Influence of salting on technological properties of lump and chopped chicken meat

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Abstract. Laying hens’ meat is a complete protein product with the mass fraction of protein equal to 18-19%. At the same time, lump and chopped (mechanically deboned) chicken meat has a reduced level of water-binding capacity and an increased content of coarse-fibrous muscle and connective tissues, which causes certain difficulties when using this raw meat in sausage production. To solve this problem, the effect of salting on the technological properties of lump and chopped chicken meat was studied. For control and experimental samples of each type of meat (lump and mechanically deboned), four curing compositions were used, while for lump meat a wet salting was used, for mechanically deboned one – dry salting. The data obtained indicate that the water-binding capacity of the mechanically deboned poultry control samples before salting compared to lump meat was steadily higher by 2.61% when salting for 0.5 days and by 5.13% when salting for 2.5. As well, with an increase in the concentration of salt solutions the averaged water-binding capacity values of lump meat prototypes increased from 98.36% to 106.10%, and mechanically deboned poultry meat – from 100.97% to 105.8%, which indicates the initial stage of the maturation process. It was found that the penetration index of the control sample of lump meat with an increase in the duration of salting from the beginning to 3 days decreased from 100.35% to 75%, and the value of the penetration index of the mechanically deboned poultry meat prototypes during the first days of salting, on the contrary, slightly increased from 100% to 104%. With an increase in the duration of curing and the concentration of curing compositions, the penetration index of the mechanically deboned poultry meat decreased from 100% to 90%, which indicated a decrease in the strength of its coagulation structure.

1. Introduction

The increased rigidity of chicken meat impedes its use in sausage technology. For this reason, an important area of research is the search for ways to improve the technological properties (water-binding capacity, plasticity and penetration) of raw meat. One of the effective ways to improve the specified properties of raw meat and protect it from microbiological spoilage is salting.

In this regard, an urgent task is to expand knowledge about the mechanism of the effect of salting on the technological properties of chicken meat, since this knowledge serves as the basis for the purposeful formation of these properties of raw meat.

Under the influence of sodium chloride in sausage meat and finished products, changes occur with the achievement of the necessary technological and consumer properties being taste, aroma, color, consistency, etc. [1, 2, 3].
At the same time, as a result of physical impact on the structure of raw meat, the integrity of the membrane structures of lysosomes, mitochondria and nuclei is disrupted. This leads to the release of intracellular enzymes and, under the diffusion-osmotic forces, together with the curing ingredients, they move to the activation zone. Under their influence, as well as enzymes that are secreted by microorganisms, part of the actomyosin fraction and other proteins hydrolytically decompose and dissolve, which results in an increase in the number of free bonds capable of retaining an additional amount of water.

Thus, intense destructive changes occur in muscle fibers during salting. In the myofibrils preserved after mechanical treatment, a violation of the sarclemma integrity is observed, the distances between protofibrils filled with salt solution and released protein and other substances forming a fine-grained mass increase. The protofibrils, in turn, undergo rupture in the areas of Z-lines, M-lines and H-zones, while the structure of the A- and I-discs is significantly weakened as a result of proteins extraction to the surface. All this testifies to the swelling and loosening of myofibrillar structures during the salting process [4, 5, 6].

It follows from the above that the formation of the sausage meat structure is influenced not only by the process of mechanical action but also by the added enzymes activity. Therefore, to intensify the formation of sausage minced meat structure and give it the necessary technological properties, to obtain products with high quality indicators, multicomponent curing compositions containing lactates being activators to enhance the proteolytic activity of endogenous and exogenous enzymes are used during salting [7].

The purpose of this work is to expand and deepen the knowledge about the effect of the salting process on the technological properties of chicken meat.

2. Materials and methods
Eviscerated chickens were cut into separate parts in accordance with the domestic standard GOST 32607-2013 “Chicken meat. Carcasses and their parts. Delivery requirements and quality control”.

The breasts and legs obtained by cutting were deboned, white and red lumpy meat was separated, and mechanically deboned poultry meat was obtained from the back.

To study the effect of wet salting of lump meat and dry salting of mechanically deboned meat on their technological properties, 4 salting compositions were developed. The compositions are presented in table 1.

| Table 1. Ingredients of curing mixtures for lump meat wet salting (by injection) and dry salting of mechanically deboned poultry meat |
|-----------------------------------------------------------------------------------------|
| Salt solution | Curing mixtures | Composition of curing agents, % |
| Control | Table salt - 2.5 |
| No.1 | Table salt – 1.0; potassium lactate – 1.0; enzyme preparation – 0.1 |
| No.2 | Table salt – 1.5; potassium lactate – 1.5; enzyme preparation – 0.2 |
| No.3 | Table salt – 2.0; potassium lactate – 2.0; enzyme preparation – 0.3 |
| No.4 | Table salt – 2.5; potassium lactate – 2.5; enzyme preparation – 0.4 |

Indicators of raw meat were studied by the following methods: mass fraction of moisture (GOST R 51479-99); mass fraction of fat (GOST 23042-86); mass fraction of protein (GOST 25011-81); mass fraction of sodium chloride (GOST 9957-73), whose obtained values are expressed as a percentage of the raw materials mass; water-binding capacity according to the Grau and Hamm method modified by V.P. Volovinskaya and B.I. Kelman, by mass fraction of bound moisture in the sample, percentage to total moisture; plasticity Ψ (according to the spot area of the test sample on filter paper with subsequent recalculation by weight, cm²/g); penetration (GOST R 50814-95 for the depth of immersion of the four-needle indenter into the thickness of the prototype for 180 seconds and the established formula, Pa).
The measured values of the indicators for the control samples were taken as 100%, the averaged values of the experimental samples were determined by their mass fraction depending on the duration of salting and the concentration of the salting compositions, expressed as a percentage relative to the values of the control samples.

3. Research results

To prepare sausage mince recipes, lump chicken meat (fillets and legs) was used, as well as mechanically deboned poultry meat was used to create a monolithic homogeneous and/or heterogeneous pattern on the cut of the finished sausage. When raw meat matures, its structural transformations occur. The transformations are associated with a change in the water-binding capacity of lump and crushed meat (Figure 1).

![Figure 1. Dependence of water-binding capacity of lump meat and mechanically deboned poultry meat, % on the ingredients of the curing mixtures (table 1) and the duration of curing, h: 1 – control; 2 – salt solution No. 1; 3 – salt solution No. 2; 4 – salt solution No. 3; 5 – salt solution No. 4; 1′ – control; 2′ – curing composition No. 1; 3′ – curing composition No. 2; 4′ – curing composition No. 3; 5′ – curing composition No. 4.]

The data presented in Figure 1 indicate that with an increase in the concentration of potassium lactate and an enzyme preparation during raw meat salting, already on the first day, there is a more intense increase in water-binding capacity in relation to control samples. At the same time, there is a slight decrease in this indicator in lump meat at the very beginning of salting in relation to unsalted raw materials. This nature of maturation at the beginning of curing in the control sample can be explained by the fact that after extrusion and massaging, the salt solution is distributed to a greater extent in the intercellular space and to a lesser extent in muscle fibers due to the collagen content in the meat structure.

Under the influence of curing compositions and an increase in osmotic pressure in the intercellular space, part of the moisture from the muscle fibers moves into the intercellular space. This nature of maturation at the beginning of curing in the control sample can be explained by the fact that after extrusion and massaging, the salt solution is distributed to a greater extent in the intercellular space and to a lesser extent in muscle fibers due to the collagen content in the meat structure.

Under the influence of curing compositions and an increase in osmotic pressure in the intercellular space, part of the moisture from the muscle fibers moves into the intercellular space. Almost simultaneously, the salt in the salt solution-meat system is redistributed and the rate of its penetration depends on both the concentration and the degree of sarclemma destruction. Therefore, the faster the salt accumulates in the muscle tissue, the faster the water-binding capacity will grow. This capacity is
accompanied by loosening and swelling of meat, destructive changes in the connective tissue and sarcolemma of muscle fiber.

For mechanically deboned poultry meat in control and experimental samples, the increase in water-binding capacity at the initial stage of maturation is due to the fact that the process of formation and strengthening of the protein structural network capable of retaining an additional amount of moisture develops under the influence of curing compositions. Achievement of the highest water-binding capacity values in shorter curing times in experimental samples, especially at higher concentrations of curing compositions in comparison with the control, proves their effect on the acceleration of secondary structure formation in mechanically deboned poultry meat. With an increase in the duration of maturation of lump meat and mechanically deboned poultry meat for all samples, a further increase in water-binding capacity is observed. Its intensity depends directly on the curing composition used. It should be noted that the higher the concentration of the curing composition is, the higher the water-binding capacity values are, and they are achieved in a shorter time.

Longer exposure to table salt, together with potassium lactate and an enzyme preparation on test samples, leads to a decrease in the water-binding capacity of lumpy and crushed meat, which can be explained by loosening of the connective and muscle tissues, followed by proteolysis of collagen and myofibrillar proteins, which ensure the preservation of moisture in the meat structure. For mechanically deboned poultry meat, at the end of the salting, a decrease in the water-binding capacity values was noted in almost all prototypes, which was due to the destruction of the structural network of the dispersed phase capable of retaining moisture.

![Figure 2. Dependence of plasticity of lumpy meat and mechanically deboned poultry meat, % on the ingredients of the curing mixtures (table 1) and the duration of curing, h; 1 – control; 2 – salt solution No. 1; 3 – salt solution No. 2; 4 – salt solution No. 3; 5 – salt solution No. 4; 1’ – control; 2’ – curing composition No. 1; 3’ – curing composition No. 2; 4’ – curing composition No. 3; 5’ – curing composition No. 4](image)

However, despite such a decrease, the water-binding capacity values for the test samples are higher compared to the control, which indicates a deeper nature of the maturation process. Such changes in the water-binding capacity of muscle and connective tissue proteins of the microstructure of meat raw materials, the content and forms of moisture bond leads to the accumulation of substances that determine the taste, aroma and stabilization of the finished products color.

The complex biochemical and mass exchange processes contribute to giving the raw material from poultry meat the necessary rheological properties determined by the average values of changes in the plasticity of prototypes of lump meat and mechanically deboned poultry meat. The increase in the duration of curing for 0.5-2 days and the concentration of curing compositions, the looseness in the
structure of lumpy meat increases from 100% to 110%. While salting mechanically deboned poultry meat for 0.5-1.0 days, a noticeable compaction of the structure of meat raw materials is observed. The established average values of plasticity vary in the range from 100% to 85%. With an increase in the duration of salting and the concentration of mixtures from No. 2 to No. 4, the plasticity of lump meat and mechanically deboned poultry meat increases to 100% and more (Figure 2).

Figure 3 shows the dependence of the penetration of lump meat and mechanically deboned poultry meat, % on the ingredients of the curing mixtures (table 1) and the duration of curing, h; 1 – control; 2 – salt solution No. 1; 3 – salt solution No. 2; 4 – salt solution No. 3; 5 – salt solution No. 4; 1’ – control; 2’ – curing composition No. 1; 3’ – curing composition No. 2; 4’ – curing composition No. 3; 5’ – curing composition No. 4.

The analysis of the data presented in Figure 3 shows that the penetration of control samples of lump meat with an increase in the duration of curing from 12 to 72 hours decreased from 100.35% to 95.25% but remained practically constant for mechanically deboned poultry meat.

With an increase in the concentration of salt solutions in prototypes of raw meat while curing for 12 hours, the penetration of lump meat decreases, and the analogous mechanically deboned poultry meat indicator does not actually change. The penetration values are at the level of 100%.

With an increase in the duration of curing from 12 to 24 hours, the penetration values of lump meat decrease from 99.5% to 91.8%, and for mechanically deboned poultry meat they remain almost constant and only after 36-72 hours of curing, the penetration decreases from 91.80% to 86.55%, and for mechanically deboned poultry meat from 104.1% to 89.85%, which indicates a decrease in the strength of the coagulation structure of mechanically deboned poultry meat.

The difference in the values of lump meat penetration while curing for 36 hours is 9.2%, and for mechanically deboned poultry meat it practically does not change. Within 72 hours of salting, the penetration values of lump meat prototypes are reduced by 8.7%, and of mechanically deboned poultry meat – by 10.75% compared to the control samples, which increases the binding capacity of both types of meat when making sausage meat.
Thus, curing of lump meat and mechanically deboned poultry meat within 36-72 hours provides the most acceptable strong consistency of raw meat according to the penetration criterion when using salt solutions with curing compositions No.1-No.4 (table 1).

4. Conclusion

The ingredients of the curing mixture (Table 1) have a significant effect on the technological properties of chicken meat (Figures 1, 2, 3). The revealed relationships between the ingredients of the curing mixture, the duration of the curing process and the technological properties of chicken meat are the basis for the targeted selection of parts of eviscerated chickens and mechanically deboned poultry meat for the purpose of using products from this raw material in technologies. The research results indicate influencing the rheological characteristics (for example, viscosity, stickiness, adhesion, cohesion) and organoleptic properties (for example, juiciness, consistency, appearance) of chicken meat by affecting water-binding capacity and plasticity.

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