INFLUENCE OF VEGETABLE ADDITIVES TO THE FORMATION OF COLOR IN HOT SMOKED SAUSAGES DURING RIPENING

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Raw materials of vegetable origin were used to increase the biological value of meat products. The parsnips, parsley and celery roots were lyophilized and the changes in their chemical composition were determined. The hot-smoked sausages were manufactured with the amount of 3 % of different lyophilized and rehydrated vegetables and 1 % NaCl. Prior to thermal processing, the sausages were ripened for 10 h, at 8 - 10 °C. By adding lyophilized vegetables sausages were enriched with nitrates. The highest additional yield of nitrates (17.59 mg/kg) was determined in the sausages with celery added. The changes of nitrate and nitrite during the manufacturing process were identified using the reducing cadmium column and was variating due to the vegetable species. The changes in sausage color during ripening were evaluated determining L* a* b* values. It was found that during the manufacturing process sausages became redder (a* value increased) and lighter (L* value increased). The results show that the red color formation process took place in tested sausages. The glutamic acid content in sausages remained unchanged during ripening process; i. e. the determined amount of glutamic acid was in line with the content, found in row meat (~ 9 mg/100 g).

Key Words – celery, parsley, parsnip, sausage ripening.

I. INTRODUCTION

Recently, the changing attitude of consumers to nutrition problems promotes the development and production of new foods with less salt, fat, cholesterol, synthetic food additives, as well as enriched by biologically active compounds. One of the solutions of this problem is to use vegetables, what allows to replace some synthetic food additives and to enrich meat products with fibers, minerals and vitamins. Vegetables chosen for this experiment were the following: parsleys - contain vitamins C and E, β - carotene, thiamine, riboflavin [1]; celery - contain vitamin C (32 mg/100g) and vitamin A (0.207 mg/100 g), and they are a great source of potassium (280 mg/100 g) [2], parsnips - contain a considerable amount of calcium, magnesium and phosphorus [3]. Lyophilization was used for water removal from vegetables, because this processing method allows remaining all biological active ingredients in the product [4].

Along with these substances some nitrates were added in the sausages for preserving and color formation of the product.

II. MATERIALS AND METHODS

Lyophilization of vegetables: washed, peeled and chopped celery, parsley and parsnip roots were frozen to minus 18 ^{o}C temperature. Frozen vegetables were dried using a vacuum of 4.0 mbar, which at the end of drying was reduced to 0.50 mbar. Lyophilized vegetables were crushed to powder-like consistency.

Production of hot smoked sausage: sausages were made from ground pork ham with 3 % lyophilized parsnips, parsley and celery after rehydrating vegetables with water (ratio 1:7). 1 % salt (NaCl) was also added to all sausages. The control product, with no added vegetables, contained 1 % NaCl, and 7 % water. Before heat treatment, sausages were ripened for 10 h, in 8 - 10 °C temperature. Sausages were hot smoked in an universal thermal camber ,,Bastra ".

The chemical composition of lyophilized vegetables was determined: moisture content by drying [5], protein content by the Kjeldahl method [6], fat content by extraction with chloroform [7] and mineral content by burning a sample at 660 °C [8].

The reducing column of cadmium and sulphanilamide and N-1-naphthylethylendiamine dihydrochloride reagents was used to determine the levels of nitrites and nitrates in sausages during the technological process.

Photometric measurements were made with a spectrophotometer (Spectronic 20 Genesys) at a wavelength of 538 nm.
Color was measured by a chroma meter (CR-410 Konica Minolta). Color was evaluated using the Commission Internationale de l'Eclairage (CIE) L* (lightness), a* (redness), and b* (yellowness) system.
L - glutamic acid content was determined by an enzymatic colorimetric method (R-Biopharm) [9].

III. RESULTS AND DISCUSSION

In Table 1 the chemical composition of lyophilized vegetables determined in this work is compared with the composition of raw vegetables, which was found in literature. As it could be expected the dry matter content significantly increased in vegetables after lyophilization. The highest content of protein (11.79 ± 0.07 %), as well as minerals (10.3 ± 0.49 %) was accumulated in lyophilized celery. Slightly lower amount of these compounds was found in lyophilized parsley and parsnip. These results show that it is possible to enrich meat products with proteins, carbohydrates, minerals, as well as reduce their energetic value, by using examined lyophilized vegetables in the production of sausages.

Table 1 Chemical composition of raw and lyophilized vegetables

Product	Moisture, %	Proteins, %	Fat, %	Minerals, %	Carbohydrates, %
Celery					
raw	87.4	1.3	0.3	1.1	7.3
lyophilized powder	9.67 ± 0.06	11.79 ± 0.07	1.6 ± 0.16	10.3 ± 0.49	66.89
Parsley					
raw	82.6	2.6	0.5	1.5	9.7
lyophilized powder	6.11 ± 0.21	8.20 ± 0.01	1.67 ± 0.06	4.16 ± 0.05	79.86
Parsnip					
raw	83.0	1.4	0.2	1.3	10.5
lyophilized powder	5.28 ± 0.06	9.05 ± 0.10	1.98 ± 0.07	5.45 ± 0.15	78.24

During natural growth conditions, many vegetables accumulate a significant amount of nitrates. It depends on the vegetables species, growing conditions and fertilizer application method. Therefore by adding vegetables into sausages we increase the amount of nitrates/nitrites as well. Nitrite/nitrate levels in sausages with added lyophilizes vegetables were determined before ripening, after 3 h, 6 h and 10h of ripening.
In the control sausage without vegetable additives, no nitrate and nitrite were found. The maximum additional amount of nitrates (17.59 mg/kg) was determined in the sausages with celery added. This product contained the highest nitrate levels and at all stages of ripening. The changes in nitrate content in other sausages, which occur during ripening are seen in Figure 1.

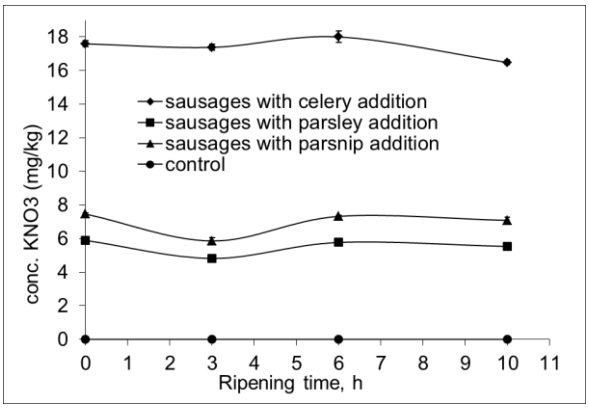


Figure 1. Changes in KNO_3 content during ripining of sausages with different vegetables added

No nitrites were found in stuffed sausages with vegetables after ripening for 3 hours, then the volume of nitrites increased rapidly due to the decomposition of nitrate.

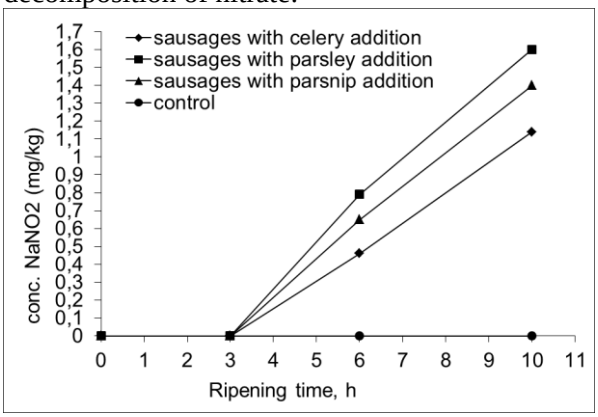


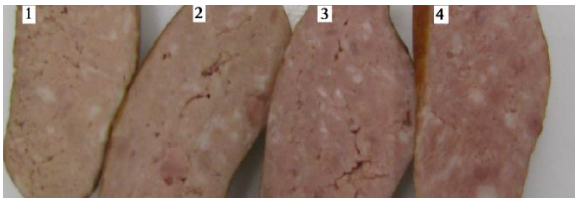
Figure 2. Changes in $NaNO_2$ content during ripining of sausages with different vegetables added

The greatest amount of nitrite was determined in sausages with parsley and the smallest – in sausages with celery (Fig. 2).
Color evaluation of sausages during ripining showed the following results: a* value (pink) changed from yelower to redder, and L* (lightness) value changed from darker to lighter.

Table 2 Influence of ripening time on L* (lightness), a* (redness) and b* (yellowness) values of sausages

	Ripening time, h	L*	a*	b*
Control	before ripening	61.90 ± 0.47	11.80 ± 0.14	12.60 ± 0.35
	after ripening	60.69 ± 0.17	16.86 ± 0.25	11.95 ± 0.27
Sausages with parsnip addition	before ripening	58.23 ± 0.39	11.87 ± 0.19	14.72 ± 0.18
	after ripening	62.36 ± 0.24	17.76 ± 0.12	14.38 ± 0.62
Sausages with parsley addition	before ripening	58.04 ± 0,12	12.30 ± 0,02	14.88 ± 0,13
	after ripening	61.12 ± 0.35	17.29 ± 0.12	12.91 ± 0.32
Sausages with celery addition	before ripening	60.51 ± 0.35	12.01 ± 0.49	15.18 ± 0.30
	after ripening	66.30 ± 0.04	16.30 ± 0.05	12.80 ± 0.04

These results indicate that the process of sausages color formation take place. The formation of specific color in the sausages with parsnip within 10 hours of ripening can be seen in Figure 3.



1-before ripening; **2** – after 3 h; **3** – after 6 h; **4** – after 10 h

Figure 3. Ripening time influence on sausages with parsnip addition colour

It was also determined that the levels of glutamic acid in the control sausage (16 mg/100 g), remained unchanged after 10 h of ripening. This level matched the amount of glutamic acid found in raw pork (~ 9 mg/100 g) [10]. From these data we can conclude that the aging conditions were not favourable for proteolysis processes during production of sausages.

IV. CONCLUSION

By using lyophilized root vegetables in sausage manufacturing we can enrich products with vegetable proteins, minerals, fiber, vitamins, change their biological value, as well as influence the quality characteristics of the final products.

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