Changes in sensory profile and microbiological quality during chill storage of cured and uncured cooked sliced emulsion-type sausages

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Abstract

Nine batches of cooked sliced emulsion type sausages, produced from organic meat with or without the use of nitrite, were packed under N_2/CO_2 (7:3) and vacuum, respectively, and stored at 8°C. During two weeks of storage, the microbiological quality was determined, as well as the sensory quality by using profile analysis. The spoilage flora consisted of lactic acid bacteria and Brochothrix thermosphacta, without clear evidence of an inhibitory effect of nitrite on the growth of these organisms. The sensory profile showed an increase of the sour and rancid aroma and flavour, in parallel to the growth of these microorganisms. These changes were more pronounced in the batches prepared without nitrite. Spots of red discolourations were occasionally observed during storage of uncured sausage slices. These may have been caused by reduction of traces of nitrate from spices by psychrotrophic Enterobacteriaceae.

Introduction

The use of curing agents in the processing of organic meat is still a controversial issue (see Lücke 2003). The Regulation (EC) 780/2006 only permits the use of nitrite and nitrate if "no technological alternative giving the same sanitary guarantees and/or allowing to maintain the specific features of the product is available". Nitrite may extend the shelf life of meat products by preventing oxidative deterioration of lipids and inhibiting spoilage bacteria. There are indications that the shelf life of chilled emulsion-type cooked sausages ("Brühwurst") is longer if nitrite is used (Graubaum et al. 2003; Friedrich 2006). If so, this could seriously affect the acceptance of uncured sausages both by retailers and consumers. On the other hand, there was no clear correlation between the overall microbiological quality of Brühwurst sausages and the methods of production (organic vs. conventional, cured vs. uncured; Albert et al. 2003).

The aim of this study was to elucidate which microbiological and sensory parameters are best suited to determine the end of the shelf life and „sell-by-date" of cured and uncured cooked sliced vacuum- or modified atmosphere (MA) packed emulsion-type sausages, and to investigate the effect of nitrite on shelf life.

Materials and methods

Batches of cooked sliced emulsion-type sausages ("Brühwurstaufschnitt") were prepared by two manufacturers (A and B) from organic meat, by use of formulations and processes common in Germany (Leitsätze, 2001). Manufacturer A prepared

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„cured“ (with 2% nitrite curing salt containing 0.4-0.5% sodium nitrite) and “uncured” (with 2% sodium chloride) sausages whereas manufacturer B used 1.83% sodium chloride and slightly more lean meat in the formulation. Sausages had been stored for up to 4 weeks before slicing, and post-process handling and slicing was without the usual precautions against bacterial recontamination. Manufacturer A packaged the sliced sausages under modified atmosphere (MA; N_2:CO_2 = 7:3), manufacturer B under vacuum. Packages were stored in a chill cabinet at 8°C and continuous illumination, reference packages were stored in the dark at 2°C.

For each batch and date, representative samples were taken from two packages and analysed for lactic acid bacteria, *Brochothrix thermosphacta, Enterobacteriaceae* and pH by official methods (Amtliche Sammlung; Baumgart 1999). For sensory evaluation, a panel of 12 individuals was recruited and trained on perception of product-specific traits. The panel identified 15 parameters as important to characterise the sensory profile of the sausages. Sensory profiling was done according to German standards (DIN 1999), using appropriate references for each parameter. 5 – 10 panelists participated in each individual session. Means and standard deviations of observations were calculated using FIZZ Calculations 2.10 Software (Biosystemes, Couternon, France).

Results

Results are summarized in Table 1. Lactic acid bacteria (*Leuconostoc spp., Lactobacillus spp.*) grew from 50 - 5,600 colony-forming units (CFU)/g to about $5*10^6$/g within 5-9 days in all products, without clear evidence for an inhibitory effect of nitrite. The pH decreased somewhat faster in the uncured sausages. In these sausages, *B. thermosphacta* reached high counts somewhat earlier than in the cured sausages; however, this could also be due to higher counts directly after slicing and packaging. Later during storage, growth of *B. thermosphacta* and *Enterobacteriaceae* ceased. Of 14 attributes used in sensory profiling, „sourness“ and „rancidity“ were found to be most important to assess shelf life. These characters were more pronounced in the uncured sausages.

Tab. 1: Spoilage of sliced bologna-type sausages, packaged under modified atmosphere and stored at 7-8°C

Batch*	Nitrite added	Lactic acid bacteria**		Days until pH <5.8	*Brochothrix thermosphacta***		Days until CFU of *Entero-bacteriaceae* $>10^3$/g	Days until deviation in	
		CFU/g, day 0	Days until $>5*10^6$ CFU/g		CFU/g, day 0	days until $>5*10^6$ CFU/g		ranci-dity	sour-ness
ASW1	+	5,600	9	10	60	>15	>15	>15	>15
ASW2	-	4,500	8	9	$1.6*10^6$	4	>15	10	10
ASW3	+	70	6	11	70	>13	13	13	13
ASW4	-	760	6	5	5,600	7	7	7	7
ALY1	+	50	6-7	9	50	10	10	13	13
ALY2	-	1,260	5	5	2,200	7	7	10	7
BJW1	-	not determined (analysis of other batches from manufacturer B indicate lactic acid bacteria and *B. thermosphacta* as spoilage agents)						7	7
BSW1	-							7	7
BLY1	-							7	7

* A and B indicate manufacturers A and B, respectively. SW indicates “Schinkenwurst”, LY indicates “Lyoner” (emulsion-type sausages with and without visible meat particles, respectively).

**arithmetic mean from 2 determinations

After 7 days of storage, areas with pink discolorations appeared in some packages of uncured sausages from manufacturer A. On discoloured slices, *Enterobacteriaceae* were found at levels up to 10^5/g.

Discussion

The emulsion-type sausages analysed had a shelf-life of about 1-2 weeks under vacuum or modified atmosphere at 8°C after being sliced without the usual precautions taken to avoid recontamination. On sausage slices produced by manufacturer A, lactic acid bacteria reached $5*10^6$/g (performance standard according to DGHM 2005) about 2-3 days before the onset of sensory deviations. Spoilage indicators were off-odours and aromas described as “sour” and “rancid”. In uncured sausages, these deviations were more pronounced and observed some days earlier. As observed by Kröckel (2000) and Albert et al. (2003), there was only a loose correlation between the counts of lactic acid bacteria, the pH value and the attribute “sourness”. This may be due to differences in the composition of the lactic flora and their metabolic products.

Data from experimentally prepared emulsion-type cooked sausages (“Brühwurst“) indicate little effect of nitrite at usual ingoing levels (80-100 mg $NaNO_2$/kg) on lactic acid bacteria, and some effect both on *B. thermosphacta* and *Enterobacteriaceae* (Nielsen 1983; Graubaum et al. 2003). Our data are in accordance with this, but gave no unequivocal evidence for an effect of nitrite on growth of these organisms because slices of uncured products had higher counts of *B. thermosphacta* right from the start (possibly due to differences in the organisation of the slicing process by manufacturer A). However, our data confirm that the accumulation of acids by lactic acid bacteria limits further growth of *B. thermosphacta,* as shown by Grau 1980, and Cayré et al. 2005.

„Rancidity“ was observed in both cured and uncured sausages. It is probably due to metabolic products of *B. thermosphacta* (short-chain fatty acids, butane-2,3-diol, 3-methyl propanol and similar compounds; Stanley et al. 1981). Apparently, the inhibitory effect of nitrite on oxidative fat deterioration is of little significance in perishable cooked sliced meats packaged under exclusion of oxygen.

Psychrotrophic *Enterobacteriaceae* in the recontaminant flora are able to reduce traces of nitrate possibly present in uncured sausages, and thus may cause pink spots on a greyish product. This defect will further reduce shelf life and acceptability.

We confirmed that the spoilage flora of cooked sliced vacuum- or MA packed meats consists of recontaminant bacteria (see Borch et al. 1996). Therefore, aseptic conditions during post-process handling of these products are much more relevant to shelf life than the use of nitrite.

Conclusions

We recommend that manufacturers of cooked sliced emulsion-type sausages (“Brühwurstaufschnitt”) from organic meat determine shelf life of these products by standardised sensory analysis, using sourness and rancidity as critical parameters. In

addition, pH value and cell densities of lactic acid bacteria, *B. thermosphacta* and *Enterobacteriaceae* are useful indicators. These bacteria normally do not survive the cooking process. Hence, shelf life of longer than 1-2 weeks at 7°C is difficult to achieve without special precautions (aseptic techniques) in post-process handling and slicing of the sausages. Sensory analysis and data from the literature indicate a significantly shorter shelf life of nitrite-free cooked sliced emulsion-type sausages. However, we could not show a clear inhibitory effect of added nitrite on the bacteria contaminating the sausages after processing.

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