size is cut out from the sample and fixed in a flask with 4-5 volumes of a 10% aqueous solution of neutral formaldehyde (the flask with meat and solution is heated on a burner flame without boiling). A fixed piece is washed for 2 min with cold water, and then cut on a freezing microtome in a plane parallel to muscle fibres. The thickness of the slice should be 15-30 microns. The obtained sections are laid out on an object glass treated with egg white with glycerine (2:1), and pressed to the glass with 3-4 layers of dry filter paper.

At least three sections are prepared from each sample. Sections adhering to the glass for 3-4 minutes are stained with Ehrlich's alum haematoxylin and washed in water for 2 minutes. Excess haematoxylin is removed by placing sections on the glass sequentially in a 1% solution of hydrochloric acid (until pink) and ammonia water (until blue), and then washed for 2 minutes with water. Then they are stained for 1 min with a 1% aqueous solution of eosin and rinsed in water. The stained sections are dehydrated by submerging twice in ethanol for 1 min, clarified in carooloxylene and washed for 1 min in xylene. Sections prepared in this way are enclosed in fir or Canadian balm under a cover glass. The preparations are examined under a microscope at first with a small magnification of the lens ×10, then at an average – ×40 and, if necessary, under immersion – ×90. Light microscopy was performed with a microscope with magnification ×40 x lens x7 (Euro-Asian Council for Standardization, Metrology and Certification, 1993).

## 3 Results and discussion

The purpose of the article is to study the histological changes in the muscular tissue of camel in the process of autolysis. Autolysis begins in the tissues of the animal immediately after its slaughter. The nature of biochemical changes acquires specificity due to the fact that oxygen does not enter the tissue and enzymatic decomposition products are not removed from them. The change in the properties of meat occurs in a certain sequence, and its quality indicators at different stages of post-slaughter storage are different. Therefore, the determination of the use of meat should be performed with consideration of the depth and nature of autolytic transformations. Biochemical processes occurring in meat in the post-slaughter period can be divided into two main groups:

- 1) a change in protein substances, causing a change in the water-binding power and consistency of meat, i.e. its tenderness;
- 2) a change in extractives, causing the formation and accumulation of products that give meat a certain taste and aroma.

Some inorganic extractive and mineral substances have a definite effect on the mechanical properties of meat proteins. At the same time, a change in extractives is associated not only with the breakdown of meat carbohydrates, but also with the appearance and accumulation of breakdown products of proteins (free amino acids). As a result of exposure for a certain time at low positive temperatures, the meat comes to a state of maturity, which is characterized by higher nutritional benefits. The ripened meat has a delicate texture, juiciness, pleasant taste and aroma.

Upon taking camel muscle tissue for histological analysis, it was established that 30 minutes after slaughter, the muscle fibres were fan-shaped, adjacent to each other, forming the so-called contraction nodes. The longitudinal striation is clearly visible. Layers of connective tissue are pronounced between the fibres. The colour of the fibres is red. The nuclei of muscle tissue are located on the periphery (Figure 1).

Analysis of histological studies 24 hours after slaughter indicated that the muscle fibres lie in a straight line, tightly adjacent to each other. Between them, layers of connective tissue are clearly visible (Figure 2). The longitudinal striation is expressed. The colour of the fibres is red. The nuclei are located on the periphery of the oval shape.

Further research 48 hours after slaughter displayed that the muscle fibres retain their inherent location and shape. Between the fibres are layers of connective tissue. The colour of the fibres is red. Muscle tissue nuclei retained their microstructural features (Figure 3).

72 hours after slaughter, the appearance of breaks and cracking of the fibres was registered. Sections of fibres with varying degrees of severity of longitudinal striation are distributed. Interlayers of connective tissue are preserved. The fibres are uneven in colour (Figure 4). Some sections of the border of muscle fibres

became indistinct, while the nuclei are located on the periphery and retain their structure.

96 hours after the slaughter, it was noted that the degree of destructive changes in muscle fibres increases, more pronounced fragmentation appears, which is represented in transverse-fissured integrity violation of muscle fibres. The colour of the fibres is pale pink. Between the fibres is connective tissue. Cell nuclei retain their inherent structure, but their number has notably decreased (Figure 5).

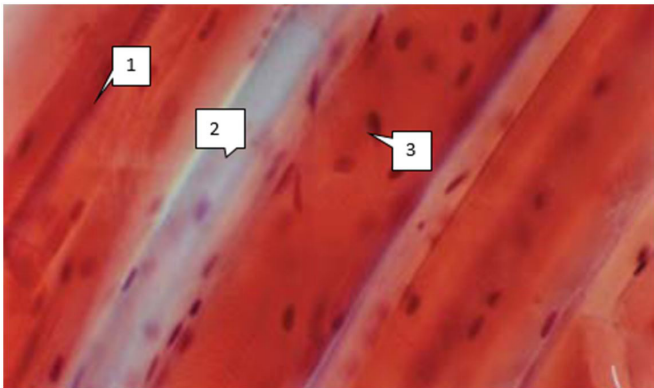
Histological examination 120 hours after slaughter revealed that isolated sections of muscle fibres, pink in colour, have retained their structure. Between the fibres is connective tissue. Cell nuclei in a single amount are in a state of lysis (Figure 6).

Conducted microstructural examinations have established the patterns of morphological changes in the muscle tissue of camels after slaughter.

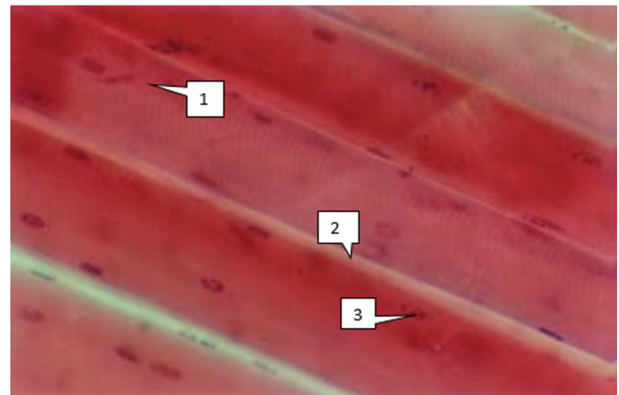
Proceeding from the data obtained, we can conclude that the nature and depth of development of autolytic processes of muscle tissue largely depend on the type of animal. In camel meat, autolysis is slower than in other types of meat of farm animals. So, the initial autolytic changes in the muscle tissue of camels were registered in micropreparations prepared 72 hours after slaughter, which is 24 hours later than in cattle (Malysheva,



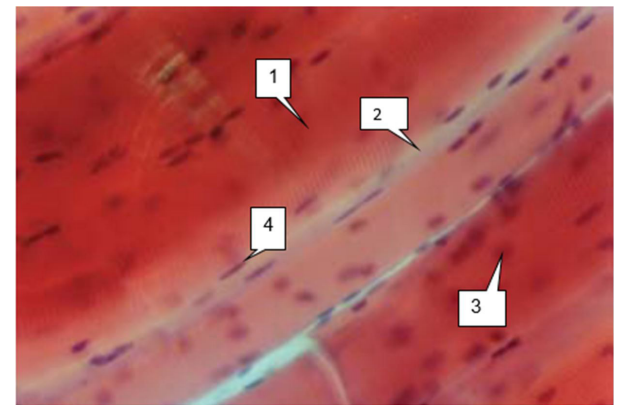
**Figure 1.** Muscle tissue of camel meat 30 minutes after slaughter (magnification x7 x lens x4): (1) muscle fibres; (2) connective tissue; (3) cell nuclei.



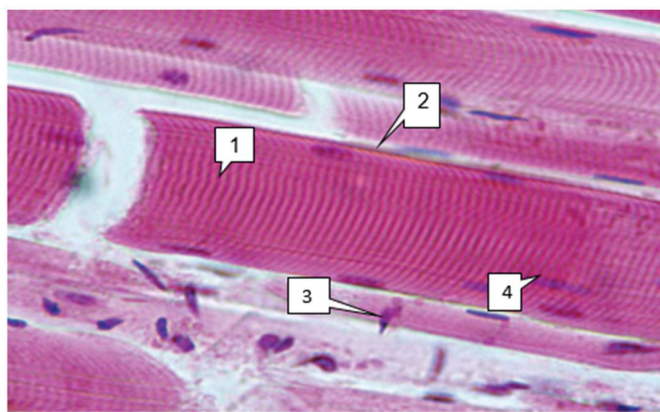
**Figure 2.** Muscle tissue of camel meat 24 hours after slaughter (magnification x7 \* lens x40): (1) muscle fibres; (2) connective tissue; (3) cell nuclei.



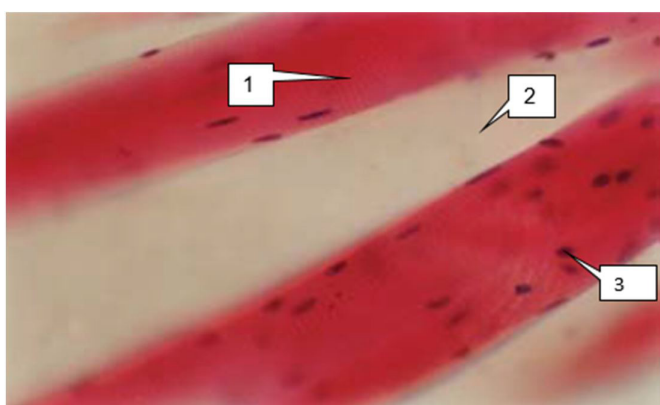
**Figure 3.** Muscle tissue of camel meat 48 hours after slaughter (magnitude x7 \* lens x40): (1) muscle fibres; (2) connective tissue; (3) cell nuclei.



**Figure 4.** Muscle tissue of camel after 72 hours after slaughter (magnification x7 \* lens x40): (1) muscle fibres; (2) connective tissue; (3) cell nuclei; (4) microcracks of muscle fibres.



**Figure 5.** Muscle tissue of camel meat 96 hours after slaughter (magnification x7 \* lens x40): (1) muscle fibres; (2) connective tissue; (3) cell nuclei; (4) microcracks of muscle fibres.



**Figure 6.** Muscle tissue of camel meat 120 hours after slaughter (magnification x7 \* lens x40): (1) muscle fibres; (2) connective tissue; (3) cell nuclei.

2013; Zinina et al., 2013; Khvylya & Pchelkina, 2013). This is due to the fact that the striated muscle tissue of camels is characterized by a high content of connective tissue – this may be due to its slower aging.

Thus, due to the increased toughness of camel meat and to accelerate the process of autolysis, it is necessary to use innovative methods of processing camel meat, such as massaging, hydrolysis with enzyme preparations, effective salting methods.

#### 4 Conclusions

To fully assess the quality of camel meat, comparative research of the histostructure of muscle tissue were performed 24, 48, 72, 96, 120 hours after slaughter, with consideration of not only the morphology of muscle fibres, but of the connective tissue layers surrounding them as well. Autolytic changes in camel meat begin 72 hours after slaughter. The appearance of breaks, cracks in the fibres is noted. Interlayers of connective tissue are preserved. The fibres are uneven in colour. Some sections of the border of muscle fibres are indistinct and have an uneven colour, while the nuclei are located on the periphery and retain their structure.

96 hours after slaughter, the degree of destructive changes in muscle fibres increases, a more pronounced fragmentation appears, which is represented in transverse-fissured violations of the integrity of muscle fibres. The colour of the fibres is pale pink. Between the fibres is connective tissue. Cell nuclei retain their inherent structure, but their number has notably decreased. Histological studies 120 hours after slaughter indicated that isolated sections of muscle fibres, pink in colour, have retained their structure. Between the fibres is connective tissue. Cell nuclei in a single amount under the action of tissue enzymes are in a state of lysis.

Microstructural analysis indicated that the striated muscle tissue of camels is characterized by a high content of connective tissue. The increased content of connective tissue in camel meat affects the structural and mechanical properties of meat. To accelerate the process of autolysis, improve the structural and mechanical parameters of camel meat and to develop a technology of high-quality meat products from this type of raw material, scientifically-based methods and modes of processing, the use of intensive methods of mechanical processing and effective methods of salting are required.

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