DETERMINATION OF SODIUM NITRITE (E250) CONTENT IN SOME SELECTED MEAT PRODUCTS

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Abstract

The main objective of this study was to evaluate the nitrite content in different meat products using the colorimetric Griess method, according to the Romanian Standard SR 13175. Six samples from different brands were analyzed, grouped into two categories: canned pork meat in its own juice and Victoria-type salami. The results revealed important differences between the two product categories. The canned pork samples showed lower nitrite concentrations, all below the maximum limit of 50 mg/kg established by national regulations. Conversely, Victoria-type salami samples presented higher nitrite levels, approaching the legal threshold of 100 mg/kg, as regulated by EC Regulation No. 1333/2008. These variations are mainly attributed to technological differences in processing, the controlled addition of curing agents, and the type of thermal treatment applied. In conclusion, all analyzed samples complied with the legal safety limits; however, salami products exhibited higher nitrite concentrations than canned meat, emphasizing the importance of continuous monitoring of food additives to ensure consumer safety and regulatory compliance.

***Key words**: sodium nitrite, inclusion level, canned pork meat, Victoria-type salami*

INTRODUCTION

Sodium nitrite (E250) is one of the most widely used food additives in the meat industry, being traditionally incorporated into curing and preservation mixtures due to its multiple technological functions. The use of nitrites in meat processing is primarily associated with the inhibition of the growth of pathogenic and spoilage microorganisms, the development and stabilization of the characteristic color of cured and preserved meat products, as well as the formation of their specific flavor. One of the most important functions of nitrite is its antimicrobial activity against *Clostridium botulinum*, a microorganism responsible for the production of botulinum toxin, which gives nitrite an important role in the microbiological safety of meat products. In addition, nitrite can inhibit the development of other microorganisms and may contribute to limiting oxidative processes in the meat matrix [1; 2].

From a technological perspective, nitrite participates in the development of the characteristic color of cured meat products. During processing, nitrite may lead to the formation of nitric oxide, which reacts with the heme pigments of meat and contributes to the formation of pigments responsible for the characteristic pinkish-red color of cured and preserved meat products. Nitrite also contributes to the development of the sensory characteristics of meat products and exhibits antioxidant properties, thereby contributing to the delay of lipid and protein oxidation. Therefore, the use of nitrite is not exclusively related to microbiological preservation, but also to the maintenance of important sensory and physicochemical

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characteristics that influence consumer acceptance of these products [1; 3].

The technological effectiveness of nitrite is influenced by numerous factors, including the concentration used, product pH, salt concentration, processing temperature and duration, water activity, microbiological composition, and the thermal treatment applied. Consequently, the amount of nitrite added during processing does not necessarily correspond to the amount remaining in the finished product. A significant proportion of nitrite is consumed in chemical and biochemical reactions occurring during processing and maturation. Therefore, the determination of residual nitrite represents an important indicator for assessing the composition and safety of meat products; however, it does not directly reflect the initial amount of nitrite used during processing. EFSA has emphasized the importance of distinguishing between the amount of nitrite added and the residual amount, since antimicrobial activity is mainly associated with the amount incorporated during processing, whereas residual nitrite determination provides information on the level present in the product at the time of analysis [1].

Despite its technological benefits, the use of nitrites in meat products is an important food safety concern. The main concern is the potential formation of *N*-nitroso compounds, particularly *N*-nitrosamines, through reactions between nitrite or other nitrosating agents and amine compounds present in the food matrix. The formation of these compounds may be influenced by product composition and processing conditions, particularly high-temperature thermal treatments. Some *N*-nitrosamines are recognized for their carcinogenic potential; consequently, controlling the use of nitrites and reducing the formation of undesirable *N*-nitroso compounds are important objectives in modern meat processing technology [4], [2].

Recent scientific literature indicates that the formation of nitrosamines in meat products is a complex phenomenon influenced by nitrite concentration, meat composition, the presence of secondary amines, water activity, pH, and heating conditions. In products subjected to high-temperature thermal treatments, certain nitrosation reactions may be promoted, potentially resulting in increased concentrations of some *N*-nitroso compounds. Recent research therefore emphasizes the need to simultaneously control the amount of nitrite used and the technological conditions applied during meat processing [4], [5]

The safety assessment of nitrites has also been conducted at the European level. The European Food Safety Authority (EFSA), in its re-evaluation of sodium nitrite (E250) and potassium nitrite (E249), established an acceptable daily intake (ADI) of 0.07 mg nitrite/kg body weight/day, expressed as nitrite ion. EFSA's assessment indicated that exposure to nitrite resulting from its use as a food additive does not generally exceed this value for the general population, although a slight exceedance may occur in certain groups of children with high exposure. EFSA also highlighted the importance of assessing total exposure, as nitrites may originate both from their use as food additives and from other dietary sources [1].

In the European Union, the use of nitrites as food additives is regulated by Regulation (EC) No. 1333/2008 on food additives, which establishes the conditions of use and maximum permitted levels for different categories of food products. The establishment of maximum levels aims to ensure a balance between the technological benefits of nitrites, particularly microbiological protection and the maintenance of the sensory characteristics of meat products, and the need to reduce consumer exposure to nitrites and to undesirable secondary compounds formed during processing.

In this context, the determination of sodium nitrite concentration in meat products represents an important tool for assessing their compliance with legislative requirements and for monitoring the use of food additives. Spectrophotometric methods based on the Griess reaction are widely used for nitrite determination because of their sensitivity, reproducibility, and applicability to different types of food products. The use of a standardized analytical method enables comparison of results obtained from different products and manufacturers and provides relevant information for assessing consumer exposure.

Therefore, the analysis of sodium nitrite content in meat products belonging to different technological categories is important from both a quality control and food safety perspective [6]. Comparing nitrite concentrations in products such as canned pork meat in its own juice and salami-type products may provide insight into the influence of processing technology, product formulation, and the use of curing agents on residual nitrite levels. In this context, the present study aimed to determine the sodium nitrite (E250) content in selected meat products using the Griess colorimetric method according to Romanian Standard SR 13175, and to evaluate the results obtained in relation to the applicable legislative limits.

MATERIAL AND METHOD

The main objective of this study was to evaluate the nitrite content in different meat products using the colorimetric Griess method, according to the Romanian Standard SR 13175. Six samples from different brands were analyzed, grouped into two categories: canned pork meat in its own juice and Victoria-type salami.

The sodium nitrite content of the meat products was determined using a UV–VIS spectrophotometer (UVmini-1240, Shimadzu, Japan), a technical balance (KERN, Germany), and a single-channel pipette (HandyStep).

The following reagents were used: saturated borax solution, potassium ferrocyanide ($[K_4Fe(CN)_6 \cdot 3H_2O]$), zinc acetate ($[Zn(CH_3COO)_2 \cdot 2H_2O]$), glacial acetic acid, Griess reagent, and sodium nitrite ($NaNO_2$) standard solution.

The saturated borax solution was prepared by dissolving 50 g of borax in 1000 cm³ of water at 40–50°C, followed by storage for 24 h at room temperature.

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For **Solution I**, 106 g of potassium ferrocyanide ($[K_4Fe(CN)_6 \cdot 3H_2O]$) were dissolved in water and diluted to a final volume of 1000 cm³.

For **Solution II**, 220 g of zinc acetate ($[Zn(CH_3COO)_2 \cdot 2H_2O]$) and 30 cm³ of glacial acetic acid were dissolved in 300–400 cm³ of water and subsequently diluted to 1000 cm³.

A ready-to-use Griess reagent was used and stored for no longer than one week.

The sodium nitrite standard solution was prepared on the day of analysis. Briefly, 0.1 g of sodium nitrite was accurately weighed using a balance with an accuracy of 0.001 g and quantitatively transferred into a 1000 cm³ volumetric flask. After complete dissolution, the solution was brought to volume with water and homogenized. According to the analytical procedure, 1 cm³ of the standard solution contained 0.001 mg of sodium nitrite.

Approximately 10 g of each homogenized meat sample were accurately weighed to the nearest 0.001 g and quantitatively transferred into a 200 cm³ volumetric flask using 100 cm³ of hot water maintained at 60–70°C.

Deproteinization was performed only when the aqueous extract was opalescent.

Clear extracts were analyzed without deproteinization. For opalescent extracts, 5 cm^3 of saturated borax solution were added, followed by heating for 15 min on a boiling sand bath with vigorous stirring.

After cooling to room temperature, 2 cm^3 of potassium ferrocyanide solution and 2 cm^3 of zinc acetate solution were added successively, with shaking after each addition, to precipitate proteins. The mixture was allowed to stand for 20–30 min and was then brought to volume with distilled water.

The extract was homogenized and filtered through folded filter paper. Clean and dry funnels and Erlenmeyer flasks were used during filtration. A small amount of activated charcoal was added to the filter paper when necessary to improve extract clarification.

For nitrite determination, 5 cm^3 of the prepared extract were transferred into a test tube and mixed with 5 cm^3 of Griess reagent. The mixture was homogenized and incubated for at least 30 min at room temperature in the dark to allow color development.

The absorbance was measured at 538 nm using a UV–VIS spectrophotometer and a cuvette with a 1 cm optical path length.

When the absorbance of the sample extract exceeded the absorbance range of the standard solution, the extract was appropriately diluted, and the corresponding dilution factor was taken into account in the calculations [7].

A calibration curve was prepared using six standard solutions. The sodium nitrite standard solution, water, and Griess reagent were added successively to the test tubes according to the analytical procedure.

At least two absorbance measurements were performed for each standard solution, and the arithmetic mean was calculated. The calibration curve was constructed by plotting the measured absorbance values on the y-axis against the corresponding sodium nitrite concentrations, expressed in mg, on the x-axis.

The sodium nitrite concentration in the analyzed samples was subsequently determined from the calibration curve.

The sodium nitrite content was calculated according to the following equation:

$$\mathbf{NaNO_2\ (mg/kg) = (c \times V \times 1000) / (V_1 \times m)}$$

where:

- **c** = amount of sodium nitrite determined from the calibration curve (mg);
- **V** = total volume of the extract (cm^3);
- $\mathbf{V_1}$ = volume of extract used for the colorimetric determination (cm^3);
- **m** = mass of the analyzed sample (g);
- **1000** = conversion factor from mg/g to mg/kg.

The final result was expressed as mg of sodium nitrite per kg of sample and was calculated as the arithmetic mean of two determinations performed simultaneously (Păunescu, 2001).

RESULTS AND DISCUSSIONS

Regarding canned pork meat in its own juice, the maximum permitted limit for sodium nitrite is generally around 50 mg/kg (50 milligrams of sodium nitrite per kilogram of final product). Considering that a can weighs 300 g, the allowable dose of nitrites for this quantity is 15 mg, calculated proportionally to the limit per kilogram (fig. 1). This represents a standard value recommended by Regulation (EC) No. 1333/2008 on food additives, being specific to preserved meat products. Nitrites are mainly used for preservation purposes and to prevent the growth of *Clostridium botulinum* bacteria. According to the results, the analyses indicated a minimal nitrite content in the tested samples, with the determined values being within the maximum limits allowed by the current legislation.

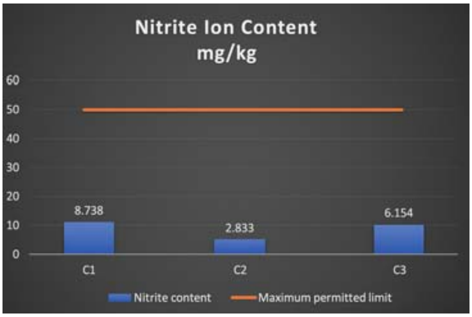

Fig. 1 Graphical representation of nitrite ion content in canned pork meat

Regarding *Victoria Salami*, the maximum permissible concentration of sodium nitrite in the final product is generally established at 100 mg/kg, in accordance with the provisions of Regulation (EC) No. 1333/2008 on food additives. Accordingly, for a 400 g salami unit, the admissible nitrite level is 40 mg, calculated proportionally to the limit per kilogram (fig. 2).

This regulatory threshold was introduced to ensure the effectiveness of the preservation process while simultaneously preventing the growth of pathogenic microorganisms. Moreover, it guarantees consumer safety by limiting exposure to nitrites and, consequently, to potentially carcinogenic compounds such as nitrosamines.

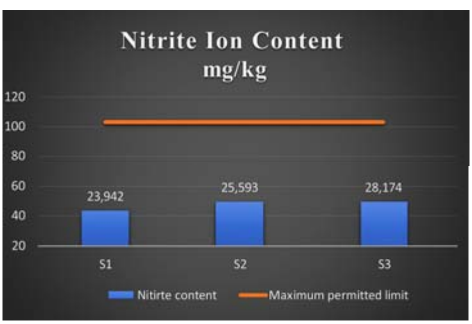

Fig. 2 Graphical representation of nitrite ion content in Victoria-type salami samples

CONCLUSIONS

The analytical evaluation of sodium nitrite content in *canned pork meat in its own juice* and *Victoria Salami* demonstrated full compliance with the maximum limits established by Regulation (EC) No. 1333/2008. All determined concentrations were significantly below the permissible thresholds (50 mg/kg for canned meat and 100 mg/kg for salami), indicating the correct technological use of this additive and the effectiveness of the preservation processes applied to the studied products.

The obtained results highlight that the nitrite levels detected in the analyzed samples do not pose health risks to consumers, considering the low percentages recorded relative to the acceptable daily intake (ADI) of 0.07 mg/kg body weight per day. The reduced concentrations of nitrites, together with the adequate technological control of the manufacturing processes, ensure both the microbiological safety and the chemical stability of the products, confirming their compliance with current food safety standards [8].

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