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New Method for Veterinary and Sanitary Control of Defrosted Meat and Fish

Diana Orlova, Tamara Kalyuzhnaya, Anton Tokarev, Yuri Kuznetsov

St. Petersburg State Academy of Veterinary Medicine, Russia
***Corresponding author:** scholar.tabriz@gmail.com

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ABSTRACT

The freezing method allows you to extend the shelf life for a long period, however, when defrosting products there is a loss of nutrients. Currently, the assessment of the thermal state of meat and fish remains a topical issue, which today is carried out using organoleptic methods, as well as a histological method for the structure of muscle tissue. These methods lose their relevance in conditions of real circulation of meat and fish products due to subjectivity, as well as complexity. To ensure the release of benign chilled products into the market and to prevent the substitution of defrosted chilled meat, a fast, effective and easily reproducible method is required. We carried out studies to assess the thermal state of 69 experimental samples of meat of animals, poultry and fish according to organoleptic indicators and also proposed a new method for the manufacture of native drugs that allows us to evaluate the structure of muscle tissue. Native meat preparations were made from thin sections of muscle tissue, crushed between the glasses of the compressorium, followed by hematoxylon-eosin staining and microscopy. it was found that the number of fibrous sections of muscle tissue in defrosted products is 11.3 times more than in samples chilled; muscle fiber breaks - 47 times. A striking identification sign that allows to differentiate the thermal state of meat and fish raw materials is the presence of thickenings at the ends of muscle fibers, which are absent in preparations of chilled material. The obtained values are statistically significant. As a result of the studies, identification criteria were established, such as a violation of the structure of muscle tissue, which is manifested by the presence of fibrous areas, tearing of muscle fibers, as well as the presence of thickenings at the ends of muscle fibers. The obtained research results allow us to use the proposed method of manufacturing and microscopy of meat and fish preparations and establish the previous freezing of products.

Key words: Defrosted meat, Meat inspection, Muscle tissue, Sanitary control

INTRODUCTION

The meat and fish retain high nutritional properties when processed at temperatures close to 0ºC, that is, above the freezing point, since there is no violation of the tissue structure, but the level of development of microorganisms causing damage to raw materials is significantly reduced. However, the cooling of products extends the shelf life by a short time, 10-14 days, which meets the needs of the consumer, but not the processing industry (Kalyuzhnaya, 2019).

Since meat and fish are products from the high price segment of the consumer basket, falsification of the thermal state is likely in the process of their sale and storage. At the same time, the frozen products received for sale undergo defrosting, and sometimes multiple, and are sold as a chilled product. In accordance with international law, these manipulations with food raw materials are prohibited, defrosted meat and fish should be sold as frozen rather than chilled, with repeated freezing and defrosting, meat and fish raw materials should be sent for industrial processing.

In connection with the foregoing, in order to strengthen control of this type of substitution in the retail network and in storage places, the state and industrial supervision bodies conduct mandatory assessments of the thermal state of meat and fish, which today is carried out by organoleptic methods, in particular, assessing the consistency of the product and broth transparency.

In laboratory conditions, this type of falsification can be detected by the histological method according to the structure of muscle tissue and the integrity of muscle fibers. The histological method is very accurate and reliable; by the presence of ruptures of muscle elements and voids in muscle cells, it is possible to accurately determine the previous low-temperature treatment (Popelka *et al*., 2014; Rahman *et al*., 2014). However, in production and commercial conditions, this method is difficult to perform; it requires special training of personnel and equipment of the laboratory. Also, histological examination is performed for a long time, which loses its relevance in the conditions of the real circulation of meat products. Organoleptic methods

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are quite subjective and under various circumstances may not give a reliable answer to the question about the thermal state of the product. To ensure the release in the implementation of benign chilled products and the exclusion of the substitution of chilled meat and fish defrosted, you need a quick, effective and easily reproducible method.

MATERIALS AND METHODS

Studies have been carried out to assess the thermal state of 69 experimental samples of the meat of animals, poultry, and fish by organoleptic indicators, and a new method for the manufacture of native preparations has been proposed, which allows us to evaluate the structure of muscle tissue.

At the initial stages, we assessed the thermal state of chilled meat and fish by determining the consistency, transparency of the broth by boiling a sample, manufacturing of native preparations of animal meat, poultry, and fish with their subsequent coloring and microscopy.

The consistency of the test samples was determined by pressing the surface of the meat and fish with a spatula and then fixed the time to fill up the resulting fossa. Chilled meat and fish, not subjected to processing at low temperatures, should have an elastic consistency, that is, when pressed, the pit aligns immediately. As a result of freezing and subsequent defrosting, muscle tissue weakens, and the resulting fossa will be leveled for one to two minutes, or not leveled.

Such an indicator as broth transparency was evaluated when a sample was made by cooking, regulated by GOST 7269-2015 "Meat. Sampling methods and organoleptic methods for determining freshness" and evaluated the transparency of the broth in the measuring cylinder in transmitted light. Chilled meat and fish broth should be clear without flakes. As a result of defrosting the raw material, the membrane of muscle cells is destroyed, the proteins contained in the sarcoplasm denature when heated and produce clouding and loss of flakes in the broth.

Native meat and fish preparations were made from thin sections of muscle tissue. Using curved scissors, thin sections were cut from the test sample in the direction of muscle fibers 2-3 mm thick, 7-8 mm long, in the amount of 3-4 pieces. Further, prepared sections were laid out between the glasses of the compressorium, with the effort they were distributed and fixed for 1-2 minutes with the screws. After a time, crushed muscle sections were removed from the compressorium using tweezers and dissecting needles and placed in porcelain cups for evaporation, where they were stained with hematoxylin-eosin according to GOST 19496-2013. Then the stained sections were again placed in the compressorium and microscopy was performed under a light microscope to increase the lens 10 and eyepiece 10, while assessing the structure of muscle tissue, the number of breaks in muscle fibers, the shape, and condition of their endings, looking at 20 fields of view, each of the above indicators were calculated, after which the arithmetic average for each meat and fish sample was calculated over the entire sample of 69 samples (Orlova *et al*., 2019b).

At the second stage of the study, the cooled meat and fish samples were subjected to freezing in a freezer at a temperature of -12-14ºC for 5 days, after which the samples were defrosted in a refrigerator at a temperature of + 2 up to + 4ºC and the thermal condition of the products were assessed by the above methods.

The obtained results of the studies were processed using the Microsoft Office Excel application programs, as well as by the method of variation statistics with calculation of arithmetic mean values of the correlation coefficient: M is the arithmetic mean, m is the arithmetic mean error, the significance of differences between the samples was determined by the Student t-test in Microsoft Office Excel ($P<0.001$).

RESULTS AND DISCUSSION

When assessing the consistency of the studied samples of chilled raw materials, the elasticity and elasticity of muscle tissue were noted, the fossa formed by pressing with a spatula was leveled for several seconds. In the sample by cooking, a clear, cereal-free broth was obtained. The consistency of the muscles of the defrosted samples became soft and less elastic. The fossa formed upon pressing was leveled out for several minutes, the broth turned out cloudy, with flakes (Leygonie *et al*., 2012; Šimoniová *et al*., 2013).

Given the main purpose of the studies to substantiate the possibility of using the method of microscopy of native meat and fish preparations to identify the thermal state, we first evaluated the organoleptic characteristics and morphological characteristics of the muscle tissue of the chilled products, which were taken as control ones, and then compared them with the corresponding characteristics of the muscle tissue of similar defrosted products. The continuous structure of muscle tissue, the uniform direction of muscle fibers, and their integrity were noted. The ends of the muscle sections were smooth, steep (Fig. 1, 2) (Orlova *et al*., 2019a).

In defrosted meat and fish, a violation of the structure of muscle tissue was found, the fibers were randomly arranged, with breaks and a violation of a single direction (Fig. 3). Also, thickenings were found at the ends of muscle fibers (Fig. 4, 5). Such formations are explained by the weakening of the sarcoplasm as a result of freezing and subsequent thawing, its exit beyond the limits of muscle cells, which is facilitated by squeezing in the manufacture of sections (Orlova *et al*., 2019b; Tokarev *et al*., 2019).

When analyzing the microscopic results of meat and fish samples, it was found that the number of fibrous sections of muscle tissue in defrosted products is 11.3 times more than in samples chilled; muscle fiber breaks - 47 times. A striking identification sign that allows to differentiate the thermal state of meat and fish raw materials is the presence of thickenings at the ends of muscle fibers, which are absent in preparations of chilled material. The obtained values are statistically significant ($P<0.0001$; Table 1).

In Popelka *et al*. (2014) deformations in muscle fibres of fish and optically empty areas were greater in frozen trout, in compared with fresh fish meat. In present study, in agreement of Popelka *et al.*, (2014), fish meat had greater muscle fiber breaks, after defrosting (Table 1).

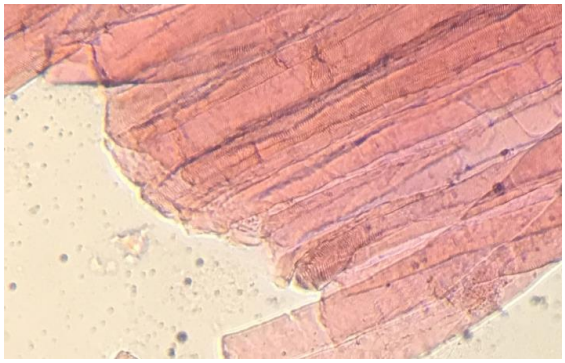

Fig. 1: Muscle of chilled beef.

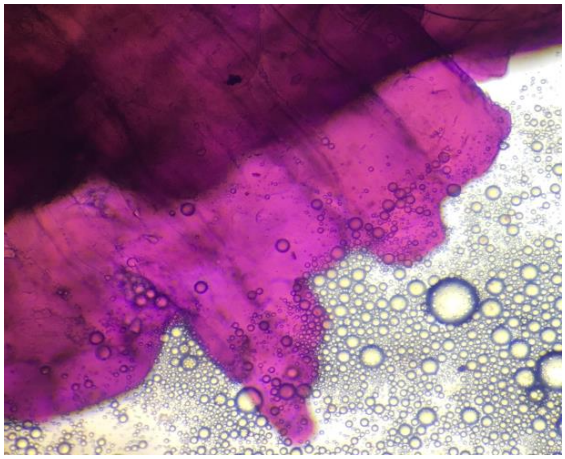

Fig. 2: Muscle of chilled trout.

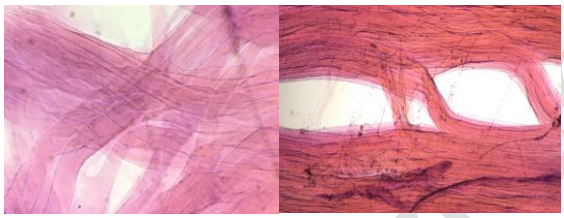

Fig. 3: Muscle of defrosted poultry meat.

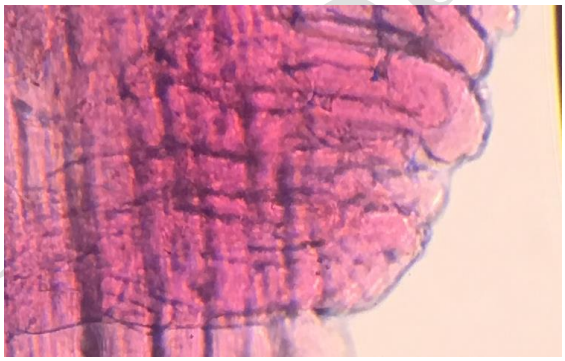

Fig. 4: Muscle of defrosted nutria meat.

Table 1: Characteristics of chilled and defrosted meat and fish samples (M ± m, n = 69)

Indicator	Chilled products (control)	Defrosted products
Muscle tissue areas	0.43±0.09	4.84±0.28*
Muscle fiber breaks	0.27±0.07	12.69±0.61*
Thickening of the ends of muscle fibers	-	20.33±0.41

*P<0.0001 statistically significant difference from control.

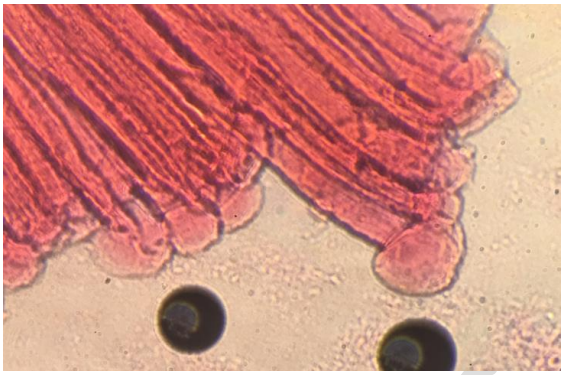

Fig. 5: Muscle of defrosted beef.

Conclusions

The obtained research results allow us to use the proposed method of manufacturing and microscopy of meat and fish preparations and establish the previous freezing of products. The identification criteria, in this case, are a violation of the structure of muscle tissue, which is manifested by the presence of fibrous areas, tearing of muscle fibers, as well as the presence of thickenings at the ends of muscle fibers. The use of this method is acceptable and promising for the implementation of input and production control of meat and fish raw materials, which will generally improve the quality and safety of food products sold.

Acknowledgement

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