MICROMORPHOLOGY OF VARIOUS HORSE MEAT CUTS

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Abstract – This paper presents the results of the complex investigation of the horse meat cuts including morphological and microstructural peculiarities of the cuts and certain muscles of horse meat with the aim of the development of the new technological scheme of horse meat cutting based on the analysis and comparative assessment of the nutritional value and quality of the certain parts of a horse carcass.

Key Words – Cutting, Meat, Microstructure

- INTRODUCTION

Occupying a relatively small place in the structural balance of the country's meat production, horse meat is a high-caloric dietary product and is in a high demand among the population of the certain Russian regions and abroad. The uniqueness of horse meat resides in its high energy intensity, balanced amino acid composition, vitamin content, presence of bioactive substances and high digestibility [1].

Horse meat proteins have a full range of amino acids; with that, the content of tryptophan, histidine, tyrosine, phenylalanine and methionine is higher than in beef. Horse meat compares well with beef in terms of calorie content and the ratio of complete and incomplete proteins.

Meat yield of adult horses with above average degree of finish is 50-57%, with the average degree of finish 45-50%, with below average degree of finish 40-45% [2]. At the same time, microstructure of horse meat, particularly, of the muscles of different cuts is studied insufficiently [3].

- MATERIALS AND METHODS

Nineteen chilled horse meat cuts were studied: hip (top, bottom, inside and side parts, m. biceps femoris, m. semitendinosus, hind shank), back and fore rib and loin (tenderloin, flank, loin), blade (m. triceps brachii, m. infraspinatus, chuck, fore shank, top part of a blade, hinder part of a blade), neck (clod and sticking) and brisket and rib cut (brisket and intercostal parts). Meat was ageing for 72 hours at 4^{o}C. Histological preparations were made using the Microtome Cryostat MICROM HM-525 and stained with haematoxylin and eosin. The computer-aided image analysis system AxioVision was used for the analysis of muscle tissue structure. Images were captured with the microscope Axio Imager A1 at the magnification 20x and more.

- RESULTS AND DISCUSSION

The highest yield of deboned meat and meatness index have been achieved when deboning hip (79.0% and 3.77, respectively), blade (77.7% and 3.48) and neck (77.4% and 3.44) cuts. Thus, these cuts are the most fully fleshed.

The morphological composition of meat allows to make judgments about the quantitative content of connective, muscle and fat tissues.

Table 1 Meatness indices of horse meat cuts

Item	Meatness index
Hip	3.77
Blade	3.48
Back and fore rib and loin, including	2.49
back and fore rib	2.83
loin	2.10
Brisket and rib, including	2.25
Rib	3.44
Brisket + navel	1.29
Neck	3.44
Hind shank	1.45
Fore shank	1.84

In order to analyze the condition of tissues in meat and their arrangement in the different cuts and muscles, the histological peculiarities of the certain parts of horse meat have been studied during the investigation. Muscle fibers of the muscles of the brisket and rib cut are straight, smooth or slightly wavy in places; alteration of light and dark disks leading to clear evidence of cross striation is observed, the boundaries between fibers are well defined. Endomysium is fairly marked, fibroblasts are almost absent. In the intercostal part, sarcomeres are relaxed, perimysium in muscles is fairly developed.

On histological examination of hip, we have observed that muscle tissue in the top part of the cut is characterized by a low degree of carcomere contraction. Endomysium and perimysium are well developed. The side part of the cut has a high degree of carcomere contraction; distinct layers of connective tissue with collagen fibers are present in places. In the bottom part of hip, meat is in the initial stage of ageing. The predominant mass of muscle tissue of the inside part has effaced striation. Connective tissue in this part of a carcass is also well developed and presented by both fibrous and amorphous substance (Fig. 1).

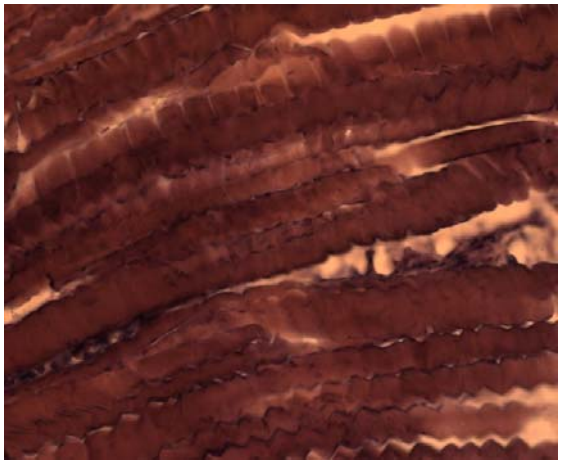

Figure 1. Hip, 20x

On histological examination of the cross section of the muscle tissue of tenderloin, we have noticed that muscle fibers quite tightly adjoin each other. Muscle tissue is characterized by a high degree of sarcomere relaxation and, as a consequence, clearly seen cross striation. A small quantity of thin layers of connective tissue is arranged between the primary and secondary bundles of muscles fibers. Swelling and destruction of cell and fiber elements have not been observed. Tenderloin is the most valuable part, which is confirmed by a small amount of connective and fat tissues in it (Fig.2).

In hind shank, muscle fibers are straight or slightly wavy, the boundaries between them are well defined. The longitudinal striation is clearly seen, which indicates the strong contraction of fibers and delayed cessation of rigor mortis. Endomysium and, particularly, perimysium are fairly marked. The elements of loose connective tissue of muscle stroma presented by fibroblasts, histiocytes, reticular cells and intercellular substance as well as the separate collagen and yellow fibers are seen between the fibers in certain areas.

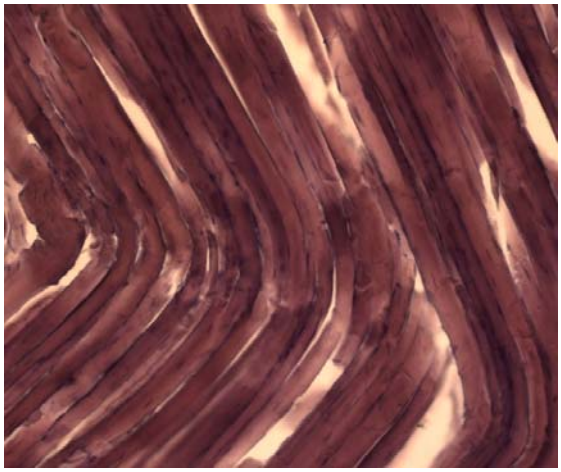

Fig 2. Tenderloin, 20x

On microstructural investigation of muscle tissue of biceps femoris, it has been found that muscle fibers are arranged quite close to each other. Endomysium and perimysium are well defined. On the section of muscle tissue of m. semitendinosus, it can be seen that endomysium is developed weaker. Postmortem contraction of muscles has completely ceased.

M. infraspinatus is fairly loose. Endomysium and perimysium are well developed in it. Muscle tissue is characterized by a high degree of sarcomere relaxation and developed cross striation.

Muscle fibers of the top part of a blade are highly "goffered" with cross striation observed everywhere, the boundaries between them are well-defined. In some areas of a fiber, the remaining contraction and longitudinal striation being a reason of such high waviness of the fibers can be observed. The destructive alterations of the fibers accompanying meat ageing have not been found. Endomysium with insignificant content of fibrous component is well revealed in the histological preparations.

Back and fore rib and chuck are characterized by a straight or slightly wavy shape of muscle fibers. The connective tissue framework of muscles of this part of a carcass is developed significantly weaker. Muscle fibers have an irregular polygonal shape and loosely adjoin each other. Muscle fibers of fore shank muscles are straight, slightly wavy in places. Marked cross striation is clearly seen in them, which indicates the complete cessation of rigor mortis of the muscles. Muscle fibers tightly adjoin each other; endomysium and perimysium are fairly well developed.

In m. triceps brachii, muscle fibers in a bundle tightly adjoin each other and there are quite thick connective tissue layers between the bundles. Fibers are relaxed, cross striation is clearly seen. In the hinder part of a blade, muscle fibers are arranged quite loose and have an irregular polygonal shape. The connective tissue framework of these muscles is well developed.

Muscle fibers of loin are straight. Endomysium is well developed. The longitudinal striation is clearly seen, which is conditioned by a high degree of sacromere contraction. The connective tissue framework in the muscles of this part of a carcass is well marked and loose connective tissue of perimysium is abundant. Flank is characterized by a tight arrangement of muscle fibers of a polygonal shape and is distinguished by inclusion of the intramuscular fat depositions.

Muscle fibers of the neck muscles are straight or slightly wavy and are quite highly "goffered" only in places. Cross striation is well-defined; in several areas of muscle tissue cross striation can be changed to longitudinal striation. Thus, rigor mortis has not completely ceased. Perimysium and its fibrous part are fairly well developed. On the cross section, muscle fibers have a round or polygonal shape; myofibrils and nuclei arranged around the periphery of the sarcoplasm are seen quite often in them. The differences in the diameter of the muscle fibers being a part of the muscles in this cut are moderate.

Mechanical characteristics of meat raw material and organoleptic peculiarities of food products produced from it depend not only on the degree of connective tissue development but also on the thickness of meat fibers per se. Thus, along with the analysis of the qualitative characteristics of muscle tissue, the investigations of the diameter of muscle fibers in different parts of cuts were carried out.

- CONCLUSION

Thus, the groups of muscles with the identical structural traits were differentiated when investigating muscle tissue of horse meat cuts by the histological and morphometric methods using the modern computer-aided image analysis system. These traits slightly vary and are determined by the morphological characteristics of muscle fibers and the development of the connective tissue framework.

Muscles with the moderate development of endomysium and perimysium and an insignificant quantity of yellow fibers in the connective tissue framework (tenderloin, m. biceps femoris, m. semitendinosus, top part of a blade) form the first group. The first group includes the most valuable parts of a carcass.

Top piece of hip, flank, fore shank, m. triceps brachii, hind shank, hinder part of a blade and loin have been included into the second group. This group is characterized by a well marked connective tissue framework at the level of cell and, particularly, fibrous elements (collagen and yellow fibers) and significant amount of fat component.

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