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Original scientific paper

The presence of nitrites and nitrates in various type of meat semi-products intended for grilling from the Serbian market

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ABSTRACT

The aim of this study was to examine the presence of nitrites and nitrates in different types of meat semi-products prepared for the grill, in accordance with the national Regulation that prohibits their use. A total of 724 meat semi-product samples, including dry-aged steaks, fresh sausages, marinated meat, and various types of minced meat, produced by the Serbian meat industry between January 2021 and January 2023, were tested. The findings revealed that none of the tested samples showed the presence of either nitrites or nitrates, aligning with the Regulation's prohibition on their use in meat semi-product production, including those intended for grilling.

1. Introduction

Meat consumption has been an integral part of human diets for centuries, providing essential nutrients and contributing to cultural and culinary traditions. As modern food processing techniques have evolved, so too has the production and preparation of meat products. One popular preparation method is grilling, which imparts a unique flavour profile and texture. However, concerns have arisen regarding the presence in meat semi-products intended for grilling of some hazards, like nitrites and nitrates, as these compounds have been associated with potential health risks. Nitrites and nitrates are chemical compounds commonly found in various food products, including meat. These compounds have attracted considerable attention due to their potential health effects and their role in food preservation. Understanding the presence of nitrites and nitrates in meat products, particularly those intended for grilling and available in the Serbian market, is crucial for evaluating their impact on human health and the development of various diseases in the Serbian population, but also, the responsibility of producers of meat and meat products in Serbia. This paper aims to review the presence of nitrites and nitrates in different types of meat products intended for grilling in the Serbian market, emphasizing the implications associated with their consumption. Nitrites (NO_{2-}) and nitrates (NO_{3-}) are naturally occurring compounds found in soil, water, and certain foods. They are also used as food additives, primarily in meat products, due to their antimicrobial properties and their ability to enhance flavour, colour and preservation (*Honikel*, 2008). Nitrites play a critical role in preventing bacterial growth, particularly the growth of *Clostridium botulinum*, which is responsible for botulism, a

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potentially fatal form of food poisoning (*Sebranek & Bacus*, 2007). However, concerns have been raised regarding the potential adverse effects of nitrites and nitrates on human health. Numerous studies have suggested a potential link between excessive consumption of nitrites and nitrates and adverse health consequences. Nitrites can react with certain compounds in the stomach, leading to the formation of nitrosamines, which are known to be carcinogenic (*Goulas et al.*, 2021; *World Health Organization [WHO]*, 2010). Nitrosamines have been associated with an increased risk of various types of cancer, including stomach, oesophageal, and colorectal cancer (*Cross et al.,* 2010; *Loh et al*., 2020). Moreover, high levels of nitrites can interfere with the normal functioning of haemoglobin, reducing its oxygen-carrying capacity and leading to a condition called methaemoglobinaemia (*Mashima & Nakazato*, 2020). In the Serbian market, meat products for grilling are widely available, including various types of sausages, kebabs, and marinated cuts of beef, pork, and poultry. These products may vary in terms of their composition, quality and processing techniques, which can influence the levels of nitrites and nitrates present (*Katsanidis et al.*, 2015). Previous studies have investigated the levels of nitrites and nitrates in meat products from different regions, providing valuable insights into their occurrence and potential health risks (*Chiavaro et al.*, 2015; *Stajić et al.*, 2020). Investigating the presence of nitrites and nitrates in different types of meat products for grilling available in the Serbian market is essential to assess the potential risks associated with their consumption. By conducting a comprehensive review of existing literature and available data, this paper aims to contribute to the understanding of nitrite and nitrate levels in Serbian meat products for grilling and their implications for human health. According to the Serbian Regulation on the quality of ground meat, meat preparations and meat products (*Republic of Serbia*, 2019, 2023), nitrites and nitrates are not allowed to be used in the production of meat semi-products, which includes meat products intended for grilling.

2. Materials and methods

2.1 Reagents

All chemicals used, for nitrites and nitrates testing in meat semi-products intended for grill, were of analytical grade and were used as received without any further purification unless otherwise stated.

2.2. Meat Semi-products and Sample Preparation

In this study, a total of 724 meat semi-product samples, produced by the Serbian meat industry or imported (6 dry-aged steaks, 234 fresh sausages, 64 marinated meat products, 420 various types of minced meat intended for grilling), were obtained from different regions from the Serbian retail market during period January 2021 to January 2023 and were analysed for nitrite and nitrate presence. In most of the meat semi-products, all parameters of quality defined by the legislation were examined, and in a smaller number, analyses were carried out as per the client's request. All meat products were kept at refrigeration temperature and analysed within 48 h. If the analyses were not conducted on the same day, the samples were stored in a refrigerator at 4°C until required for testing. The analysed samples were warmed to room temperature and blended in a commercial kitchen blender unit (Homogenizer Blixer 2, Robot Coupe, Vincennes, France (2.9 L) 700 w, 3000 rpm). For each sample, two composite samples were prepared. All samples were then analysed in duplicate.

2.3. Determination of Nitrite and Nitrate Content

The content of nitrites and nitrates in tested meat products was determined according to the respective standard ISO procedures (*ISO*, 1975a, b) with a limit of quantification (LOQ) of 0.03 mg kg^{-1} for both parameters. A representative sample amount was measured using an analytical balance (Mettler, AE 200, USA). Following the analytical procedure provided in ISO standards, absorbance was measured using a spectrophotometer (GENESYS 10S Series UV-Visible Spectrophotometers). A procedural blank was run with every batch of samples.

2.4. Analysis and graphical presentation of results

The results analysis and graphical presentation of their distribution was performed using Microsoft Office Excel 2016.

3. Results

The results of determination of nitrites and nitrates presence in the tested samples of meat semi-products intended for grill are shown in Table 1. Also, distributions of samples by type of the meat product, and by presence of nitrites and nitrates in all samples, are graphically presented in Figures 1 and 2.

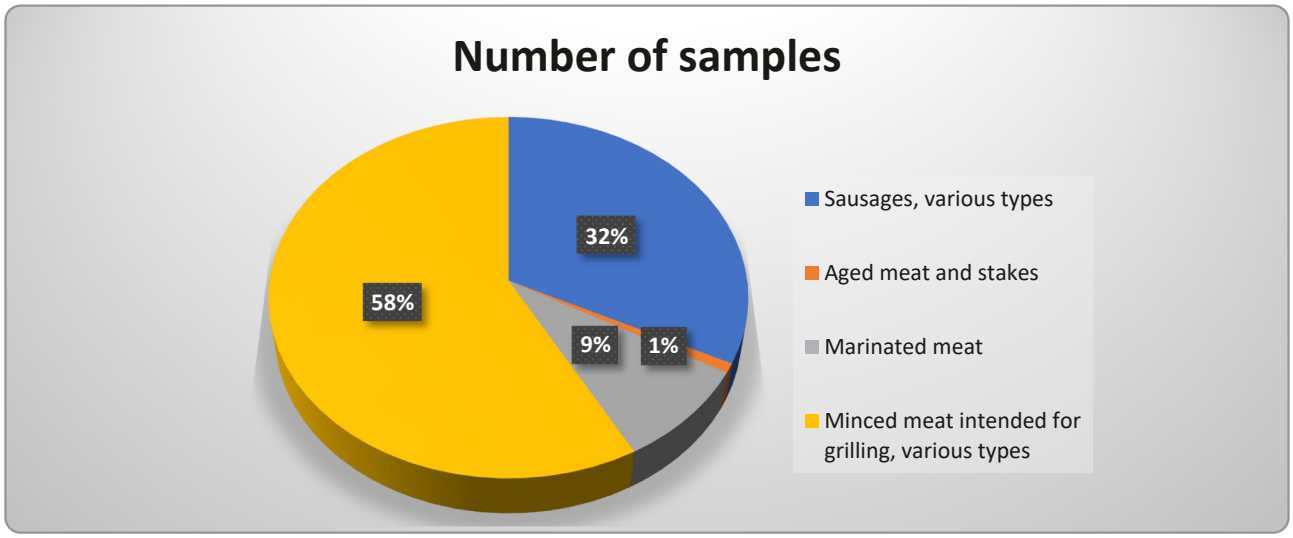

Figure 1. Distribution of samples by type of meat product

Table 1. Number of samples of meat semi-products intended for grill in which the presence of nitrites (as $NaNO_2$) and nitrates (as $NaNO_3$) was determined, in the period January 2021 to January 2023

Type of samples	Not detected ($NaNO_2$ <0.03 mg kg^{-1})	Not detected ($NaNO_3$ <0.03 mg kg^{-1})
Aged meat and steaks (6)	6	6
Marinated meat (64)	64	64
Sausages, various types (234)	234	234
Minced meat intended for grilling, various types (420)	420	420
All samples (724)	724	724

These results are graphically presented in Figures 2 and 3, respectively.

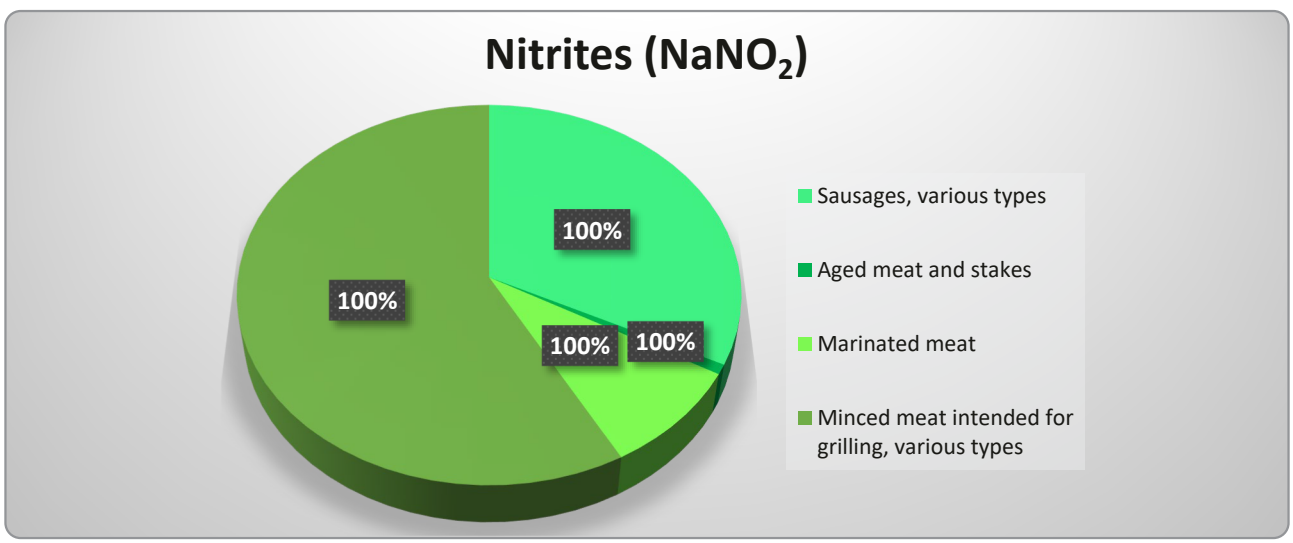

Figure 2. Percentage of samples by type of meat product in which nitrites were not detected

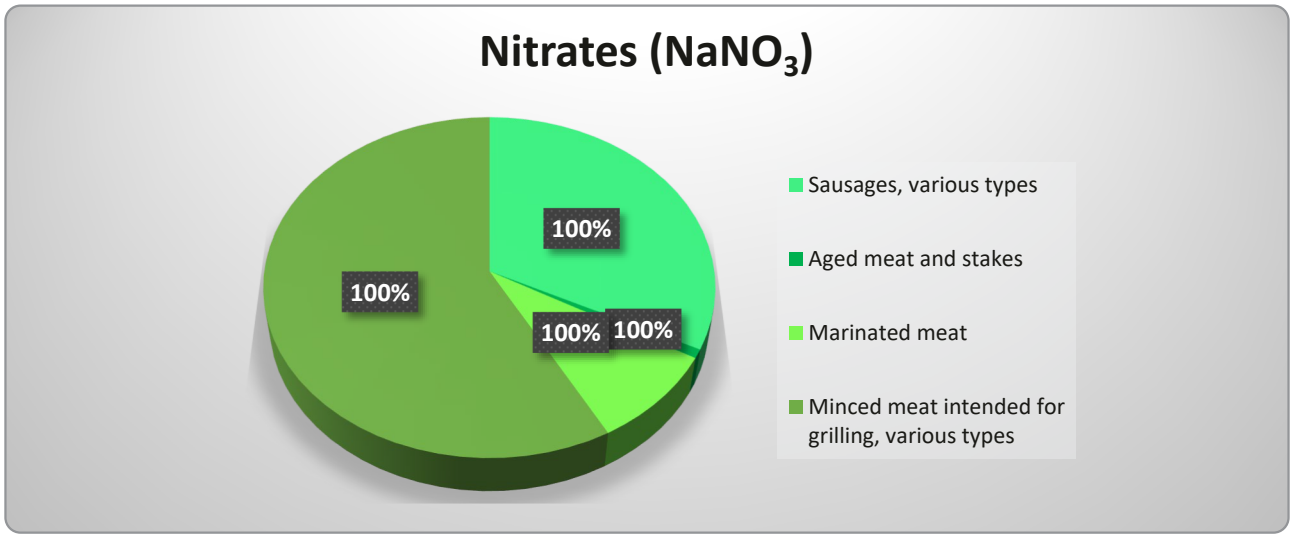

Figure 3. Percentage of samples by type of meat product in which nitrates were not detected

4. Discussion

The results obtained from the analysis of the various types of meat semi-products intended for grilling showed that none of the 724 samples contained nitrites or nitrates. This finding confirms that all the tested samples comply with the Serbian national regulation (*Republic of Serbia*, 2019, 2023), which strictly prohibits the addition of nitrites and nitrates in these types of meat semi-products. The absence of nitrites and nitrates in these samples suggests that the producers and manufacturers have complied with the regulations, ensuring that these meat semi-products are safe for consumption without the need for added nitrites or nitrates. This finding is significant from a food safety perspective, as excessive consumption of nitrites and nitrates has been associated with potential health risks, including the formation of potentially carcinogenic compounds.

5. Conclusion

The successful adherence to the regulation indicates the effectiveness of the monitoring and control measures implemented by the regulatory authorities and the food industry in Serbia. It showcases their commitment to ensuring the safety and quality of meat semi-products intended for grilling. It is important to note that the absence of nitrites and nitrates in these samples does not imply a lack of other potential contaminants or food safety concerns. It is crucial to continue monitoring and conducting regular quality assessments to ensure compliance with other safety parameters, such as microbial contamination, storage conditions, and labelling requirements.

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