

CONTENT CHANGES OF NATRIUM CHLORIDE AND NITRATES DURING MATURATION PERIOD IN FERMENTED SAUSAGES¹

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ABSTRACT

The paper presents the dynamics of changes in the content of sodium chloride and nitrates in fermented sausages produced in the local meat industry, from the beginning until the end of maturation period (3; 7; 14; 20-day). Sausages are produced using Glucon Delta Lactone (GDL) additive and starter cultures. The addition of sodium chloride and nitrates has great influence of the overall enzymatic process and of the achieved degree of ripening and drying. In relation to the content of salt, the produced sausages are in accordance with the production technology and in accordance with the Rulebook for Quality of the products produced outside our country.

Key words: ripening, sausages, nitrates, sodium chloride, quality

INTRODUCTION

Durable pork sausage, according to the Rules for the requirements in terms of quality of minced meat, meat preparations and meat products, (R.N.Macedonia, No. 63, 2013) belongs to the group of durable fermented sausages which are produced from I or II category pork and beef, solid fatty tissue, salt, substitute for salt, additives, spices, extracts of spices, sugar and starter culture.

Meat and the fatty tissue are basic raw materials which have a large influence on the consistence, fermentation process of maturation of the sausages and their nutritive value. The assortment of fermented sausages is quite developed, depending on the composition of the filling, the degree of chop of the components in the filling, the diameter of the casing, the seasonal production, and the duration of ripening, (Vuković, 2006).

¹ original scientific paper

Fermentation of sausages is a complex chemical-biochemical process of degradation of proteins, fats and carbohydrates, in which besides the enzymes of the muscles and fats, the enzymes of the added starter culture are part of the afore-mentioned processes as well (Žlender, 2001).

The formation of dye along with the mixing of the components to a full consistency, the pH change and the change of the taste and aromatization (alteration of taste and smell) happens throughout the process of maturation.

Sausage ripening is a dual-phase process. In the first phase, which is short-term but not very sensitive, fermentation results in carbohydrates within the lactic acid and dehydration. In the second phase, which is a long-term, organoleptic changes occur gradually with loss of water, which are considered as quite significant for the quality of the product (Čavlek & Mavračić, 1993).

Sodium chloride is an essential additive in fermented sausages, as it primarily participates in the formation of taste and viability of the product, increases the solubility of myofibrillar proteins, allows the binding of components in the filling to form the desired texture, increases the ability to reduce emulsification and the aw value.

The effect on fermentation varies which is due to the added amount of salt in the filling, i.e. the development of lactic acid bacteria, especially in sausages whose current microbiological stability is based on the action of lactic acid bacteria, (Čavlek & Mavračić, 1993).

On the other hand, nitrates and nitrites are an integral part of the brine and fulfil several functional properties regarding the fermented sausages. It is advisable to use nitrites in the form of "nitrite salt" for the brine.

In the initial stage of ripening, nitrites are especially important in terms of the microbiological stability of sausages, emphasizing their inhibitory effect on the development of pathogenic bacteria, participation in the formation of taste, color and texture; moreover those nitrites take part in irreversible reactions.

MATERIAL AND METHODS

The material in the researches were durable pork sausages produced in industrial conditions according to standard recipe in the factory for meat "MIK" – Sveti Nikole in the Republic of N.Macedonia.

Three different series were produced:

Group A (40% first category pork meat (thigh), 40% second category pork meat (shoulder blade), 20% firm fatty tissue (back bacon) and Glucon delta-lacton (13g/50kg).

Group B (40% first category pork meat (thigh), 40% second category pork meat (shoulder blade), 20% firm fatty tissue (back bacon) and freeze-dried starter culture Bactoferm F-SC-111, Chr. Hansen (30g/50kg).

Group C (40% first category pork meat (thigh), 40% second category pork meat (shoulder blade), 20% vegetable fat (palm fat) and freeze-dried starter culture Bactoferm F-SC-111, Chr. Hansen (30g/50kg).

The starter culture was mixed culture with *Lactobacillus sakei* and *Staphylococcus carnosus*. The following additives were used: nitrite curing salt (2.2%), sodium erythorbate (0.05%), dextrose (0.5%), grinded pepper (0.025%), garlic in powder (0.015%) and a mixture of spices “Koleks” for durable pork sausage.

Every group of products was produced in three repeated series in a quantity of 50 kg. Seven samples of each group during the three repeated series (at the day of filling, at the 3rd, 7th, 14th and 20th day of the ripening) were taken for examination.

Technological process of production

The temperature of the pork meat before the chopping was -3. 2°C, - 11 °C of the firm fatty tissue (Group A and B). The frozen meat and the fatty tissue were chopped in pieces of 10 cm, and then chopped again with granulation of 10 mm. To the chopped mixture with temperature of -3 °C, spices and GDL (Group A) and starter culture (group B) were added.

Then, the filling was additionally chopped and mixed with granulation of 3 mm for a period of 2-3 minutes. After the chopping, the temperature of the prepared filling was -2. 5 °C. The prepared filling was then filled with vacuum machine in collagen skin with a diameter of 36 mm. The filled sausages were hanged on metal rails and washed with cold water and then, were transported to thermo-chambers where they were drained for 24 hours at a temperature of 16 °C. Then, there was a phase of smoking for 12 hours at a temperature of 15-20 °C, and relative humidity of 95%.

After the smoking, the sausages were left to ripening to the 20th day, with two more phases of smoking at the 7th day of their ripening, for 5 to 10 hours (5 hours of smoking with 5 hours of pause), at a temperature of 18 °C and humidity of 82% and at the 14th day of their ripening for 5 hours at a temperature of 14 °C and relative humidity of 75%.

RESULTS AND DISCUSSION

The changes of the salt content throughout the period of fermentation and maturation are shown in Table 1 and Graph 1. The salt content of the examined product series at the end of the maturation process is consistent with the technology for production of tea sausages, respectively with the Rulebook for Quality of Meat Products. As of the presented results it is observed that there is a tendency of increase of the percentage of salt

during the ripening period. The amount of salt is almost equal to the amount of salt in the brine at the filling day for all three production series. A minimal increase is being determined on the 3rd day. The content of salt on the 7th day for the production series (A; B; C) appears as: $2.42 \pm 0.13\%$; $2.51 \pm 0.16\%$; $2.56 \pm 0.11\%$.

An increase of the content of salt is determined on the 14th day of filling as a result of the increased content of water and increased content of dry matter, therefore its ratio is: $2.93 \pm 0.09\%$; $2.79 \pm 0.16\%$ and $2.69 \pm 0.13\%$ in all three product lines.

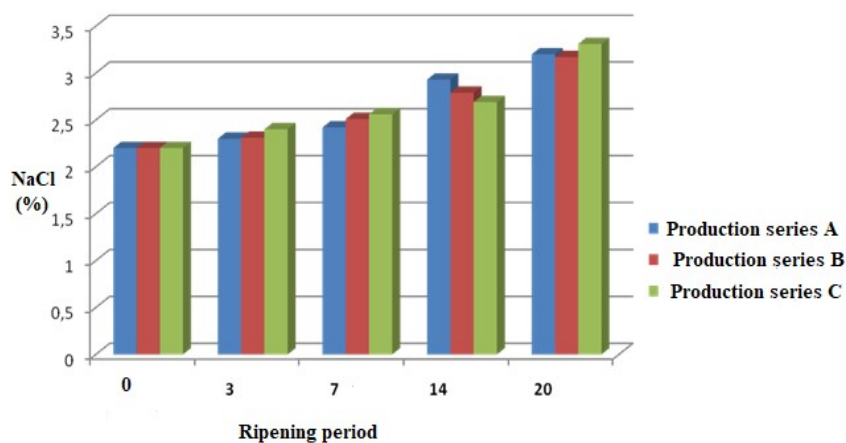
At the end of the ripening process, the process the content of salt in tea sausages in three product series (A; B; C) appears as: $3.20 \pm 0.14\%$; $3.17 \pm 0.14\%$; $3.31 \pm 0.20\%$.

Table 1 Content changes of Natrium chloride during maturation period in fermented sausages (%)

Production series	A			B			C		
Parameters (mg/100g)	$\bar{x}$	Sd	Cv	$\bar{x}$	Sd	Cv	$\bar{x}$	Sd	Cv
Filling day	2.20 ± 0.13	0.41	18.70	2.20 ± 0.15	0.49	18.80	2.20 ± 0.16	0.50	18.82
3rd	2.30 ± 0.17	0.54	23.38	2.31 ± 0.17	0.53	23.38	2.40 ± 0.14	0.44	18.41
7th	2.42 ± 0.13	0.42	17.46	2.51 ± 0.16	0.46	18.63	2.56 ± 0.11	0.35	13.86
14th	2.93 ± 0.09	0.28	9.35	2.79 ± 0.16	0.46	16.39	2.69 ± 0.13	0.41	15.07
20th	3.20 ± 0.14	0.45	14.09	3.17 ± 0.14	0.44	13.77	3.31 ± 0.20	0.63	19.07

$$*F_{0,05} = 3.55 / p < 0,05$$

$$F_{0,01} = 6.01 / p < 0,01$$



As from the results in Table 2 the decrease in the content of nitrites during the production process of sausages can be seen in the production series A, such as from the values of 1.01 mg to 0.99 mg, respectively up to 0.95 mg on the 7th day of maturation, 0.90 mg on the 14th day or 0.87 mg at the end of the production process.

The same dynamics of decrease of nitrite content in sausages is seen in the production series B, such as on the 3rd day of maturation from 1.02 mg nitrite content decreases to 1.00 mg, on the 7th and the 14th day it decreases from 0, 97 to 0.94 mg, and on the 20th day it decreases to 0.90 mg / 100gr.

As for C production series of sausages the content of nitrites on the filling day is 1.00 mg; on the 3rd day of filling appears as 0.98 mg; on the 7th day it appears as 0.95 mg; on the 14th day appears as 0.91 mg; down to 0.88 mg at the end of the ripening process, i.e. on the 20th day Graph 2.

The identified differences in nitrite content at functionally fermented sausages from all three series of products result as not statistically significant ($p < 0.05$).

The dynamics of nitrite reduction is the same at all three production series. The most remarkable reduction is seen on the 7th day. During this period nitrates bind to myoglobin, forming nitrosyl myoglobin which is important for stabilizing the attractive red color of sausages.

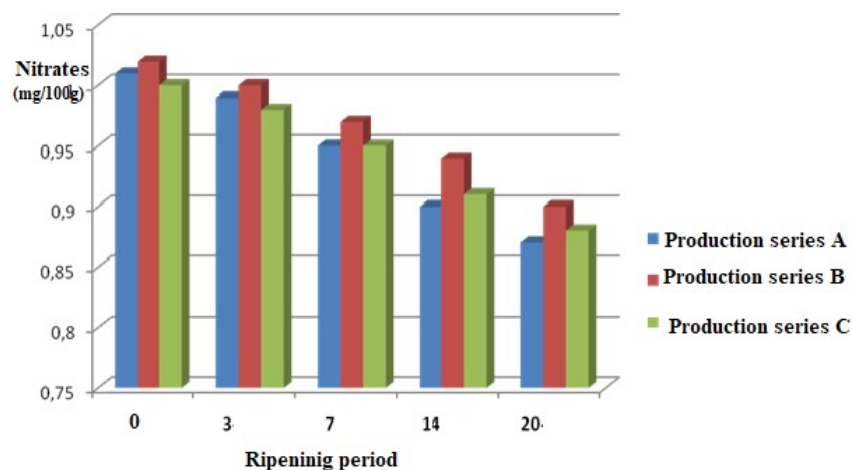
The reduction on the 7th day to the end of the ripening process is subsequent from the oxidative processes during fermentation process.

Table 2 Content changes of nitrates during maturation period in fermented sausages (mg/100g)

Production series	A	B	C
Parameters (mg/100g)	$\bar{x}$	$\bar{x}$	$\bar{x}$
Filling day	1.01±0.01	1.02±0.01	1.00±0.01
3rd	0.99±0.01	1.00±0.01	0.98±0.01
7th	0.95±0.01	0.97±0.01	0.95±0.01
14th	0.90±0.01	0.94±0.01	0.91±0.01
20th	0.87±0.01	0.90±0.01	0.88±0.02

* $F_{0,05} = 3.55 / p < 0,05$

$F_{0,01} = 6.01 / p < 0,01$



The results obtained for the content of salt and nitrites in fermented sausages correlate with the results of the following authors:

Petrović et al., (2011), stated that the traditional fermented sausages contain salt ranges from 3.01% to 3.28%, which is lower than the salt content in the fermented sausages from the research conducted by (Casiraghi et al., 1996; Tojagić, 1997; Moretti et al., 2004).

In the Italian traditionally fermented sausages Botilio (Lorenzo et al., 2000; Comi et al., 2004), confirmed similar level of salt content such as $3.37 \pm 0.06\%$, which is lower than the Spanish Chorizo cebolla (Salgrado et al., 2006) and the Croatian fermented sausages (Gasparik-Reichardt et al., 2005).

According to the research of Vranić et al., (2009), the content of NaCl in the tested products from the group of fermented sausages is $2.61 \pm 0.38\%$ less than the results of this research. However Zanardi et al., (2004), confirmed NaCl content from: $3.2 \pm 0.1\%$ to $4.7 \pm 0.1\%$, in seven types of Italian traditional fermented sausages, which is in accordance to the values expressed in this research.

Vesković-Moraćanin et al., (2011) determined salt content from 3.65% to 3.96% in fermented sausages.

Mandić et al., (2010) stated that the salt content on tea sausage ranges from 2.8% to 4.8%.

Žlender and Gašperlin (2005), based on the study of meat products from the Slovenian meat industries, determined up to 5% of salt in dry fermented sausages, which is remarkably higher than the results in this research.

Certain differences in the content of salt and nitrites that occur in the results of this study and the results with in which the comparison is observed are a consequence of the different technology in the production of fermented sausages and the consumption demand in different regions and producers.

CONCLUSIONS

Sodium chloride is an essential ingredient in sausages, as it is contributing primarily into the formation in the taste and aroma of the product. According to the results obtained a regular fermentation flow is determined, proper ripening and authentic sensory characteristics for fermentation of sausages. During the whole production process an increase is confirmed regarding the percentage of salt during the ripening to all three production series.

The decrease of nitrite is considered as a positive result according to the recommendations of the World Health Organization which accepts a daily intake of nitrites not higher than 0.2 milligrams per kilogram of body weight.

In relation to the content of salt, the produced sausages are in accordance with the production technology and in accordance with the Rulebook for Quality of the products produced outside our country.

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