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Role of Nitrite in Processed Meat Products and its Degradation during their Storage

ILIRJANA BOCI[1]*, ELDA ZIU[2], GENTIANA BARDHI [3]

[1*] Department of Industrial Chemistry, Faculty of Natural Sciences, University of Tirana, Tirana, Albania,

[2] Head of Quality Control, Meat Processing Plant, EHW,Tirana, Albania,

[3]Food National Authority, Tirana, Albania,

*corresponding author e-mail ilirjanaboci@yahoo.com

Abstract

This paper represents the analytical data of nitrite level obtained from the experimental work done on meat processed samples taken from a meat processing plant in Tirana. There has been a long debate and health concern about the nitrite content in meat products. Nitrite is added to e.g. sausages, and hams and other meat products to preserve these products and keep them free from dangerous bacteria. Among the aims are preventing botulism, a dangerous food poison. But also it's important to use the smallest possible amount of nitrite as a preservative because nitrite in meat can also form nitrosamines, which can damage the health. That's why the role of nitrite in processed meat and its recommended level conform to new EC Regulations are given in the introduction part of this paper. It is important that the nitrite level be monitored during all the processing steps up to the end consumers. This makes the objective of this paper. It gives the analytical data on nitrite level on meat processed samples taken and tested during their storage and ripening period of time. Different kinds of meat products are taken and tested to evaluate the influence of various parameters (storage time, time until to the end consumers, various kinds of packing) in the degradation rate of ingoing nitrite.

Keywords: Nitrite content, degradation rate, storage time

1. Introduction

Meat is an ideal medium for the growth of microorganisms because its high content in moisture, proteins, minerals and accessory growth factors. In addition it has some fermentable carbohydrates, usually glycogen and has a favorable growth pH for multiplication of most microorganisms. Consequently, meat and meat products are extremely perishable unless appropriately preserved and/or stored under conditions designed to retard microbial activity and proliferation. [2]

For extended storage of meat products, preservation is necessary. Important methods include heating, drying, fermentation and the use of preservative agents, but their use may be limited by their effect on the food. For example, the quantity of salt as preservative is limited by sensory acceptability, while heating is limited by loss of eating quality. To maintain the quality of meat products, a combination of preservation methods is often used, such as a mild heat treatment and the use of curing salts. Near the turn of the century it was determined that nitrate, present in some salt, was responsible for this special color and flavor. In was early in 1900's that was determined that nitrate actually is changed to nitrite by bacterial action during processing and storage and that nitrate itself has no effect on meat color. Today the nitrite used in meat curing is produced commercially as sodium nitrite which is now accepted as responsible for the preservation and characteristic color/ flavor of the cured meats. [3]

By definition, "cured meat products" contain curing salts, usually salt (sodium chloride) and either nitrites or nitrates. The function of nitrite in meat is fourfold: (1) to stabilize the color of the lean tissues. Sodium nitrite, is most commonly used for curing (although in some products such as fermented ones, sodium nitrate is used too, because of the long aging period). In a series of normal reactions, nitrite is converted to nitric oxide. Nitric oxide combines with myoglobin, the pigment responsible for the natural red color of uncured meat. They form nitric oxide myoglobin, which is a deep red color (as in uncooked dry sausage) that changes to the characteristic bright pink normally associated with cured meat, (2) to contribute to the characteristic flavor of cured meat, (3) to inhibit growth of a number of food poisoning and spoilage microorganisms, and (4) to retard development of rancidity.[4]

Although color stabilization was originally the primary purpose of adding nitrite to curing mixtures, its effects on flavor and inhibition of bacterial growth are even more important.[4]

Nitrites exert a concentration-dependent antimicrobial effect in cured meat products. Their antimicrobial effects are pH-dependent, increasing ten-fold for each unit fall in pH. Safety, however, cannot be totally attributed to nitrites alone, but rather to a number of factors acting in combination, such as heat treatment, pH, salt (aw), redox potential, and the initial numbers of bacterial spores, normally low, in the meat and other ingredients. Other agents, such as ascorbate or isoascorbate, have also been reported to influence the efficacy of nitrite. One of the purposes of using ascorbate is that, in concentrations equimolar with nitrite, the formation of nitrosamines is reduced [2]. The extent of protection provided to cured meats against microbial growth has been attributed by different researchers to many factors including the input concentration of nitrite, the residual nitrite concentration, the salt concentration of the product, the addition of sodium ascorbate (or isoascorbate / erythorbate), the heat treatment applied, the storage temperature, the initial pH of the meat, and the spore load initially present. The extent of protection is due to a combination of factors rather than any single factor.[2] Before '90 the norm allowed in Albania for nitrite content was not more than 20 mg/100gr product, but later on under the frame of approximitation of EU legislation even for food safety, our Ministry of Food and Agriculture approved the New Regulation Nr.16, dated on 29.08.2011 "On Food additives other than colors and sweeteners" in conformity with the Annex Part C of European Parliament and Council Directive 95/2/EC. According to this Regulation the permissible norms of potassium and sodium nitrite (E 249 and E 250) for use in processed meat products (sausages in our case) is not more than 15 mg/100g and the residual nitrite amount to the end consumer not more than 10 mg/100g product.

As we already told the cured meat contains nitrite, which combines with natural meat pigments, to give these products their characteristic pink color which is one of the main reasons of using nitrite. On exposure to light in the presence of oxygen, these nitroso-compounds are converted to a brownish gray color. This undesirable color is called light fading and it can be prevented by vacuum packaging the meat, packaging it in oxygen impermeable films or by using opaque packaging materials.

Table 1: Norms of nitrite/nitrate used for cured meat products according to Albanian Regulation

E No	***Name***	***Foodstuff***	***Indicative ingoing amount (mg/kg) expressed as $NaNO_2$***	***Residual amount (mg/kg) expressed as $NaNO_2$***
E 249	Potassium nitrite	Cured meat products	150	100
E 250	Sodium nitrite			

Basing just on this observation this paper aims to give an analytical evaluation of the initial quantity of nitrite in sausages (packaged in different modes) and its degradation rate in time until the end of storage period (period of time until expiring date) keeping all other conditions unchanged, except of the package mode.

2. Materials and method

2.1 Test material

The experimental work was based on the in–time analysis of nitrite content in one type of cured meat product, sausage which prevails in its consuming rate in Albanian domestic market. One type of product was taken for the study but stored and traded in different way: unpackaged sausage, sausage packaged in vacuum and sausage packaged in modified atmosphere (20% CO2+ 80% N2).All samples were taken from processed meat products produced in a Meat Manufacturing Plant in Tirana, and analyzed in the chemical laboratory of the same manufacturing plant.

2.2 Technologic parameters of production

The conditions studied for the experiments are given below.

- NaCl (% on wet basis) 2.5
- the level of added nitrite (mg/kg) 250
- chemical additives
- sodium nitrate (0 mg/kg);
- sodium ascorbate (1000 mg/kg);
- poly phosphate (0.5%);
- heat treatments starting from low temperature 56 ° C up to 75° C and maintained in this temperature until the temperature in the product core gets to 70 °C;
- the pH of the product (5.5-6.3)

2.3 Analytical method

Analytical method used for the determination of nitrite content in all samples sausages was according to AOAC 973.31 Method [1] adopted from Codex Alimentarius, using a "JENWAY" 6405 UV-Vis SF. The method consists in mixing a portion of 5 g of homogenized products in hot water at 80° C and maintained in water bath at this temperature for 2 hours. At the end of this time a aliquot of solution was taken then 5 ml of Griess reagent was added and absorbance at 540 nm was read. The value obtained was compared to the nitrite calibration curve and the results were expressed as mg $NaNO_2$/100 g product.

3. Results and discussion

Production date for the three types of products was 20.11.2013. The first test of nitrite content was carried out on the same date as production date (0 days after production) and the tests continued to be carried out in successive days until to their best before date as written on the package. For the fresh unpackaged sausages the period of storage time is 7 days, for the modified atmosphere packaged sausages is 21 days and for the vacuum packaged sausages the best before date is 90 days, all of them kept in suitable storage condition (storage temperature 4-8 °C). Results of the nitrite content and its degradation in time are shown in the Figure 1.

Nitrite content is given in mg $NaNO_2$/100 g product.Based on the results obtained we can say that the degradation rate of nitrite is dependent of packaging mode and hence storage period of sausages, keeping all the other parameters the same for all three types of sausages samples.

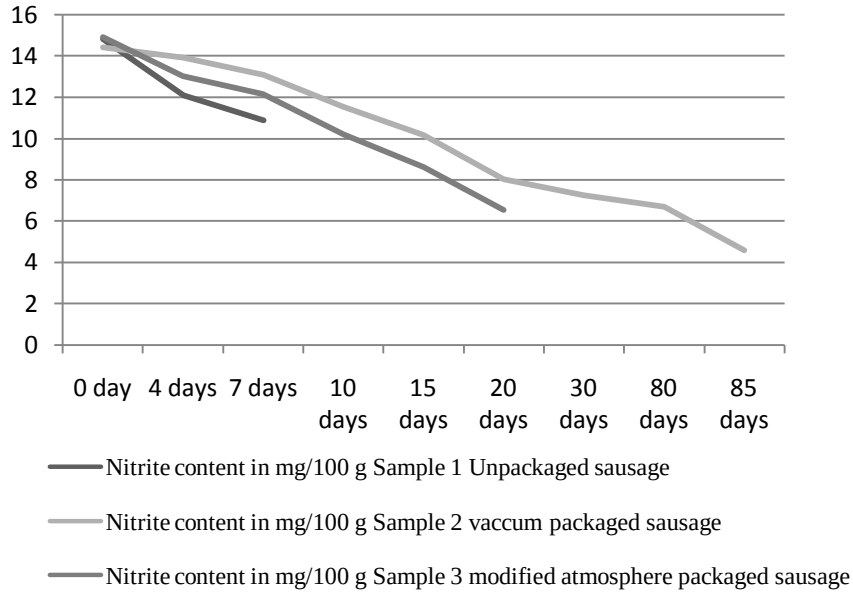

Figure 1. Degradation of nitrite in the three types of sausages samples

The package mode presented an influence on the residual level of nitrite. At the end of the storage period all the samples showed good appearance in color and not any specific off –flavor. The measurements show also that the added amount of nitrite is reduced in a rapid but different way in the types of products tested. For the unpackaged sausages with an intended storage time of 7 days, almost only 25% of the initial added nitrite is degraded within seven days of storage in 4-6 ° C. For the other sample type, sausages packaged in vacuum the only 10% of initial nitrite content has been degraded during the same period of storage. The other type of sausage packaged in modified atmosphere stands somewhere in between them. The nitrite content still remaining during the first week of storage for all the three types is less than 10 mg/g product and at the end of the storage time for the two packaged types is reduced to less than 50% of the original concentration (6.54 mg/100 g and 4.60 mg/100 g respectively).

4. Conclusions

It is known the fact that the nitrite loss in meat products is dependent on a number of factors including the heat process used, pH, storage condition and the addition of ascorbic acid or other reducing agents but analyzing the data obtained we can say that the rate of nitrite loss is dependent also of the packaging type keeping all the other factors the same. It falls more slowly in the vacuum packaged sausages following by the modified atmosphere

packaged sausages, while as it was expected for the fresh unpackaged sausages the decline was sharper.

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6. References

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