INVESTIGATIONS OF MICROSTRUCTURE OF SMOKED-COOKED PRODUCTS FROM HOT AND CHILLED PORK

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Abstract -the microstructure investigations of smoked-cooked products manufactured from hot and chilled pork were conducted at the V.M.Gorbatov All-Russian meat research institute. The purpose of the investigations was to evaluate the influence of the used technique of dressing and hot-boning of the raw materials and combined processes of chilling and aging of boneless vacuum-packed raw materials and curing (injecting and massaging) on microstructure indices of final products.

Index terms: ageing, curing, food-grade phosphates, hot and chilled pork, microstructure, salt, sensory evaluation, smoked-cooked pork products, sodium nitrite, vacuum packaging, yield

I. INTRODUCTION

A method of production of pork products using curing and vacuum treatment of hot meat has been known for a long time (Heinrich Keim, et al., 1999), however the data about microstructure investigations of such products are unavailable in literature.

Therefore, the evaluation of the influence of pork processing technological methods consisting of immediate dressing and boning in hot condition, combination of the processes of chilling and ageing of boneless raw materials in vacuum packaging with the use of curing (injecting and massaging) on microstructure of smoked-cooked final products presents scientific and practical interest.

II. MATERIALS AND METHODS

Sample 1 was manufactured from hot pork, vacuum-packed, transferred to chilling and ageing for two days, with subsequent curing with brine, containing water, salt and sodium nitrite.

Samples 2 and 3 were manufactured from hot pork, salted, vacuum-packed and transferred to ageing. Sample 2 was salted with brine, containing water, salt and sodium nitrite. Sample 3 was salted with brine, containing water, salt, sodium nitrite, food grade phosphates.

Sample 4 was manufactured from chilled and aged pork, salted with brine, containing water, salt, sodium nitrite, food grade phosphates.

Then all the samples were subjected to massaging and thermal treatment according to generally accepted technological schemes of production of smoked-cooked products from pork.

The analysis of microstructure of samples 1-4 was carried out together with sensory evaluation and determination of the yield of final products.

III. RESULTS AND DISCUSSION

Analysis of the data obtained has shown that the conditions and time of evacuation and curing of meat raw materials have sufficiently large effect on the microstructure of morphological components, causing different changes in them, which determine the quality of final products.

Curing of hot, preliminarily vacuum-packed meat raw materials (sample 1) and stored for two days in polymer package leads to production of final product with swollen muscle fibers and moderate degree of destruction.

In the meat raw materials which were vacuum-packed in hot condition, with the development of autolytic processes, favorable conditions for lactic acid microflora development are creating.. And under the influence of own meat enzymes the permeability of structures to salt solutions (including sarcolemmas of muscle fibers), increases. Subsequently introduced brine is distributed over loose connective tissue, moving the muscle bundles and individual muscle fibers apart. Under the influence of

salt solution swelling of muscle fibers and connective tissue fiber elements, primarily in the places, adjacent to the points of brine introduction is gradually developed.
In their cross section muscle fibers acquire round form and become tightly adjacent to each other (Fig.1).

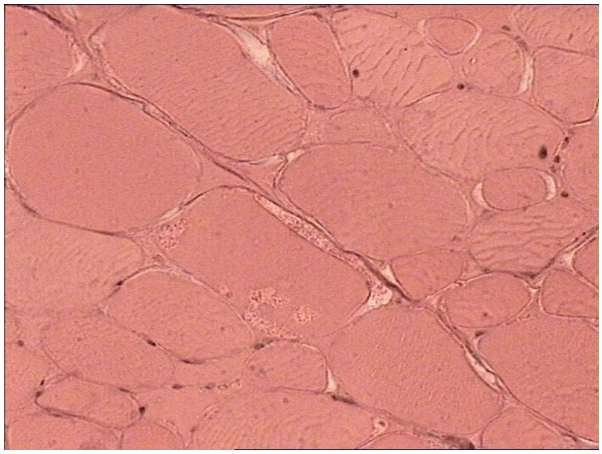

Fig.1. Microstructure of sample 1 of final product, manufactured from hot meat raw materials, salted after 2 days of storage under vacuum. Cross section. x 360.

Cross striation of muscle fibers gradually weakens, nuclei are subjected to pycnosis and become homogenous. Detachment and destruction of sarcolemma and the escape of salt-soluble proteins from muscle fibers are observed with the formation of fine-grain protein mass between muscle bundles and fibers and in loose connective tissue. Destructive changes in muscle fiber structures are characterized with gradual generation of cross micro cracks and slot-like spaces with subsequent fragmentation of myofibrillar structures of fibers due to their destruction under the influence of own enzymes and the enzymes of the developing lactic acid microflora, and with loosening of collagen fibers bundles.

Simultaneously tenderness of meat is increased, and the share of strongly bound moisture in meat grows. By the degree of muscular fibers destruction the samples of final products are not inferior to the samples manufactured from chilled raw materials. The found behavior is typical for all the samples, no matter from what morphological part of the carcass they were manufactured (neck, loin, leg).

Curing of hot meat raw materials with subsequent vacuum treatment (sample 2) has a negative effect on the degree of destruction of muscle and their swelling, as it slows down not only the development of rigor mortis in muscle tissue (which is shown by the length of sarcomers of muscle fibers and uniform cross striation, clearly defined in all muscle fibers), but also the processes of its ageing.

The brine components penetrate through intact sarcolemma into muscle fibers more slowly, which reduces the degree of moisture binding of myofibrillar proteins. The meat is worse salted-through, the changes in microstructure typical for curing, are developing more slowly, the development of lactic acid microflora is inhibited. During thermal treatment the part of weakly bound moisture escapes into interfiber spaces, which can be seen from the not-stained by colorants areas between sarcolemma of a muscle and the endomysium (Fig 2). The loss of moisture during thermal treatment is increased.

Fig. 2. Microstructure of sample 2 (final product, manufactured from salted hot meat raw material). Cross section. X 360.

The diameter of muscle fibers in samples is by 30-32% less as compared to the diameter of muscle fibers in final product, manufactured from hot raw materials, cured after 2 days of storage.

The use of food grade phosphates (sample 3) in this case allows increase solubility of myofibrillar proteins and decrease moisture losses after thermal treatment (Fig.3).

The analysis of microstructure of samples has shown, that the influence of phosphates is manifested, primarily, in the increase of the degree of swelling of myofibrils and muscle fibers, and thus, increase in the amount of strongly-bound moisture in muscle tissue and the yield of final product. At the same time, the use of phosphates helps enhance the destructive changes of myofibrils, positively influencing tenderness of the final product. Muscle fibers are characterized with the evident wide cross and distinct longitudinal striation, deeper destructive changes in myofibrils structure as compared to the similar version without phosphates, pointing out to good moisture-holding capacity and juiciness of final product.

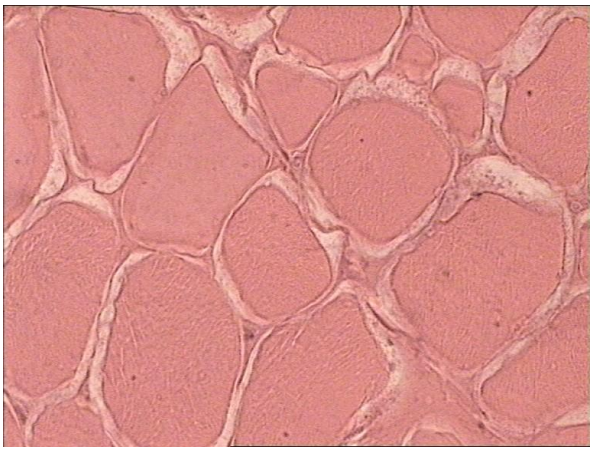

Fig. 3. The microstructure of sample 3 of final product, manufactured from salted hot meat raw materials with phosphates. Cross section x 360.

The microstructure of final product manufactured from chilled meat raw materials, vacuum-packed after curing (sample 4) was characterized with deep destructive changes in myofibrils structure and sarcolemma of muscle fibers which could be seen from fragmentation of whole groups of myofibrils, deterioration of integrity of basal membrane of the sarcolemma, destruction of sarcoplasm with the escape of fine-grain protein mass under a sarcolemma and into the space between muscular fibers Partial destruction of actin filaments, fragmentation of myofibrils over Z-plates and I discs (Fig. 4) were also observed.

The microorganisms presented primarily by cocci forms were found in interlayers of loose connective tissue and in the places of cross slot-like disruptions of the integrity of muscle fibers.

In the areas of muscle fibers, immediately adjacent to the agglutinations of microorganisms a different degree destruction of myofibrils and Z-plates was observed, with the formation of fine-grain protein mass, and lysis of intra-nuclei structures.

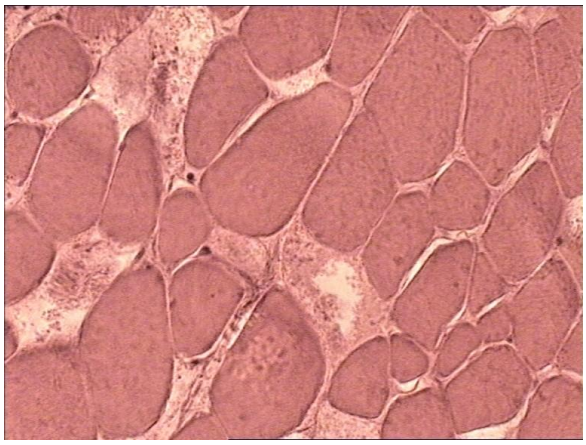

Fig. 4. Microstructure of sample 4 of final product, manufactured from chilled meat raw material. Formation of fine-grain protein mass in inter-fiber space. Cross section x 360.

Comparative investigations of microstructure of pork products made from hot raw materials with massaging or without it have shown that in final products without massaging the degree of destruction of muscle fibers was much less, which resulted in more springy consistencyof product.

Destructive changes in muscle fibers are manifested in the appearance of cross cracks. Moderate destruction of myofibrils in the form of breakdown along Z-plates is marked; there is also a fine-grain protein mass between fibers. The degree of swelling of muscle fibers is significantly lower, that can be explained, among other things, with a less uniform distribution of injected brine over the volume of the product. The use of massaging allows correct negative processes and obtain the product with high sensory indices.

The organoleptic evaluation of taste has shown high quality scores. Samples 2 were more salty, therefore they obtained a lower score for taste. A saltier taste could be explained by a lower yield because of a greater moisture loss compared to other samples.

No major differences were found between the samples of smoked-cooked pork products with regards to the appearance, color, aroma and consistency.

The yield of final products (neck, loin, ham) as produced with massaging for samples 1 was 108-111.8%, for samples 2 – 95-101%, for samples 3 – 100-105% for samples 4 – 108-110%. The average yield of final products was 105.7%.

The yield of the products manufactured from hot pork, salted with brine with phosphates (sample 3) was 3.8-6.3% higher, as compared to samples 2, but by 4.5-8.0% lower, than of the samples 1 and 4.

IV. CONCLUSIONS

The obtained results led to the conclusion that:

- the technology incorporating dressing of hot pork, packaging under vacuum and combination of chilling and ageing of the raw materials during 2-3 days at 0…4^{0}C followed by curing has a positive influence on microstructure of final products.
- the final products manufactured using the technology of combining of chilling and ageing of meat raw materials without vacuum packaging, with subsequent curing was characterized with large destructive changes;
- all the samples of smoked-cooked products produced from hot pork, subjected to chilling and ageing under vacuum, had high sensory indices (appearance, color, aroma, consistency).
- the yield of smoked-cooked products manufactured from hot pork, having been subjected to chilling and ageing under vacuum, followed by curing and massaging was not actually different from the yields of similar products manufactured from chilled bone-in pork.