ASSESSMENT OF THE IMPACT OF TECHNOLOGICAL FACTORS ON QUALITY OF SAUSAGES IN MGA

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Abstract – Formation of quality and safety of sausage products depends on a variety of factors, among which are water content of a product, thermal condition of meat raw material, changes in gas composition and others. The results of the investigation of technological factors effect on physico-chemical indices of sausages allowed us to establish that despite the significant reduction of carbon dioxide proportion during storage, packaging of cooked and semi-smoked sausages in the conditions of a modified atmosphere containing 20% CO_2 did not affect product pH and had no negative influence on product quality throughout a storage period with some exception associated with the changes in color characteristics.

Key Words – sausage, carbon dioxide, packaging.

I. INTRODUCTION

In the conditions of tough competition between meat processing enterprises, production of meat products with prolonged shelf life, mainly in the modified gas atmosphere (MGA), which use does not result in compression of a product and associated defects, has gained increasing topicality. However, quality formation in packaged products including moisture separation in a package is not always a result of compression and deformation [1, 2]. These issues are mainly related to occurrence of physico-chemical, microbiological and biochemical processes upon product storage before and after package opening.

Many factors form quality and safety of meat products, among which are the presence of free moisture in a packed product, sanitary-hygienic condition of a product surface before packaging, stability of gas media in a package and others. In this connection, the aim of the work was to establish the most important technological factors for ensuring quality and safety of sausage products.

II. MATERIALS AND METHODS

The subjects of the research were the samples of semi-smoked sausage "Krakovskaya" and cooked sausage "Doctorskaya" made from cooled and frozen meat raw material and packed in the condition of MGA with different storage period. The sausages were packed in the ready-made gas mixture containing nitrogen (80 %) and carbon dioxide (20 %) and were stored at a temperature of 4 ± 2^{o}C. From the obtained samples, the specimens were taken for the determination of moisture mass fraction by the method of drying to constant mass, water activity by the cryoscopic method using the AWK-20 instrument (Germany), color characteristics in the CIELab system using the spectrocolorimeter "Spectroton", acid value (AV) by the method based on titration of free fatty acids in ether/ethanol solution of fat with aqueous solution of alkali; peroxide value (PV) by the method based on oxidation of iodhydric acid by peroxides contained in fat with the following titration of liberated iodine with sodium thiosulfate; thiobarbituric acid (TBA) value by the method based on the development of stained substances as a result of the reaction of fat oxidation products with 2- thiobarbituric acid and measurement of the color intensity using spectrophotometer. During storage of the packed products, the gas ratio in the packages was detected using the gas analyzer.

III. RESULTS AND DISCUSSION

It is known that upon long-term storage of meat in frozen condition its functional-technological characteristics are impaired as a result of the denaturation changes in proteins under the influence of freezing temperatures. With that, thermal condition of used meat raw material can also affect the processes of moisture separation upon finished product storage. In order to study this issue, we performed examination of the semi-smoked sausages packed in the conditions of

MGA at the different stages of storage – before and after package opening.

During storage of the sausages packed in a modified gas atmosphere, the insignificant reduction in moisture mass fraction in the product was observed (Table 1), apparently as a result of moisture exchange between the medium and the product. For example, on the 54th day of storage, moisture mass fraction in the sausage made from cooled raw material decreased by 2.1 %, and in the sausage made from frozen raw material by 3.6 %.

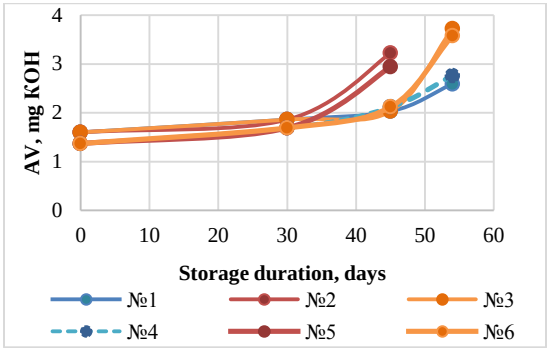
Table 1 Effect of different fat substitutes on chemical composition of farce model samples

	Storage period, days		moisture mass fraction, %	water activity (aw), units.
	before package opening	after package opening		
Semi-smoked sausage made from cooled raw material	back-ground		56.8	0.9656
	30		55.9	0.9632
		15	46.1	0.9498
	45		55.8	0.9619
		10	49.3	0.9494
	54		54.8	0.9639
Semi-smoked sausage made from frozen raw material	back-ground		56.9	0.9669
	30		52.7	0.9628
		15	46.3	0.9564
	45		53.7	0.9646
		10	51.0	0.9517
	54		53.3	0.9631

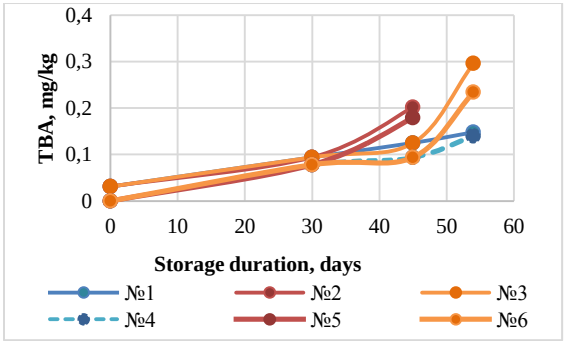
However, with these changes in moisture content, the apparent moisture separation in the package was not observed throughout the storage period. After package opening, moisture mass fraction in the sausages decreased a little faster. With that, a significant difference in the character of this loss for sausages made from cooled and frozen raw material was not observed.

During storage of the packed product for 54 days, a decrease in water activity, which corresponded to the change in moisture mass fraction, was observed: by 0.0017 units for sausages from cooled raw material and by 0.0038 units for sausages from frozen raw material. The change in pH value in the sausages upon storage had a tendency to rise both before and after opening and as a consequence, did not influence moisture loss in a product and strength characteristics of a finished product.

It is known that during storage of sausages containing fat, the oxidative processes occur both as a result of the contact with air oxygen and due to reaction with earlier absorbed oxygen. The data obtained upon detection of acid value (AV), peroxide value (PV) and thiobarbituric acid (TBA) value during storage of the semi-smoked sausages packed in the modified gas atmosphere increased compared to the initial (background) indices (Fig. 1).



a



b

Figure 1. Indices of sausage oxidative spoilage
a) AV; b) TBA;
1,2,3 – from cooled raw material; 4,5,6 - from frozen raw material;
1,4 – without package opening; 2,5 – opening on the 30th day; 3,6 - opening on the 45th day

It was established on the basis of the experimental data that on the 54th day of storage the standardized values for indicators of the oxidative spoilage were not exceeded in any tested sausage samples. However, the accumulation of the oxidation products occurred; the AV index increased from 1.37−1.60 (background) to 2.59–2.76 (the 54th day of storage) mg KOH. However,

the thermal condition of the initial raw material did not significantly affect the indicators of oxidative spoilage. The investigations showed that after opening a package of the sausages that were stored in it for 45 days and additionally in air for 10 days, the AV indices as well as the quantity of secondary oxidation products, which were characterized by AV and TBA indices, did not exceed the established norm.

The results of the physico-chemical and structural-mechanical investigations showed that upon storage of semi-smoked sausages in the modified gas atmosphere, some changes in moisture mass fraction, pH, water activity, indices of oxidative and microbiological spoilage occurred. However, the thermal condition of meat raw material used for their production practically did not affect these indices.

Storage of produce after package opening also confirmed that the thermal condition of used meat did not significantly affect the dynamics of changes in microbiological and physico-chemical indices.

It is known that carbon dioxide, which has a bactericidal action on microorganisms, is used as a modified atmosphere in storage of sausage products in order to ensure their microbiological safety [3, 4]. In this connection, the risks associated with meat product safety and quality can be related to instability of gas composition in a package during storage. Taking into consideration the solubility of carbon dioxide in water and fat [5], we studied the dynamics of changes in gas composition in a package of meat products (cooked and semi-smoked sausages) with different water content during their storage (Table 2).

Table 2. Changes in carbon dioxide concentration in a package of sausages with different water content during storage

Storage period, days	carbon dioxide concentration in a package, %	
	cooked sausage	semi-smoked sausage
background	18.5	18.8
7	9.4	13.1
14	8.2	12.2
21	7.5	11.9
28	6.6	10.7
36	5.7	9.6
45	-	8.9
54	-	7.8

According to the obtained data, the highest rate of carbon dioxide dissolution was observed during the first 7 days of storage. It is necessary to notice that the rate of decrease in carbon dioxide proportion was higher in the cooked sausage samples. Reduction of this gas proportion as a result of its solubility in water influenced the insignificant drop in pH value after 7 days of storage (Fig.2).

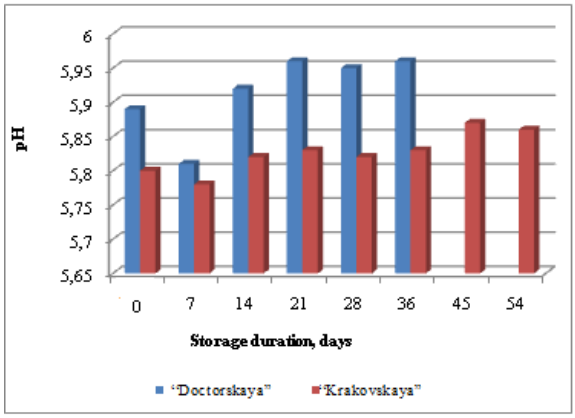


Figure 2. pH values of sausages during storage

However, in the process of further storage, the pH value increased by 0.06-0.15 units for cooked sausage and by 0.004−0.09 units for semi-smoked sausage.

In addition, carbon dioxide solubility resulted in a slight reduction of moisture mass fraction (not more than 2.0%) (Fig. 3).

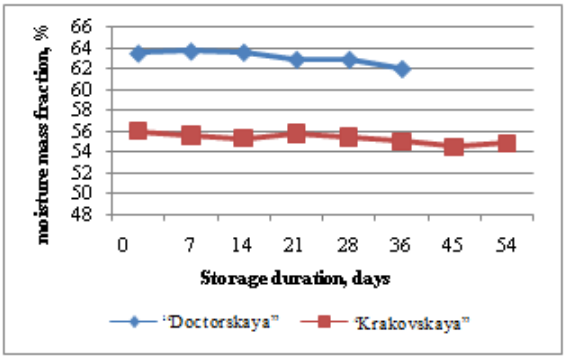


Figure 3. Moisture mass fraction in sausages during storage

It is known that physico-chemical changes occurring during storage in the presence of carbon

dioxide affect sausage product color. During storage, color characteristics of sausages were changed, which was expressed in decrease in lightness (by 12 % for cooked sausage "Doktorskaya" and 0.2 % for semi-smoked sausage "Krakovskaya") and increase in yellowness (by 37 % for cooked sausage "Doktorskaya" and by 56 % for semi-smoked sausage "Krakovskaya") (Fig.4).

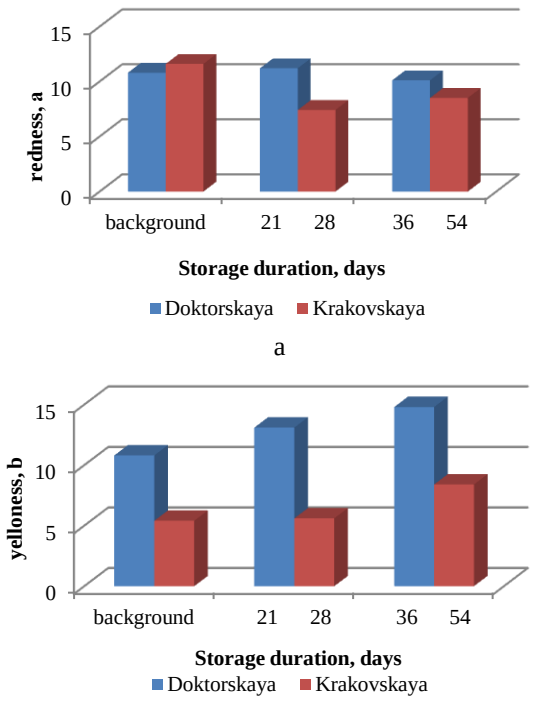


Figure 4. Color indices of tested sausages
a) redness; b) yellowness

Despite changes in color as a result of the oxidative processes upon storage, the experimental data showed that on the 36th day of cooked sausage storage and on the 54th day of semi-smoked sausage storage, the established standardized values for oxidative spoilage indicators (peroxide value 10 mmol of active O_2, acid value − 4 mg/kg) were not exceeded in any tested sausage sample, although the accumulation of these products occur.

IV. CONCLUSION

According to the results of the performed investigations, packaging of cooked and semi-smoked sausages in the conditions of a modified atmosphere containing 20% of carbon dioxide does not negatively affect the product quality throughout a storage period with some exceptions related to changes in color characteristics. Thus, it is possible to ensure safety and quality of packed meat products provided that there is compliance with recipes, technological regimes of production and storage of sausage products with different moisture content irrespective of the initial thermal condition of raw material.

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