

Reduced nitrite in organic meat products

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Introduction

By order of the Dutch Ministry of Economic Affairs, Agriculture and Innovation and Biologica, a Dutch umbrella organization for organic farming and food, literature surveys on alternatives for nitrite in organic meat products and practical experiments on reducing nitrite in organic meat products have been carried out. A study, carried out in 2006/2007, showed that the ingoing amount of nitrite could be reduced considerably while maintaining product quality. Meanwhile the maximum level of ingoing nitrite in meat products is set at 80 ppm. Further research was asked in order to obtain information about possible microbiological risks for products with lower amounts of nitrite. Two studies were carried out, a study focussed on the organic meat products ham and Bologna type sausage, and a study focussed on sausages with high amounts of liver and dry fermented sausages. Challenge tests with cooked ham and Bologna type sausage were carried out with *Listeria monocytogenes*; Bologna type sausage was also challenged with *Clostridium botulinum*.

A few studies which have been published about liver sausages concluded that nitrite does not show inhibiting of *C. botulinum* when ingoing amounts of nitrite below 80 ppm are used. However, it is not known whether inhibiting effects are present at higher ingoing amounts of nitrite. Perhaps the level of 80 ppm nitrite will be too low in case of products containing liver. For fermented sausages, the main microbiological risk may arise from uncontrolled development of *Staphylococcus aureus* at the beginning of the ripening process. Therefore challenge test were carried out with this microorganism.

Objective

The objective of the study was to determine the effect of reduced amounts of ingoing nitrite on the microbiological safety of organic meat products, i.e. ham, Bologna type sausage, liver sausages and fermented sausages. The focus was to minimize the amount of nitrite, while retaining safe food products. The results will be used in the international discussion on reducing or banning sodium nitrite in organic meat products.

Materials and methods

Organic meat products, a cooked ham, a Bologna type sausage, a cooked liver product and a fermented sausage, were produced by four different Dutch meat processing companies. Besides the standard recipes, containing 100 till 160 mg nitrite per kg product (ingoing content), comparable products were made with reduced nitrite content, i.e. 80, 50

and 0 mg/kg product. The products were sliced vacuum packed. Challenge tests were carried out with *L. monocytogenes* in the cooked ham and Bologna type sausage and *S. aureus* in the fermented sausage and *C. botulinum* in Bologna type sausage and liver sausage.

Challenge tests

For the challenge tests with *L. monocytogenes* in cooked ham and Bologna type sausage, both products with different nitrite contents were inoculated with a cocktail of three types, e.g. type 1/2a (ATCC 35152), type 4a (ATCC 19114) and type 4b (ATCC 13932) at a final level of about 10^3 colony forming units (cfu) per gram product. After inoculation, the meat products were minced and homogenized for 2 minutes and subsequently vacuum packed and stored at 7°C for up to 32 to 35 days.

For the challenge tests with *C. botulinum* resp. in Bologna type sausage and liver sausage, both psychotropic non-proteolytic (type E, code BM 299) and mesophilic proteolytic spores (type A, code BM 272) were added at a final level of approximately 10^2 cfu per gram. After inoculation the products were homogenized and vacuum packed, pasteurized at 76°C until a core temperature of $\geq 74^\circ\text{C}$ during 10 minutes ($P_{70} = 55$ min.) was reached. For the Bologna type sausage, two recipes were prepared with different a_w value (high a_w , 0,973 to 0,975 and low a_w , 0,968 to 0,971). After pasteurization and cooling, products were stored at three different temperatures: 7, 10 and 15°C.

A comparable procedure was followed for the challenge test with the fermented sausage inoculated with a regular amount of lactic acid bacteria and additionally with *S. aureus* at a level of 10^3 cfu per gram product. After inoculation the product was mixed well, put into casings and stored for 48 hrs at + 28-30°C for ripening. Subsequently the final products were stored at different temperatures: 7, 10 en 15°C. After 4 weeks, the products were microbiologically evaluated.

Results & Discussion

***L. monocytogenes* in cooked ham**

In all ham products with nitrite contents of 157, 80 or 40 mg/kg the inoculated *L. monocytogenes* bacteria increased by a factor 100 (2 log units) in circa 1,5 weeks storage at 7°C (see Figure 1). Also the aerobic plate counts, mainly consisting of lactic acid bacteria, did increase rather fast in all ham products, exceeding a generally accepted maximum level of 10^7 (log 7) cfu per g within 2 weeks at 7°C (see Figure 2). Growth rates for both bacteria in hams with

standard, medium or low nitrite contents did not differ significantly. The relative rapid development of both *L. monocytogenes* and lactic acid bacteria can be attributed

to the rather high, but quite common, water activity (a_w value) of the ham products ($a_w = 0,972$).

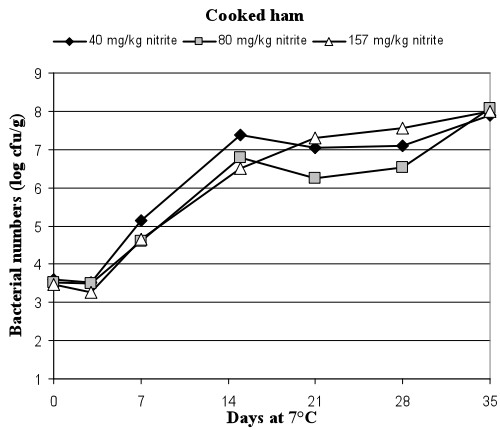


Figure 1 Development of *L. monocytogenes*

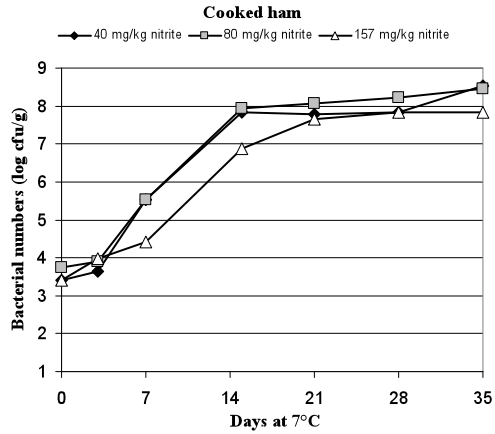


Figure 2 Development of aerobic bacteria

***L. monocytogenes* in Bologna type sausages**

L. monocytogenes inoculated in Bologna type sausage with 160 or 80 mg/kg nitrite did not increase during the entire storage period of 32 days at 7°C (see Figure 3). In the Bologna type sausage with 40 mg/kg nitrite a rather small increase of *L. monocytogenes* by a factor 5 (0.7 log units) was seen during mentioned storage period. The aerobic plate counts in all sausages, mainly consisting of lactic acid bacteria, increased to a level of 10⁷ cfu per g in 3 to 4 weeks (see Figure 4). The reason for the better microbiological stability of the Bologna type sausage compared to the ham product is the relative low water activity ($a_w = 0.965$). Furthermore the presence of lactate in the products is known to have anti-listerial activity.

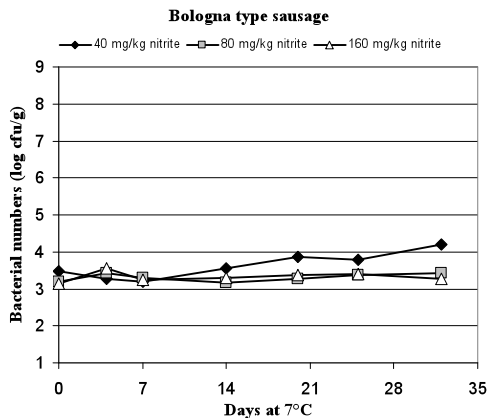


Figure 3 Development of *L. monocytogenes*

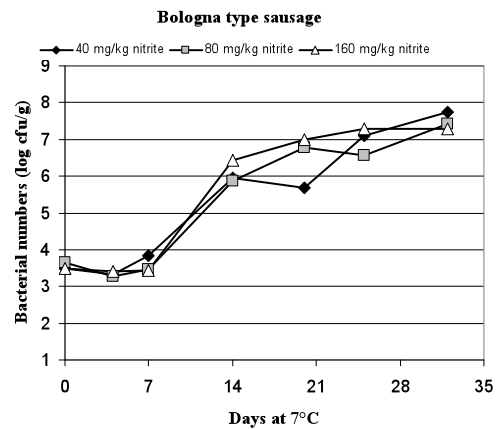


Figure 4 Development of aerobic bacteria

***C. botulinum* in Bologna type sausage.**

Development of *C. botulinum* inoculated in Bologna type sausage without and with 54 and 108 mg/kg nitrite respectively was not detected when stored during 12 weeks at temperatures of 7 or 10°C. Also the botulinum toxin was not determined. This result was irrespectively of the wateractivity of the product. When stored at 15°C development of *C. botulinum* was detected in all products which were produced without nitrite (Figure 5). In the products with a higher a_w value development of *C. botulinum* was detected

earlier. After 56 days of storage, development of *C. botulinum* was detected in all products with high a_w value.

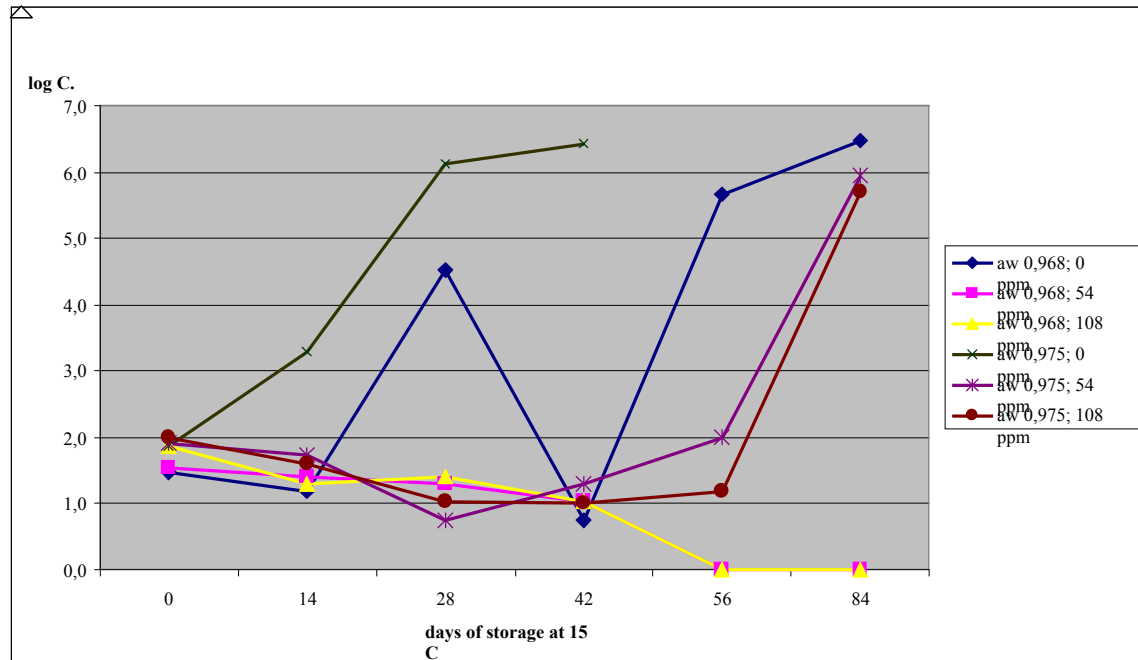


Figure 5 Development of *C. botulinum* in Bologna type sausage

Botulinum toxin was detected in the Bologna type sausage with high a_w value and without nitrite after 6 weeks, in the Bologna type sausage with a lower a_w -value and without nitrite after 8 to 12 weeks and in one case in the Bologna type sausage with high a_w value and with 54 mg/kg nitrite after 12 weeks.

***C. botulinum* in liver sausages and *S. aureus* in fermented sausages.**

Results of experiments with *C. botulinum* and *S. aureus* are pending and not yet available for publishing (June 2011)

Conclusions

- From the challenge tests with cooked ham and Bologna type sausage with standard, medium and low nitrite levels it can be concluded that *L. monocytogenes* as well as lactic acid bacteria are not particularly sensitive to nitrite. Growth rates of these bacteria in both products with different nitrite contents did not differ significantly.
- Differences in water activity (a_w value) between the ham products and the Bologna type sausages appeared to have a more pronounced effect on inhibition of lactic acid bacteria, whereas the relatively low water activity in combination with the presence of lactate in the Bologna type sausage almost completely inhibited the

development of *L. monocytogenes* during the storage period of 32 days at 7°C.

- For meat products with relatively high water activity and/or absence of lactate *L. monocytogenes* can be controlled only by prevention of contamination due to stringent hygiene measures during production.
- At a storage temperature below 10°C, development of *C. botulinum* inoculated in Bologna type of sausage was not detected.
- At higher storage temperatures the risk of botulinum toxin formation in products without nitrite did increase.

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