SALT REDUCTION IN COOKED SAUSAGES

H. Kneubühler[1*], P. Eberhard, S. Schlüchter, D. Guggisberg, P. Piccinali

Agroscope Liebefeld-Posieux Research Station ALP, Schwarzenburgstr. 161, CH-3003 Bern, Switzerland

[*]Corresponding author (phone: +41 31 323 89 48; fax: +41 31 323 82 27; e-mail: helena.kneubuehler@alp.admin.ch)

***Abstract*—High salt intake can increase the risk of cardivascular diseases for salt-sensitive individuals. Therefore salt reduction in processed food is an important challenge also for meat industry. The present study evaluated four levels of salt concentration (19, 17, 15 and 12 g NaCl/kg) and three levels of salt substitution with KCl (3, 6, 9 g KCl / kg) in cooked sausages regarding food safety, sensory perception and technological issues. Results showed that reduction to 12 g NaCl /kg is not viable due to reduced solubility of proteins and critical water-binding capacity. But also hedonic evaluation revealed a significant difference to the standard formulation. The sensory profile showed significant differences only for the attribute salty. A reduction to 15 g NaCl / kg seems to be attainable regarding technological aspects and consumer acceptance. But as there existed a significant difference for the attribute salty compared to the standard formulation (19g NaCl / kg), a reduction has to be done gradually. Regarding replacement with KCl no significant differences to the standard formulation were observed, but further investigations are needed.**

I. INTRODUCTION

Excessive salt consumption could lead to hypertension in salt-sensitive individuals. As hypertension is a major risk factor in the development of cardiovascular diseases, WHO experts advise to reduce NaCl intake below 5 g / d (WHO 2003). In Switzerland a 12-year dietary surveillance program in the region of Geneva (1993-2004) estimated a salt intake of 10.6 g/d in men (n= 6,688) and 8.1 g in women (n=6,647) (Beer-Borst et al. 2009). In this study meat and meat products contributed 8% to the total salt intake. Based on these data Swiss Federal Office of Public Health aims to achieve a 16% reduction to less than 8g per day per person over the period from 2008 to 2012 (Swiss Federal Office of Public Health 2009). Longterm vision is to reach the WHO recommendation of 5g / day.

Sodium chloride in meat products is an essential flavouring agent and exerts some antimicrobiological activity (Ruusunen et al. 2001). Salt also plays an important role in formation of protein emulsion and water binding (Honikel 2008). Therefore salt-reduced meat products have to meet microbiological, technological and sensory criteria.

In the present study salt reduction and salt substitution (KCl) in cooked sausages were evaluated.

II. MATERIALS & METHODS

Cooked sausages (Lyoner) were produced at the Education Centre of the Swiss Meat Industry (ABZ), Spiez, Switzerland according to the standard formulation in table 1. Batch size was 10 kg. In 5 alternatives NaCl content was either reduced or partly replaced by potassium chloride (table 2) compared to the standard formulation. After mincing the raw material the resulting batter was stuffed into 50 mm casings (weight of sausages: 400g), cooked to 69°C core temperature and cooled. Lyoner sausages were stored at 2°C before analysis.

Table 1. Standard formulation of cooked sausage (Lyoner)

Ingredient	Standard formulation
Veal V-II [%]	16.0
Pork P-III [%]	23.0
Neck fat P-V [%]	13.0
Shoulder fat P-VII [%]	16.0
Ice water [%]	32.0
Other ingredients [g / kg]	
Nitrite curing salt (99.4%NaCl, 0.6%Na-Nitrite)	19.0
Aufschnitt Kombi (Pacovis AG, CH-5608 Stetten) (2g phosphate, 2g ascorbic acid, 1 g glutamate, 5g spices)	12.0

Table 2. Experimental design Lyoner

alternative	curing salt (sodium nitrite) [g/kg]	potassium chloride [g/kg]
1	19	-
2	17	-
3	15	-
4	16	3
5	13	6
6	10	9

Microbiological analyses were done for total count of mesophilic aerobic bacteria 1d and 21d after fabrication. Samples were further analysed on Na-, K- and Cl-contents and jelly percentage.
Firmness was determined with Warner–Bratzler-apparatus (WB) attached to a Universal Testing Machine (Zwick Z2.5/TN1S, Zwick, Ulm, Germany). The crosshead speed was 100 mm/min. The results were expressed in N for the force (WB-shear force) and mJ for total WB-work.

A panel of nine trained judges rated the attributes salty, bitter, spicy and firm on a 10-point intensity scale. Definitions and references were provided. The samples were tested monadically in a randomised design with one repetition. The tests were performed in separated booths with normal illumination. Tea and white bread were used to neutralize between samples.

Additionally a hedonic evaluation of the cooked sausage was performed by 177 consumers from two sites (easter/western part of Switzerland) by judging 3 different Lyoner (19, 15 and 12g NaCl/kg) on a 9-point scale from 1 (= dislike extremely) to 9 (= like extremely).

Statistical analyses for the descriptive sensory tests were performed by a two-factorial ANOVA followed by a Fisher LSD-test. The hedonic test was analysed using a Friedman-Test ($P \leq 0.05$).

III. RESULTS AND DISCUSSION

All products were of good microbiological quality (< 100 cfu / g), except alternative 4 had a slightly elevated content of mesophilic aerobic bacteria after 21d (3’500 cfu / g). These results were not surprising due to the terminal pasteurisation step during fabrication. Salt does not play an essential role for conservation of this product, correct cooling and avoiding recontamination are much more important.

Results of sodium chloride and potassium are shown in table 3. Results were within the expected range.

Table 3. Sodium chloride and potassium content of different Lyoner

alternative	NaCl [g/kg]	potassium [mg/kg]
1	19.3	1710
2	17.2	1794
3	15.9	1802
4	16.7	3210
5	13.6	4713
6	10.7	6394

In firmness a slight reduction of maximal shear force could be observed from 11.1N to 9.9N with decreasing NaCl content. Also jelly formation was higher for the samples with altered compared to the standard formulation. Although it was not measured instrumentally, texture of Lyoner with 12g NaCl/kg (only for hedonic test) seemed to be clearly less firm. There existed already some problems in solubilisation of the proteins and therefore in water-binding capacity of the batter. This observation confirms earlier findings of Ruusunen & Poulanne (2005), who suggest 1.5% NaCl as a minimal concentration to have good water-binding and stable gel formation.

Significant product differences ($p<0.05$) in sensory analysis were only found for the attribute „salty“. The standard formulation and the formulation with 6 g potassium chloride (alternative 5) were rated saltier than the two alternatives with reduced NaCl-content (Figure 1). Results for samples with potassium chloride were ambiguous and could not be explained. For the attribute bitter no significant differences were found. According to Desmond (2006) 25-40% replacement of NaCl with KCl has no noticeable impact on flavour. As in sample 5 around 47% of sodium chloride was replaced by potassium chloride, the result was quite surprising.

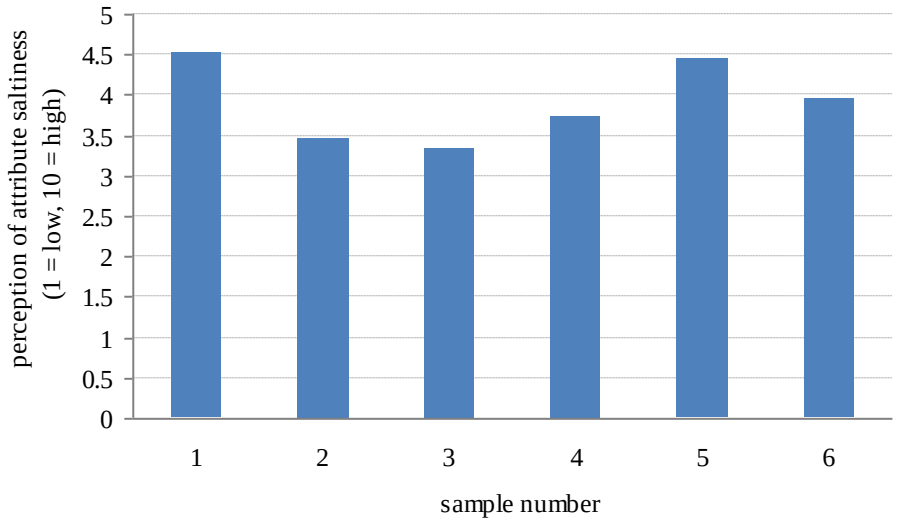

Figure 1. Means of sensory rating for the attribute salty (n=9)

As shown in figure 2, overall liking decreased by reduction of salt content as expected. A significant difference ($p<0.05$) in hedonic ratings was observed between the sample with 19g NaCl/kg and the sample with 12g NaCl/kg. Compared to the results of the analytical panel significant difference in salty taste seems not to evoke significant difference in overall liking.

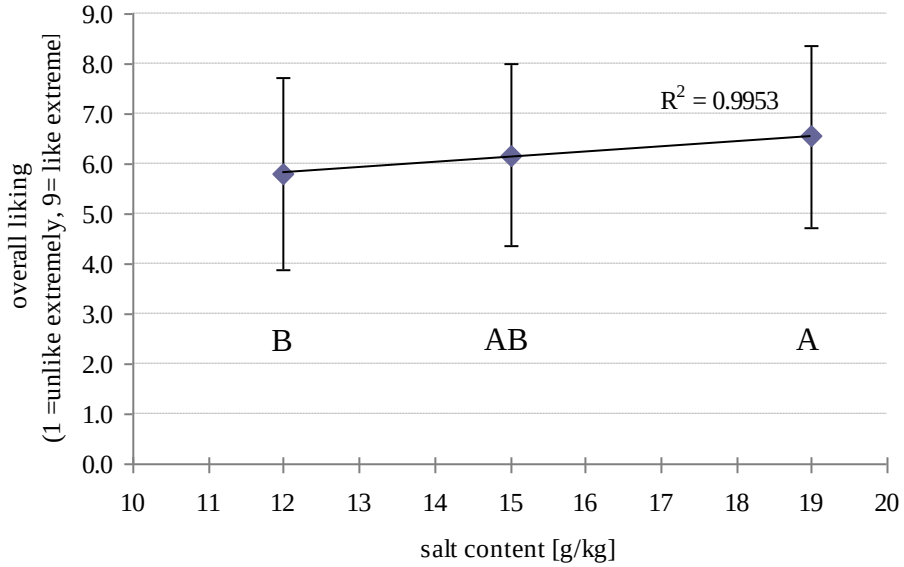

Figure 2. Means of hedonic rating (n=177)

IV. CONCLUSION

Results of this study showed, that salt reduction in Lyoner is limited either by technological conditions or sensory acceptance of the consumers. Sodium chloride reduction to 12g/kg is not reasonable due to insufficient protein solubilisation and reduced water-binding capacity of the batter. Furthermore this sample also was judged significantly lower than standard formulation in overall liking. A reduction to 15g NaCl / kg seems to be attainable regarding technological issues and hedonic rating. Nevertheless it has to be considered, that there was a significant difference in rating of the attribute salty between samples with 15 and 19 g NaCl/ kg, respectively. Therefore the reduction limit has to be verified and a stepwise reduction is suggested.
Replacement of sodium chloride with potassium chloride didn't change technological behaviour. As there was no impact on the attribute "bitter" further investigations also on the level of hedonic tests should be planned.

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