NITRITE REDUCTION IN ORGANIC MEAT PRODUCTS: FERMENTED SAUSAGE AND LIVER SAUSAGE

Theo J. Verkleij and Wilbert H.M. Oostrom

TNO Earth and Life Science, P.O. Box 360, 3700 AJ Zeist, The Netherlands.

Abstract- Nitrite is used in meat products for formation and stabilization of the red, cured meat color. Nitrite also has antimicrobial and anti-oxidative properties. The use of nitrite in organic meat products is currently being evaluated in the EU (E250), therefore this project was undertaken to establish minimum concentrations needed in fermented and liver sausage to yield stable products. Lower concentrations of nitrite are added to meat products and during storage and exposure to light (7 days 500 Lux) discoloration and decrease in nitrite concentration were analyzed. Challenge tests were done with *Staphylococcus aureus* in fermented sausage and *Clostridium botulinum* in liver sausage. A minimum above 50 mg nitrite/kg is necessary for colour stability in liver sausage especially when exposed to light. Challenge tests showed the growth of *S. aureus* in fermented sausage was not influenced by the amount of nitrite added. Growth of *C. botulinum* was observed when liver sausage was stored above 10°C.

Key words: *Clostridium botulinum*, fermented meat products, liver sausage, nitrite reduction, *Staphylococcus aureus*.

I. INTRODUCTION

Organic meat products, especially pork, are still a steadily growing segment in the EU and in the Netherlands. In line with consumer expectations, a small list of additives may be used for meat products to preserve the products and create structure and yield. For some years profound discussions have been ongoing in the EU regarding the use of nitrite as an additive for organic meat products. As an additional non-organic component, nitrite is a not a desired component. The use of nitrite is still allowed for food safety reasons, but regulations have become more stringent [1]; lower levels of nitrite are permitted for organic meat products than for regular conventional meat products. Replacements were created using vegetables products with a high nitrate concentration to add nitrite for forming and stabilizing the cured red meat colour, obtain a cured aroma and for its antimicrobial properties. Labeling of nitrite is no longer required, although nitrite can be present at higher concentrations as are used in conventional products [2]. Several studies at TNO were carried out to determine the effect of reduced amounts of ingoing nitrite [3-6]. A final study was carried out to determine the effect of reduced amounts of ingoing nitrite on the quality of organic fermented sausages and organic liver sausages. The goal was to gather insight to minimize the amount of nitrite, while still obtaining safe food products. The results can be used in the international discussion on reducing or banning sodium nitrite in organic meat products.

II. MATERIALS AND METHODS

Organic meat products as fermented sausage and liver pate were produced by two different Dutch meat processing companies. Beside the standard recipes, containing approximately 80 mg sodium nitrite per kg product (ingoing content), comparable products were made with reduced nitrite content, i.e. 40 or 0 mg/kg product. Both products were processed in accordance with standard processing methods. The fermented sausage was stuffed in a fibrous casing and stored in a Fessmann ripening cabinet at 30°C at 70% RH for 48 h. Subsequently, the sausage was stored for 4 wk at 7°C and then sliced and packed aerobically. Challenge tests were carried out on *Staphylococcus aureus* by adding a concentration of 10^3 viable microorganisms per gram of product during production. The processing of those products followed the same procedure as described above. The standard organic liver pate was produced with concentration of 100 mg/kg nitrite (ingoing content), two tests were performed using 50 mg nitrite/kg and 0 mg/kg. Products were stuffed in artificial casings and pasteurized at 76°C for 60 min. A part of the liver mass (reference and two nitrite concentrations) was inoculated with

100 spores of *Clostridium botulinum*, pasteurized at 76°C for 60 min, cooled and stored at three different temperatures to enable the *C. botulinum* spores to germinate. During storage and illumination after packaging (7 d at 500 Lux), instrumental (CIElab) color comparison was carried out as well as nitrite and microbiological analyses.

III. RESULTS AND DISCUSSION

Colour analysis.

Several moments after production and during 7 days of illumination at 500 Lux, the colour of the liver pate was analyzed using the CIElab system. Results for liver pate are given in Figure 1. During storage, a* values decreased during the first 61 days of storage and were fairly stable thereafter. The difference in the a* values between the different treatments did not change. After 1 day of illumination, the liver pate with 100 mg nitrite per kg added was stable, the pate with 50 mg.kg decreased strongly.

The development of the color of the fermented sausage during storage, slicing and illumination at 500 Lux is shown in Figure 2. There was no difference in a* value although this was expected from products where no nitrite was added. All products decreased in a* value in the same order.

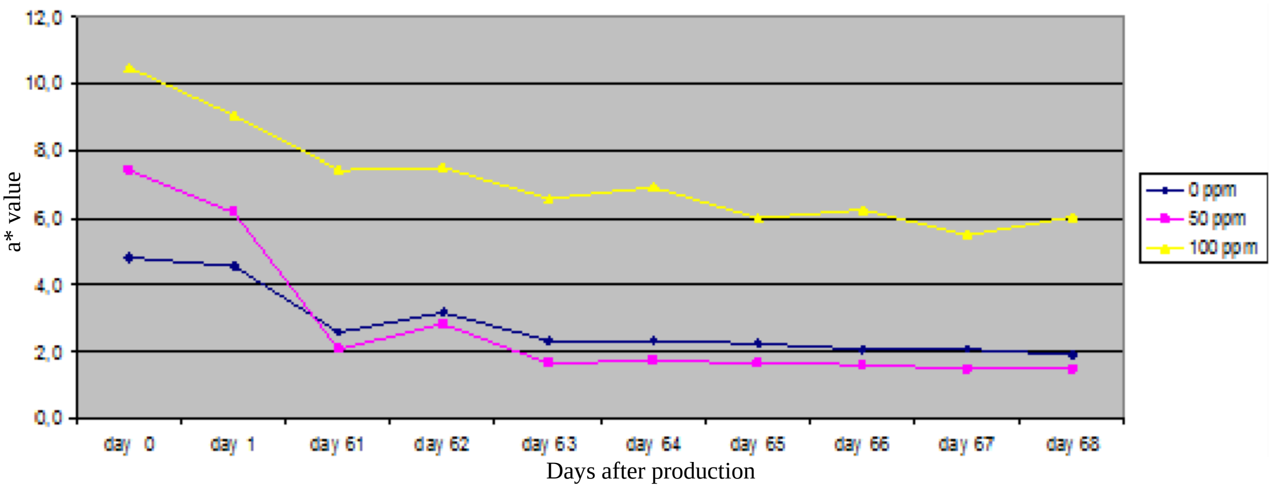

Figure 1. a* colour development of liver pate during storage and 7 days of illumination

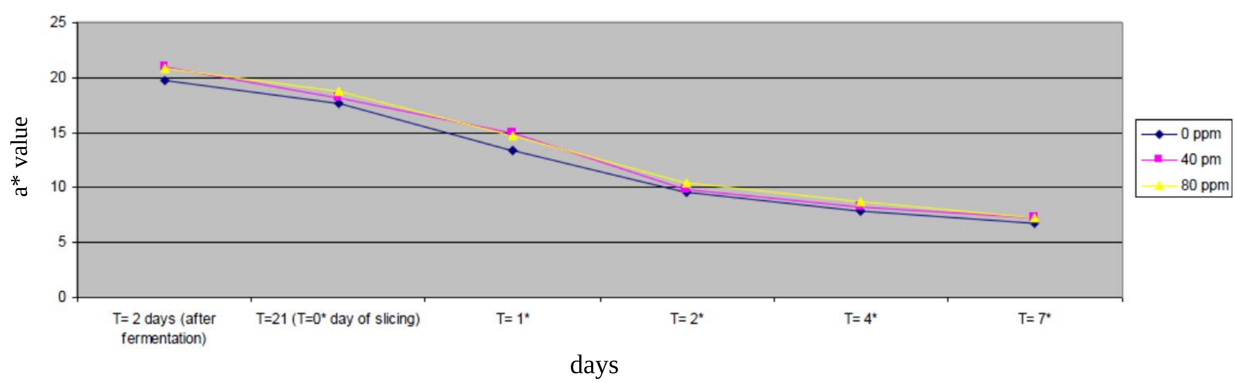

Figure 2. a* colour development of fermented sausage during storage and 7 days illumination

Nitrite analysis

Directly after preparation, after fermentation and after slicing (i.e. 21 days after production) and after 7 days of illumination, the amount of nitrite was determined. Results are given in Table 1.

The residual nitrite analysis showed that nitrite concentrations declined sharply after production for both type of products.

Table 1: Analyses of nitrite content in fermented sausage and liver pate during a shelf life and slicing.

Nitrite content [mg/kg]	fermented sausage			liver pate		
Ingoing nitrite	0	40	80	0	50	100
After fermentation or pasteurisation	0	< 2	3.4	0	3.4	15
At slicing moment (21 days or 60 days)	0	< 2	< 2	0	< 2	< 2
After 7 days illumination at 500 Lux	0	< 2	< 2	0	< 2	< 2

Challenge tests

Challenge tests carried out with *S. aureus* showed a small increase of the countable *S. aureus* from 10^3 CFU/g added to 10^4 CFU/g after fermentation. At the end of storage and 7 days after slicing and storage at 6°C the counts of *S. aureus* were still at the level of 10^4 CFU/g. No difference was noticed in growth of *S. aureus* in products with lower amounts of added nitrite.

Challenge tests carried out with *C. botulinum* showed no growth of spores at storage temperatures of 7°C or 10°C. At a storage temperature of 15°C during 10 wks, *Clostridium* was detected at 10^4 CFU/g for the pate with no nitrite added, $5x10^5$ CFU/g for the pate with 50 mg nitrite per kg added and 10^2 CFU for the liver pate with 100 mg nitrite per kg added. Those results were noticed before [4].

IV. CONCLUSION

An ingoing amount of 50 mg nitrite per kg liver pate is too little for a colour stable product after exposure to light.

Below 10°C, development of *C. botulinum* inoculated in liver pate was not detected. At storage temperatures above 10°C development of *C. botulinum* was observed after 10 weeks in liver pate. When 100 mg/kg nitrite was added, the development of *C. botulinum* was less.

The growth of *S. aureus* in fermented sausage was not influenced by the amount of nitrite added.

Complete abandoning of nitrite in the processing of organic meat products is not advisable, as it will give less colour stable products and the risk of growth of *C. botulinum* is higher when products are stored above 10°C.

ACKNOWLEDGEMENTS

The authors thank Bionext for the contribution in this project.

REFERENCES

1. EC (2008). Commission regulation No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control, Official Journal of the European Union L 250/1.

2. Montserrat Vaquero-Mart et al, Effect of manufacturing with vegetable juice powder as source of nitrites of cooked loin. Consejer de Agricultura, Instituto Tecnolgico Agrario, Salamanca, Spain.

3. Stegeman, D., T.J. Verkleij, and F.K. Stekelenburg (2006). Reduction use nitrite producing organic meat products. Report AFSG 658 - ISBN 9085850185.

4. Stegeman, D., J. Hulstein, T.J. Verkleij, and F.K. Stekelenburg (2007). Reducing the amount of nitrites in the production of pasteurized organic meat products: experiments on industrial scale, Report AFSG 799.

5. Stegeman, D. and T.J. Verkleij (2008). Reducing the amount of nitrites in the production of pasteurized organic meat: summary of the project and implications, Report ASFG 940.

6. Stegeman, D., T.J. Verkleij, (2010). Reduction of nitrite in the production of organic meat products. Report AFSG BO- 04-002-003.044.