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Development of An Algorithm for Identifying the Thermal State of Meat and Fish Raw Materials

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Abstract*: Modern methods of differentiating chilled and thawed meat are based on the development of organoleptic indicators and morphological changes in tissues defined in histological preparations. We conducted studies to assess the thermal state of 69 prototypes of meat and fish using a histological method to evaluate the structure of muscle tissue. Microscopic examination of histological preparations of chilled meat and fish showed a clear and even tissue structure, whole muscle fibers in the transverse section of muscle fibers, and indicators such as the structure of muscle tissue, voids within and between muscle fibers, and the presence of thickened muscle fibers were recorded in defrosted samples fibers, while in similar preparations made from chilled products, similar morphological changes were found in isolated cases or were not detected in the material. The above information allows us to consider these criteria as identification and to differentiate the thermal state of meat and fish raw materials.

Keywords* : thermal state, meat, microscopy, histological preparations.

I. INTRODUCTION

Meat and fish are some of the most valuable types of raw materials and are widely used in the food industry, since they are characterized by a high content of high-grade proteins, vitamins, especially group B, and mineral elements. An effective way to maintain quality indicators at a high level is the cooling of meat and fish, and for longer storage of products it is rational to use its freezing at various temperature conditions. However, as a result of exposure to subzero temperatures, free water crystallizes in muscle cells, which, when defrosted, leads to mechanical damage to muscle elements. As a result of such destruction of muscle cells, part of the nutrients is lost from the product and the nutritional value of meat and fish is significantly reduced, therefore, the sale and circulation of raw materials falsified by thermal state is unacceptable [5, 7].

Modern methods of differentiation of chilled and defrosted products are based on the assessment of organoleptic indicators and morphological changes in tissues, determined in histological preparations. 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 [3, 6, 8].

II. MATERIALS AND METHODS

We conducted studies to assess the thermal state of 69 prototypes of meat and fish using a histological method to evaluate the structure of muscle tissue.

Histological examination of meat was carried out according to GOST 19496-2013 “Meat and meat products. The method of histological examination. " Microscopy of histological preparations assessed breaks in muscle fibers, the presence of voids inside muscle cells and between them, thickened myofibrils. Microscopy of histological sections examined 20 fields of view at a magnification of x100, each of the above criteria was calculated in each field of view, and then the arithmetic average for each sample of chilled and defrosted products was calculated.

The obtained results of the studies were processed using 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 ($p < 0.001$).

III. RESULTS AND DISCUSSIONS

First, the morphological characteristics of the muscle tissue of the chilled products were evaluated, which were taken as control and then compared with the corresponding characteristics of the muscle tissue of a similar defrosted product. Microscopic examination of histological preparations of chilled meat and fish showed a clear and even tissue structure and integral muscle fibers in a transverse section of muscle fibers (Fig. 1, 2) [1, 3].

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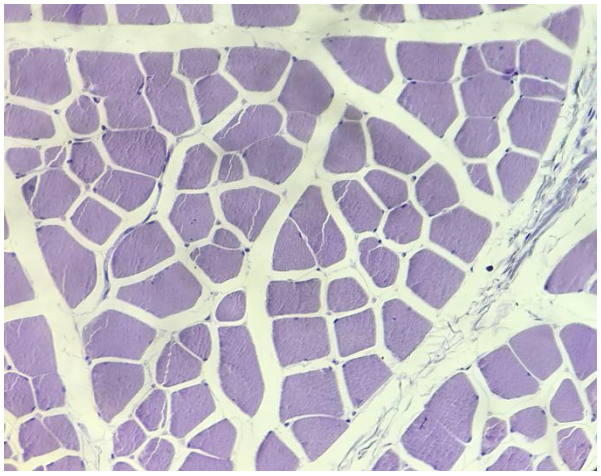

Fig. 1. The histological preparation of muscle tissue of chilled beef

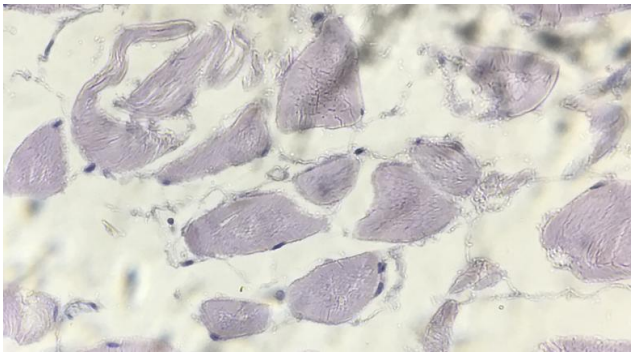

Fig. 2. The histological preparation of muscle tissue of defrosted fish

Microscopy of histological preparations of defrosted raw materials revealed that such indicators as the structure of muscle tissue, determined by the number of breaks in muscle fibers, the presence of voids inside and between muscle fibers, thickened muscle fibers were recorded in each sample (Fig. 3, 4), while in similar preparations made from chilled products, similar morphological changes were encountered in isolated cases or were not found in the material [2, 4].

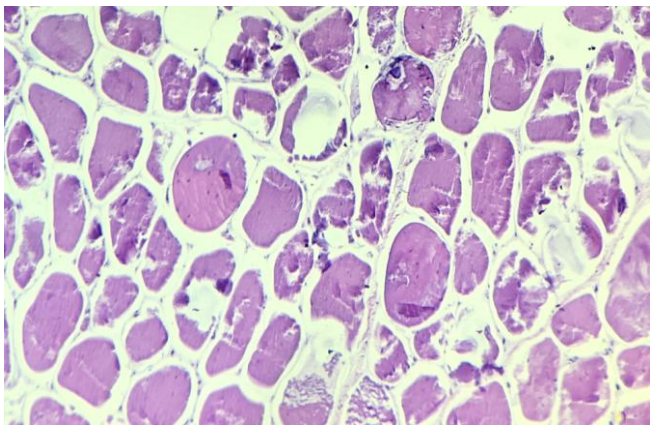

Fig. 3. The histological preparation of muscle tissue defrosted pork

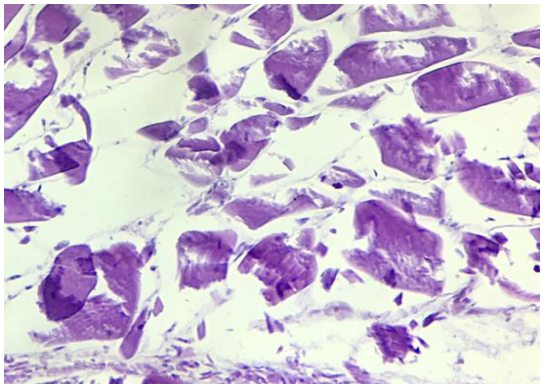

Fig. 4. The histological preparation of muscle tissue defrosted poultry

The above information allows us to consider these criteria as identification and to differentiate the thermal state of meat and fish raw materials, which is consistent with the results of studies of other authors [4, 9].

Table - I: Morphological characteristics of muscle tissue in histological preparations of chilled and defrosted meat and fish samples (M ± m, n = 69)

Characteristic	Chilled products (control)	Defrosted products
The number of breaks in muscle fibers, units / 20 p.z.	2,69±0,21	41,21±1,01*
The number of voids inside the muscle fibers and between them, units / 20 p.z.	1,04±0,12	2,67±0,13*
Thickening of myofibrils, units / 20 p.z.	2,14±0,13	5,55±0,17*
*p<0,0001 - statistically significant difference from control		

Analyzing the obtained values, it was found that the number of thickenings of myofibrils in defrosted products was 5.55, which is 259% more than in chilled products; the number of voids inside the muscle fibers and between them - 2.67, by 256.78%, more than in chilled raw materials; the number of muscle fiber breaks in defrosted meat and fish was 41.24, which exceeds this value in chilled products by 15.3 times. The obtained values are statistically significant - p <0.0001.

IV. CONCLUSIONS

The identification of the thermal state of meat and fish in modern conditions of the food industry and economic activity is crucial in ensuring food security and protecting the interests of consumers. Histological examination is the most informative, reliably allows differentiating chilled meat and fish products at any stage of its circulation.

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"Development of an express method for determining the thermal state of meat and fish by the structure of muscle fibers".

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