Meat Science 80 (2008) 1225–1230

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Sensory characterisation and consumer acceptability of small calibre fermented sausages with 50% substitution of NaCl by mixtures of KCl and potassium lactate

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ARTICLE INFO

Article history:
Received 24 December 2007
Received in revised form 23 May 2008
Accepted 26 May 2008

Keywords:
Sodium substitution
KCl
Potassium lactate
Fermented sausages
Sensory attributes
Acceptability

ABSTRACT

The effect of six mixtures with 50% molar substitution of KCl (0–50%) and potassium lactate (0–50%) as NaCl substitutes in small calibre fermented sausages on some sensory parameters and on the acceptability was studied. Also, the relationship between sensory profile and consumer acceptability using external preference mapping was investigated. The results showed that as the K-lactate substitution increased, pH, sweetness, crumbliness and pastiness also increased, and piquantness, hardness, cohesiveness, ripened flavour, acid taste and saltiness decreased. However, the treatments prepared with a high level of salt substitution by KCl showed scores of sensory attributes similar to those of the control.
Consumer segmentation showed differences in acceptability between genders, place of residence, educational level and age group. Consumers rejected fermented sausages with high K-lactate substitution but not those with a high KCl substitution. External preference mapping split consumers up into four clusters with different preference patterns. According to these results and from a sensory point of view, it is possible to achieve a reduction of 50% of NaCl in small calibre fermented sausages and to obtain a product acceptable to most consumers.

1. Introduction

The evidence for adverse cardiovascular effects of sodium, which is supported by a number of observational studies, indicate an association of increased risk of morbidity and mortality from cardiovascular diseases, including coronary heart disease and stroke, with increased sodium intake (Dahl, 1972; Kannel, 1996; Law, 1997). However, although sodium restriction is widely recommended to prevent hypertension, this approach is debatable (Freedman & Petitti, 2001) because some studies show that sodium restriction might be beneficial only for a fraction of the population, defined as salt-sensitive (Morris, Sebastian, Forman, Tanaka, & Schmidlin, 1999). For this reason, Chockalingam et al. (1990) recommended moderate salt reduction in normotensive people and salt restriction in those with high blood pressure.

Sodium chloride is the most abundant salt occurring naturally in food and the main source of sodium in the human diet. Recent reports from the European Food Safety Authority (EFSA, 2005) have shown that the general intake of sodium across Europe is high and exceeds the necessary amount. Thus, mean daily sodium intakes range from about 3 to 5 g (about 8–13 g salt) and are in excess of dietary needs (about 1.5 g sodium/day in adults). The largest quantities of salt now consumed originate from industrially processed food (Altschul & Grommet, 1982; Hermansen, 2000).

Based on the scientific information, meat industry and consumers have become more aware of the possible relationship between sodium and hypertension and, as a consequence, the demand for a variety of reduced salt meat products in many countries has increased (Brandsma, 2006; Ruusunen & Puolanne, 2005). In Ireland and in UK, cured and processed meats contribute 20.5% and 20.8%, respectively, to the human sodium intake (Desmond, 2006). Similarly, in Spain meat products represent an important part of the total sodium intake (20–30%) as a result of their large consumption (Anonymous, 2004). For this reason, reduction of sodium in meat products could be of great interest from a health point of view.

NaCl is an essential ingredient in processed meat products, contributing to the water-holding capacity, colour, fat binding properties and flavour. Moreover, salt decreases water activity (a_w) and this significantly affects the shelf-life (Sofos, 1984; Wirth, 1989). Nevertheless, according to Terrell (1983), sodium content in meat products can be lowered by NaCl reduction or substitution with other ingredients, and/or by altering the processing techniques. Several studies state that potassium chloride and potassium lactate (K-lactate) could be used as partial substitutes of NaCl in meat products. KCl has similar functional properties to NaCl, but its addition to meat products is mainly limited by its bitter taste (Askar, El-Samahy, & Tawfik, 1994). In meat products, K-lactate is used to enhance flavour and extend shelf-life. However, the total

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doi:10.1016/j.meatsci.2008.05.031

substitution of NaCl by K-lactate is also limited by its taste (Brewer, McKeith, Martin, Dallmier, & Meyer, 1991; Gou, Guerrero, Gelabert, & Arnau, 1996). Even though reduction of sodium in meat products is possible from a technological and sensory point of view (Askar et al., 1994; Gelabert, Gou, Guerrero, & Arnau, 2003; Gou et al., 1996; Kim & Brewer, 1996), little information exists on consumer acceptability and attitudes towards reduced salt fermented sausages (Guàrdia, Guerrero, Gelabert, Gou, & Arnau, 2006) and on the critical sensory parameters that could lead to rejection by consumers.

External preference mapping is a tool which allows consumer data to be mapped on a multidimensional space, derived from other non-preference (external) descriptive data related to the stimuli (McEwan, 1996; Schlich, 1995). The external space is usually obtained by principal component analysis of descriptive sensory data generated by a trained panel (Greenhoff & MacFie, 1994) which characterise and quantify the sensory properties of food. By integrating consumer and sensory data, directional information may be acquired (Elmore, Heymann, Johnson, & Hewitte, 1999).

The aim of this study was to evaluate the effect of 50% molar substitution of NaCl by mixtures of KCl and K-lactate on some sensory parameters and on consumers' acceptability in small calibre fermented sausages. In addition, the relationship between the sensory profile obtained and consumers' acceptability was evaluated by means of External Preference Mapping.

2. Materials and methods

The study was carried out in small calibre fermented sausages with reduced sodium content in two different steps: a quantitative descriptive analysis (QDA; Stone & Sidel, 1993) and the evaluation of the consumers' acceptability.

2.1. Treatments

According to the results previously obtained by Gou et al. (1996), Gelabert et al. (2003) and Guàrdia et al. (2006), K-lactate and KCl were selected as sodium chloride substitutes in small calibre fermented sausages. Seven treatments of fermented sausages were manufactured: a control (without substitutes) and six treatments with a molar substitution of 50% of the NaCl by different mixtures of K-lactate and KCl (Table 1).

2.2. Fermented sausage preparation

Gilt carcasses with a pH measured on the *semimembranosus* muscle at 45 min *postmortem* of above 6.0 and at 24 h *postmortem* (pH_{24}) lower than 6.2 were selected. Shoulders and bellies were frozen at −20 °C for 3 days, thawed at 4 °C for 2 days and ground in a meat grinder by passing through a 6 mm plate. A shoulder/belly proportion of 50/50 was prepared. The mean fat and moisture contents of the meat preparation were determined by triplicate. Fat was determined by near infrared transmittance (NIT) spectroscopy with an INFRATEC™ 1265 Meat Analyser (Tecator AB, Sweden) and water content was determined by drying at 103 ± 2 °C (ISO 1442) until reaching constant weight. The mean fat and moisture content of the initial meat preparation was 13.0% ± 0.3 and 63.8% ± 0.4, respectively. This meat preparation was mixed with the common additives (g per kg of meat): dextrose 5, lactose 50, black pepper 2, dehydrated garlic 0.3, dehydrated nutmeg 0.3, sodium ascorbate 0.5, starter (Texel, ELCE 10) 0.3, KNO_3 0.15 and $NaNO_2$ 0.1. The mixture was divided into 30 kg portions. Each portion was assigned to a substitution treatment and the correct amount of NaCl and NaCl substitutes were added. K-lactate was added as a liquid solution (purity 60%; PURAC Bioquímica S.A., Montmeló, Barcelona, Spain). Therefore, water was also added to each treatment to achieve a total added water of 30 g/kg of meat. 22 g of NaCl per kg of meat were added to the control. Initial moisture content of each treatment was estimated from the moisture content of the initial meat preparation and the added additives and ingredients. The mix was stuffed in natural pork casings (diameter approximately 40 mm), dipped in a *Penicillium candidum* (Texel) suspension which is a generally practice in the industry to obtain the typical external appearance in the product, and fermented at 18–20 °C and at 80–85% of relative humidity (RH) for 48 h. Drying was carried out at 14–16 °C and at 70–80% of RH for 18 days. Convection in the dryer chambers was intermittent and the air velocity around the low calibre fermented sausages when the fan was running ranged between 0.1 and 0.2 m/s.

Table 1
Percentage of molar substitution of 50% of the NaCl by different mixtures of potassium lactate and potassium chloride

Substitute	Treatments						
	Control[a]	1	2	3	4	5	6
NaCl	100	50	50	50	50	50	50
K-lactate	0	50	40	30	20	10	0
KCl	0	0	10	20	30	40	50

[a] Control: 22 g NaCl/kg product.

2.3. Sensory analysis

Eight selected and trained assessors (ASTM, 1981; ISO 8586-1, 1993 and ISO 8586-2, 1994) undertook the sensory analysis on 5 mm slices of fermented sausages. The generation of the descriptors was carried out by open discussion in three previous sessions. The descriptors retained were: cured colour intensity (intensity of cured colour of the lean), crusty appearance (score of the dry, hard surface), pale core (score of the central discolouration), sweetness (basic taste sensation elicited by sugar), acid taste (basic taste sensation elicited by an acid), saltiness (basic taste sensation elicited by NaCl), bitterness (basic taste sensation elicited by caffeine and L-Tryptophan), piquantness (stinging sensation in the mouth and throat), K-lactate flavour (flavour of a water solution containing K-lactate), garlic flavour (intensity of garlic flavour), ripened flavour (pleasant flavour characteristic of fermented sausages), off-flavours (flavour differing from the typical flavour), hardness (force required to bite through the sample), cohesiveness (textural property perceived by the tongue and teeth related to the strength of the internal bonds of the sample), crumbliness (textural property characterised by ease with which a sample can be separated into smaller particles during chewing), pastiness (textural property characterised by flour–water paste), fat fluidity (perception of the fluidity of the fat during chewing). A non-structured scoring scale (Amerine, Pangborn, & Roessler, 1965) was used, where 0 meant absence of the descriptor and 10 meant high intensity of the descriptor. Sensory evaluation was undertaken in four sessions and a complete block design was used (Steel & Torrie, 1983), where each taster assessed all the treatments in each session. Samples were coded with three random numbers and were presented to the assessors balancing the first-order and the carry-over effects according to MacFie, Bratchell, Greenhoff, and Vallis (1989).

2.4. Consumers' survey on acceptability

Two hundred and thirty nine consumers evaluated the acceptability of the seven different treatments of fermented sausages following a complete block design. A non-structured scoring scale (0 = dislike extremely and 10 = like extremely) was used. The sam-