ASSESSMENT OF SODIUM CHLORIDE EFFECT ON THE COMPOSITION OF FATTY ACIDS AND VOLATILES IN BACKFAT

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Abstract – Manufacture of meat products with prolonged shelf life has been gaining high topicality. Shelf life extension can be achieved by different ways including high doses of salt having a bacteriostatic effect. However, the risks of deteriorating quality and safety of sausage products can be associated not only with microbiological but also with oxidative changes in fat. Therefore, the aim of this research was to study an effect of different sodium chloride doses on the composition of fatty acids and volatiles that determine meat product flavor and characterize the degree of fat hydrolysis and oxidation in meat products that contain backfat. An analysis of the composition of volatiles and etherified fatty acids identified in salted backfat allowed studying accumulation dynamics of hydrolysis and oxidation products depending on the concentration of sodium chloride. It was established that backfat salting in the presence of 2.0 and 3.5% of sodium chloride led to a decrease in the proportion of secondary oxidation products with respect to the total amount of volatiles. However, sodium chloride in higher doses acquires the pro-oxidant properties initiating generation of saturated fatty acids and their oxidation with formation of carbonyl compounds.

Key Words – sodium chloride, backfat, volatiles.

I. INTRODUCTION

High attention to the problem of fat oxidation in meat products is mainly associated with the fact that oxidative processes affect formation of quality and safety of meat and meat products, cause changes in the nutritive value and organoleptic indicators (deterioration of color, taste, consistency and appearance of off-odor), and reduce product shelf life. A significant role in generation of oxidative products play non-meat recipe ingredients that are used to attain the necessary technological properties of meat and organoleptic characteristics of finished products. Salt is an essential component of all meat product types and its impact on oxidative changes in fats is quite significant. Despite a great number of studies on quality and safety formation in meat products during salting [1-3], the available literary data concerning a salt effect on the mechanism of the oxidative processes are rather contradictory.

The aim of this research was to study an effect of different sodium chloride doses on the composition of fatty acids and volatiles that determine the flavor of meat products and characterize the degree of fat hydrolysis and oxidation in meat products that contain backfat.

II. MATERIALS AND METHODS

Backfat from pork of the 2nd category (White Large females at the age of 2 years) was taken as a subject of research. Backfat was minced in a grinder through plates with a hole diameter of 2-3 mm and salted with sodium chloride in amounts of 0.0, 2.0, 3.5 and 5.0 %.

After that, backfat was divided into 2 batches: the first batch was stored at a temperature of 4±2 °C for 1 and 3 days, the second one was vacuumed and cooked in a water bath at a temperature of 80 °C for 40 min. Then it was cooled and stored at a temperature of 4±2 °C for 1 and 3 days.

The composition of volatiles was analyzed in all backfat samples using the gas chromatograph 7890A with the mass selective detector 5975C VLMSD (Agilent Technologies, USA).

To detect the maximum amount of chemical substances responsible for backfat aroma with the mixture component content more than 0.001 %, the method of liquid extraction was used with the following methylation of lipids and analysis by chromatography - mass spectrometry.
The Folch extraction (1:1) with chloroform-methanol followed by methylation with a solution of acetyl chloride in methanol was used.
The content of flavor components, chemical names of which are presented according to the IUPAC classification, was calculated using the automated system for data search and identification NIST 08 MS Library with the peak match probability of more than 65%.
Fatty acid composition was detected by gas chromatography using the flame ionization detector.
The sensory analysis was carried out on the VOCmeter of AppliedSensor Company (Germany), which included 8 QMB sensors and 4 MOS sensors. The data were processed using the software package Argus, version 2.4.8.1.

III. RESULTS AND DISCUSSION

The sensory analysis of the test samples of backfat using the VOCmeter electronic nose allowed a quantitative evaluation of the odor intensity in the samples salted with different salts based on an assessment of their visual fingerprint areas. The comparative analysis of the visual fingerprints showed that addition of sodium chloride led to an increase in the visual fingerprint areas (Fig.1), and, consequently, the odor intensity. Salt addition in an amount of 5.0% promoted an increase in volatiles by 48% compared to unsalted backfat.
An analysis of the qualitative composition of volatiles enabled identification in backfat of more than 400 compounds, which belonged to different classes of organic substances: aliphatic and aromatic hydrocarbons, alcohols, carbonic acids, amino acids, aldehydes, ketones, lactones, aliphatic amines, amides, nitriles, heterocyclic compounds (piperidines, pirasins, pyridines, furanic compounds, thiophenes, thiols, quinolines, pyrrols, oxazoles, imidazoles, indoles) and their derivatives.

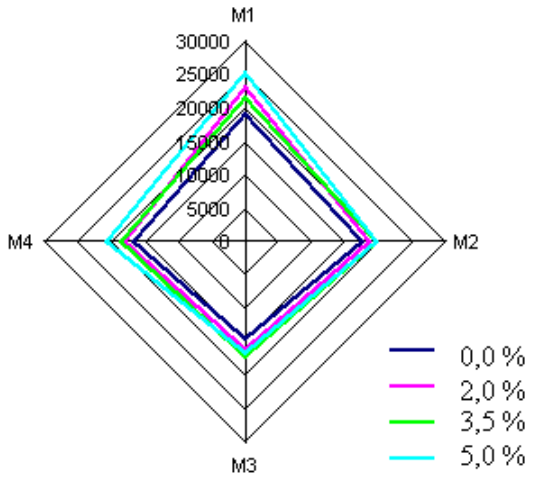

Figure 1. The visual fingerprint areas of salted backfat depending on sodium chloride doses

Considering the morphological composition of backfat represented mainly by fatty tissue, an analysis of lipid oxidation products (aldehydes, ketones, lactones, oxyacids and different products of polymerization) was of special interest. The total quantity of identified volatile carbonyl compounds (aldehydes, ketones and lactones) was more than 80 items, of which heterocompounds were identified in the largest quantities (up to 0.1-0.6%). However, their mass fraction in the total mixture of volatiles was insignificant (less than 0.5%) except for a sample of backfat salted with sodium chloride in an amount of 5.0% after thermal treatment. The mass fraction of aldehydes and ketones in this sample was more than 8.0%, which can suggest more profound oxidation processes in a sample. It is necessary to note that thermal treatment led to a slight reduction in the quantity of ketones and aldehydes for backfat samples salted with salt in an amount of 2.0 and 3.5%.
Taking into consideration the fact of the insignificant amino acid content in backfat, we identified not more than 1.5% of heterocyclic compounds of the total amount of volatiles.

However, the total amount of heterocycles identified in backfat before and after thermal treatment included more than 150 items (of which more than 40 items were heterocyclic ketones), mainly the derivatives of pyridines, pyrimidines, indoles, imidazoles and quinolines).

As regards formation of meat aroma in thermally processed products, much attention is usually given to the following heterocycles and their derivatives: furans, thiophenes, thiazoles and pirasins. However, these compounds were represented in the composition of volatiles of the tested samples in an insignificant amount, which can be explained by quite a limited content of amino acids and sugars in pork backfat. Independent of storage duration of the backfat samples under investigation, a decrease in the oxidation product proportion was observed when adding sodium chloride in an amount of 2.0%, and this tendency remained when a salt dose was increased up to 3.5%. However, sodium chloride addition in large quantities (up to 5.0%) led to a significant increase in an amount of hydrocarbons, ketones, aldehydes, alcohols and heterocyclic compounds, which was accompanied by a reduction in the proportion of carbonic acids as a result of their oxidation (Fig.2).

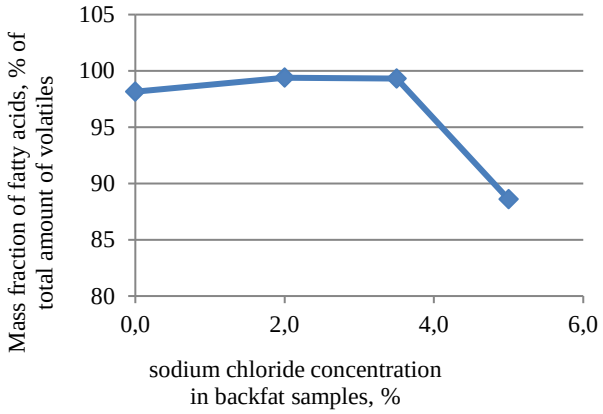

Figure 2.Dynamics of changes in mass fraction of fatty acids in the composition of volatiles depending on sodium chloride concentrations

For a more detailed analysis of a salt effect on the qualitative and quantitative composition of fatty acids in backfat as a result of their oxidation, the fatty acid composition was determined. Salting backfat with sodium chloride in an amount of up to 3.5% led to an increase in the content of polyunsaturated fatty acids compared to the unsalted sample (Fig.3). A further increase in the salt concentration up to 5.0% led to a decrease in an amount of polyunsaturated fatty acids as a result of their oxidation and an increase in an amount of saturated fatty acids.

Heat treatment and following backfat storage affected an amount of polyunsaturated fatty acids in the composition of fatty acids. For example, after cooking, the content of polyunsaturated fatty acids reduced by 0.9-1.9% (Fig. 4).

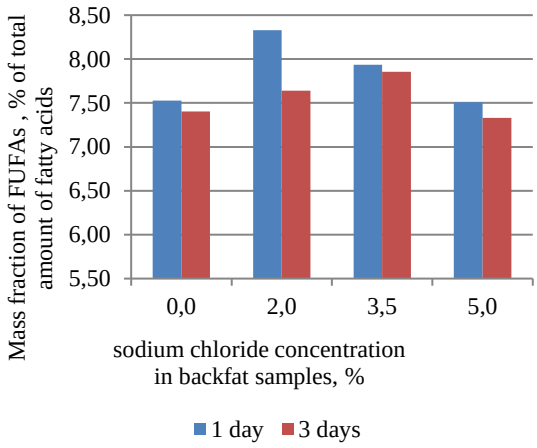

Figure 3. Dynamics of changes in mass fraction of fatty acids in backfat depending on sodium chloride concentrations and storage duration

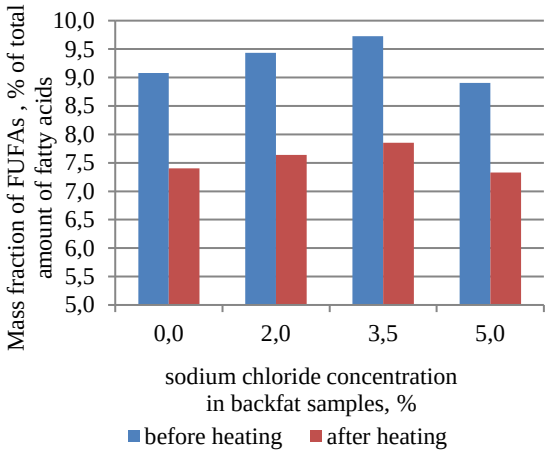

Figure 4. Dynamics of changes in mass fraction of fatty acids in backfat depending on sodium chloride concentrations and heat treatment

IV. CONCLUSION

Addition of high doses of sodium chloride up to 5.0% accelerates the oxidative changes in backfat in meat products produced both without and with heat treatment and initiates generation of oxidative products (ketones, aldehydes and oxyacids) responsible for appearance of unpleasant odor in fatty raw material. Therefore, the use of sodium chloride in high doses requires substantiation of shelf life not only with regard to microbiological indicators but also with regard to indicators of oxidative spoilage.

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