INFLUENCE OF NITRITE ON OXIDATIVE AND COLOUR STABILITY OF SLICED FROZEN DRY SAUSAGES

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Background

The market for convenience products and the demand of consumers and producers for a longer product shelf-live is steadily increasing. When meat products are added to convenience food products, e.g. pizzas, oxidative changes such as rancidity occur. To control and improve the oxidative stability of meat products, additives with antioxidant activity are used.
Nitrite is an important and widely used food additive, particularly for the preservation of meat. It produces a characteristic flavour and red colour in treated meat. Furthermore, nitrite appears to 'chelate' non-haem iron forming a stable complex, thus inhibiting catalytic activity. The antioxidant activities of nitrite are also affected by the formation of nitrosylmyoglobin which have antioxidant properties [1].
Nitrite and nitrate are well known to have antioxidant effects, so lipid oxidation in foods is effectively inhibited at concentrations of less than 50 ppm [2]. Zanardi et al. [3] found sodium nitrite alone to be able to control lipid oxidation of fatty acids and less efficient cholesterol oxidation in fermented sausages. The regulation of oxidation in different meat products in a dose-dependent manner was examined by the supplementation of sodium nitrite. [4].

Objectives

To clarify the effect of sodium nitrite on lipid oxidation and colour stability during storage time, dry fermented sausages were produced with and without varying levels. The results are analysed by monitoring 2-thiobarbituric acid reactive substances (TBARS), hexanal, oxygen and sensory characteristics and changes in red colour which are measured as Minolta *a*-values.

Methods

<u>Dry sausage production:</u> The initial sausage mixture contained 40% lean frozen pork (approx. 5 % fat), 30% frozen pork back fat and 30% 3mm minced beef (approx. 5 % fat). Other ingredients and additives were added (g/kg) as follows: NaCl (28.0), sodium ascorbate (0.5), monosodium glutamate (0.5), white pepper (3.5), dextrose (4.0), lactose (5.0) and starter cultures *L. sakei* + *P. pentosaceus* (0.5). Sodium nitrite (Merck, Germany) was added in 4 different concentrations (mg/kg): 0, 7, 14, 25 (batch 1 to 4, respectively). The mixture was stuffed in 65 mm diameter casings of regenerated collagen (R2, Naturin, Germany) and placed in a ripening chamber under standard conditions including smoke after 2, 3 and 5 days for 30 minutes each time. After reaching 25% weight loss, the sausages were cooled overnight to 5°C and cut in 3 mm slices.
<u>Storage-conditions:</u> The slices were put in tinplate cans (73/58) and stored at -20°C for 6 weeks under air-accelerating conditions. To reach a uniform contact of the slices to the surrounding air in the can, V-formed pieces of high-grade steel wire (Ø 5 mm) were put between the slices.
<u>Analysis:</u> The oxygen to be measured was taken out of the can with an applied adhesive rubber with a syringe and injected in an oxygen analyser, a solid cell type oxygen meter using a zirconia system solid electrolyte (LF 700, TORAY).
To detect TBARS, a previously described [5] and modified [6] method was used, values were expressed in mg malondialdehyde/kg dry sausage. Hexanal was measured by gas chromatography, based on a combination of 2-butanol-concentration and retention times [7]. All analyses were performed in duplicate.
For the enzymatic determination of nitrite and nitrate a testkit from Boehringer (Mannheim, Germany) was used.
The colour measurements were carried out using a Minolta colorimeter CR 200 (Minolta, Japan).
<u>Sensory evaluation:</u> A taste panel consisting of 10 members described the rancidity using a 10-point scale as follows: not perceived (0-1), slightly perceived (2-3), moderately perceived (4-5), strongly perceived (6-7) and very strongly perceived (8-9). The results shown in figure 4 present averages of the ratings reported by the panellists.

Results and discussion

The amount of nitrite is dose-dependent decreasing from fresh mince to finished sausage. As expected no nitrite could be found in batch 1. Batch 2 is decreased from 55 to 8.4 ppm, batch 3 from 102 to 12.4 ppm and batch 4 with the highest addition from 193 to 23.4 ppm. These low final nitrite concentrations are due to the action of sodium ascorbate and starter cultures during ripening. The concentrations of nitrate, however, increase with the amount of added nitrite (Figure 5).

The colour of fresh sliced sausages was not influenced by nitrite concentration. Batch 1, without nitrite, showed significantly weak colour stability compared to the other batches. After a storage time of 5 days at 7°C and subjected to light, the red colour for batch 4 was more intense than for batch 2 and 3 with smaller amounts of nitrite.
Changes in red colour measured as Minolta *a*-values gave similar results to the visual assessment. Other authors have also shown that colour development in cured turkey hams and in saveloys was significantly improved by higher sodium nitrite levels [8, 9].

Lipid oxidation during 6 weeks of frozen storage was found to be affected by the amount of nitrite. Batch 1, produced without sodium nitrite, shows the highest amount of the secondary oxidation products TBARS and Hexanal (Figures 2 + 3) and also a small content of oxygen in the cans (Figure 1). The rancidity during the storage period of batches 2 and 3 is significantly smaller than that of batch 1 due to the use of nitrite. Batches 2 and 3, however, show similar results. Batch 4, in which the highest concentration of nitrite was used, showed the lowest oxidation level (Figure 1).
Sodium nitrite at 900 ppm, clearly slowed down the oxidation of the sliced frozen dry sausage having TBARS values above 7 mg malondialdehyde/kg after 6 weeks.
A good correlation between the secondary oxidation products (TBARS and Hexanal) and the content of oxygen in the cans was found. The analytical data also correlate well with the sensory results as demonstrated in Figure 4.
These results are in agreement with the data presented by Cheng et al. and Morrissey et al. [10, 1] who found a significant reduction in the oxidation of cooked or heated meat products using nitrite. The possibility of controlling the oxidation of fatty acids using nitrite was also reported by Zanardi et al. [3].

Conclusions

In the present study, the quality of the sausage during frozen storage was dependent on the levels of added sodium nitrite. To improve the oxidative and colour stability of the sliced frozen dry sausages significantly, the added nitrite concentration in mince should be above 900 ppm.

Pertinent literature

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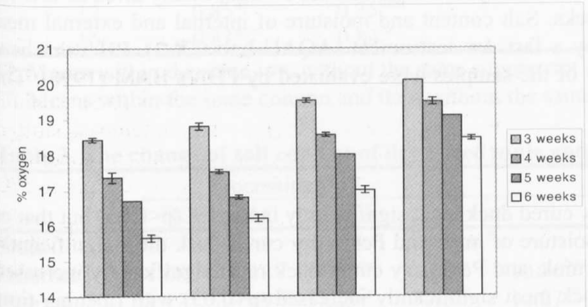

Figure 1: Content of oxygen in cans after frozen storage

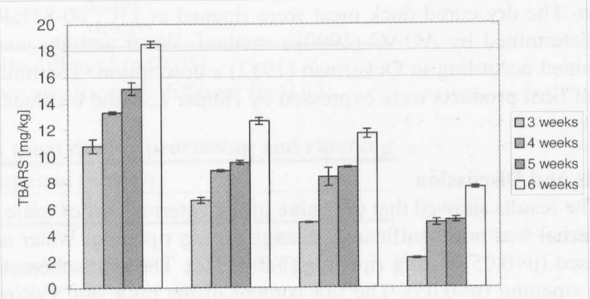

Figure 2: TBARS after frozen storage

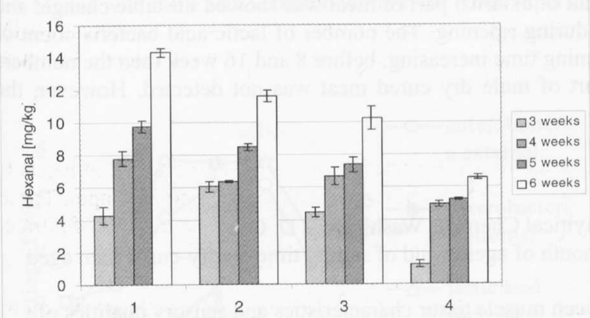

Figure 3: Hexanal after frozen storage

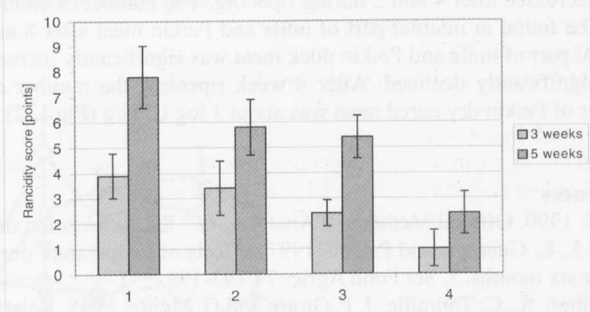

Figure 4: Sensory evaluation after frozen storage

sample	$NaNO_2$ [ppm]	KNO_3 [ppm]
1	0.05	0.1
2	8.4	9.9
3	12.4	17.4
4	23.4	49.2

Figure 5: Content of nitrite and nitrate of sausages