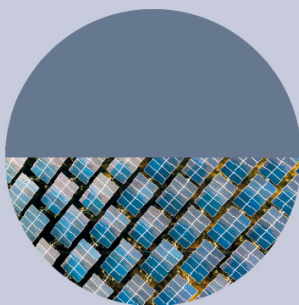


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The nitrite content in domestic and foreign cooked sausages from the Serbian market

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Abstract. The nitrite content (expressed as NaNO₂) was measured in 236 samples of different types of domestic and foreign cooked sausages from the Serbian market, according to standard ISO procedure. The highest content of nitrite (expressed as NaNO₂) was found in fine comminuted cooked sausages from foreign producers. Similarly, the coarse comminuted cooked sausages from foreign producers contained higher nitrite compared to domestically produced cooked sausages. According to National and EU Regulations, the maximum allowed nitrate content (expressed as NaNO₂) is 150 mg/kg. All tested cooked sausages had nitrite levels below the regulatory limits set by National Regulation and Regulation (EC) No. 601/2014, but the highest nitrite contents were found in cooked sausages from foreign producers.

1. Introduction

Nitrites are one of the most important additives in the meat industry because of their beneficial effect on the quality and microbiological safety in meat products. Nitrite has been used for preservation of meat products (sausages, ham, bacon) and is an efficient inhibitor of the growth of pathogenic bacteria (*Clostridium botulinum*, *Listeria monocytogenes*, *Bacillus cereus*, *Staphylococcus aureus* and *Clostridium perfringens*) [1-2] and, thereby, decreases the risk of *Clostridium botulinum* producing toxins [3]. However, nitrite provides the processed meat with its sensory characteristic (color and aroma) and it inhibits lipid oxidation processes [4]. On the other hand, the major concern of nitrites in meat products is related to the potential of nitrites to form carcinogenic compounds. Over the past several decades, the nitrite content in different meat products was evaluated [5-9]. Nitrite contents of foodstuffs should be monitored in the context of dietary intake and to provide insights into new manufacturing meat technologies.

The aim of this study was to determine the nitrite content in cooked sausages (fine and coarse) from domestic and foreign producers in the Serbian market.

2. Materials and Methods

A total of 236 samples of different types of cooked sausages (fine and coarse comminuted cooked sausages) were obtained from different producers (domestic and foreign); sausages were available on the Serbian market. The nitrite content (mg/kg) was determined according to standard ISO procedure [10] and expressed as NaNO₂. The cooked sausages were sampled and homogenized in a Braun



CombiMax 600 homogenizer (Braun, Germany) and analyzed immediately. The nitrite content of different type of cooked sausages was evaluated according to Regulation (EC) No. 601/2014 (Table 1).

Table 1. Nitrite content limits reported in Regulation (EC) No. 601/2014

Meat products	Nitrite legal limit (mg/kg)	Limit application
Non-heat- treated processed meat	150	Maximum amount that may be added during manufacturing.
Heat-treated processed meat	150	Maximum amount that may be added during manufacturing.
Only sterilized meat products ($F_0 > 3.00$)*	100	Maximum amount that may be added during manufacturing.
Traditionally cured meat products with specific provisions concerning nitrites and nitrates	50-180	Depends on product: Maximum added amount or maximum residual amount, residue level at the end the production process.

* F_0 -value 3 is equivalent to 3 minutes heating at 121 °C for *C. botulinum*

The statistical analysis of the results was performed using the GraphPad Prism version 7.00 software. The nitrite content of cooked sausages from the Serbian market were expressed as the mean \pm standard deviation and were subjected to analysis of variance (One-way ANOVA). The graphical presentation of nitrite content was performed using Microsoft Office Excel 2010.

3. Results and Discussion

The nitrite contents (expressed as NaNO_2) of the cooked sausages from domestic and foreign producers are shown in Table 2. The nitrite content in fine comminuted cooked sausages from domestic producers ranged between 3.13 mg/kg and 76.42 mg/kg. The mean content of nitrite in fine comminuted cooked sausages from foreign producers ranged between 6.42 mg/kg and 62.09 mg/kg. Similarly, mean content of nitrite in coarse comminuted cooked sausages from domestic producers ranged between 3.15 mg/kg and 33.97 mg/kg. The mean nitrite content in coarse comminuted cooked sausages from foreign producers ranged between 8.31 mg/kg and 58.73 mg/kg.

Table 2. Nitrite content (expressed as NaNO_2) in cooked sausages from the Serbian market (mg/kg)

Statistics	Type of sausages			
	Fine comminuted cooked sausages		Coarse comminuted cooked sausages	
	Producers		Producers	
	Domestic	Foreign	Domestic	Foreign
N*	136	32	56	12
Mean \pm SD	38.97 \pm 19.44	39.14 \pm 17.15	22.46 \pm 16.83	34.26 \pm 15.80

Standard error of Mean	2.37	4.95	9.71	3.95
Range (min-max)	3.13-76.42	6.42-62.09	3.15-33.97	8.31-58.73

*N – number of examined samples.

Reinik et al. [11] found the mean sodium nitrite contents in ham were 20.8 mg/kg. However, in our current study, the mean nitrite concentration in cooked sausages ranged between 22.46 ± 2.62 mg/kg and 39.14 ± 17.15 mg/kg. Öztekin et al. [12] presented the nitrite content in ham; 35.6 mg/kg. Stalikas et al. [13] reported that nitrite content in salami were 54 mg/kg. Thus, differences are more likely to be due to the manufacturing processes and different meat products. It was reported by Dennis et al. [9] that the mean nitrite content in bacon was 24.0 mg/kg. Siu and Henshall [14] reported the nitrite content in salami was 108.0 mg/kg.

The distribution of the nitrite contents is presented in Figure 1. The highest nitrite content was detected in fine and coarse communitated cooked sausages from foreign producers, means of 39.14 ± 17.15 mg/kg and 34.26 ± 15.80 , respectively. According to the Commission Regulation [15] and the National Regulation [16] nitrite content must be lower than 150 mg/kg. All tested cooked sausages met this regulation.

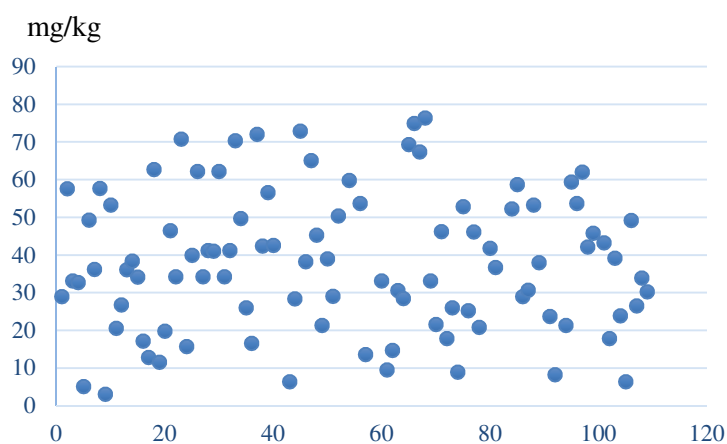


Figure 1. Distribution of nitrite content (expressed as NaNO_2) in cooked sausages from the Serbian market

Different countries have set their maximum limits for the addition of nitrite salts in meat products [7]. Under the Serbian National Regulation [16] the maximum nitrite (potassium or sodium salts) permitted is 150 mg/kg. Given the established antimicrobial effect of nitrite salts, its level should remain sufficient to prevent the growth of foodborne hazards. On the other hand, it is advisable to minimize dietary nitrite intake in light of nitrite's potential adverse health effects. Nitrite contents in the various cooked sausages were below the maximum allowable limit set by National Regulation [16] and Commission Regulation [15], but the actual amount of nitrite was higher in sausages from foreign than domestic producers.

Acknowledgements

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