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The effect of yeast extract addition on quality of fermented sausages at low NaCl content

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ABSTRACT

Fermented sausages with 25% or 50% of their NaCl replaced by KCl and supplemented with 1% or 2% concentrations of yeast extract were produced. The sausage production process was monitored with physical, chemical and microbiological analyses. After production, the sausage samples were submitted to a consumer study and their volatile compounds were extracted by solid-phase microextraction and analyzed by GC–MS. The replacement of NaCl by KCl did not significantly influence the physical, chemical or microbiological characteristics. The sensory quality of the fermented sausages with a 50% replacement was poor compared with the full-salt control samples. The use of yeast extract at a 2% concentration increased volatile compounds that arose from amino acids and carbohydrate catabolism. These compounds contributed to the suppression of the sensory-quality defects caused by the KCl introduction, thus enabling the production of safe fermented sausages that have acceptable sensory qualities with half as much sodium content.

1. Introduction

Diet is not the only factor affecting well-being and health, but it is one of the most important. More and more, throughout the developed world, people seek to have a balanced diet consisting of healthy food that is still appealing to the senses. Meat products have traditionally been described as villains in the diet because of their high fat, cholesterol and salt (or sodium) content, along with the chemical additives often present. However, these foods have recently become part of the new balanced-diet-seeking market segment. To create truly healthy meats, efforts should be directed toward the reduction of those components in the formulation that are less healthy and thereby improve the image of meat products for consumers.

The clear association between meat consumption and the incidence of hypertension (Dickinson & Havas, 2007; Paik, Wendel, & Freeman, 2005) makes sodium reduction a necessity for the survival of the meat industry. Meat products contribute 20% to 30% of an average person's daily intake of salt (NaCl). In industrialized countries, the amount varies from 9 to 12 g/day which is much higher than the 5 g recommended (Jiménez-Colmenero, Carballo, & Cofrades, 2001; WHO, 2003). Because of the dehydration process undergone during their production, fermented sausages are among meat products that have the highest NaCl content, which can reach as high as 6%.

However, a simple reduction of NaCl content in fermented sausages is unacceptable from a sensory appeal and technological point of view because this ingredient not only determines the characteristic salty taste of meat products but it contributes to microbiological safety (Ruusunen & Puolanne, 2005). The replacement of NaCl by other ingredients that perform similar technological functions while maintaining its sensory characteristics is suggested as an alternative for making this meat product have a healthier appeal.

The partial replacement of NaCl by other chloride salts is one attempted strategy. Substituting potassium chloride is the most well-studied example (Champagne, Fontaine, Dussault, & Delaquis, 1993; Gelabert, Gou, Guerrero, & Arnau, 2003; Guàrdia, Guerrero, Gelabert, Gou, & Arnau, 2008). KCl is recognized as safe (GRAS) and has an antimicrobial efficiency equivalent to NaCl (Bidlas & Lambert, 2008). Nevertheless, sensory defects related to the rise of a bitter taste and to the reduction of the salty taste are commonly reported and present the main limitation of KCl's use as substitute for NaCl in fermented meat products (Gelabert et al., 2003; Gimeno, Astiasarán, & Bello, 1998; Gou, Guerrero, Gelabert, & Arnau, 1996).

Thus, the use of ingredients that can improve the sensory attributes of KCl is a promising alternative to be studied. Yeast extracts are a natural source of a number of volatile compounds and have been widely used as flavoring agents and as precursors to the formation of compounds that have pleasurable tastes and aromas in meat products (Mahadevan & Farmer, 2006). In the manufacture of fermented sausages there occur many biochemical reactions that are catalyzed either by microbial enzymes or by tissues. The use of these

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compounds, themselves sources of amino acids, could help the emergence of compounds that have tastes and aromas that help offset the bad taste and lack of saltiness of KCl use.

So far, it appears to the authors, that the potential of using yeast extract combined with KCl to reduce the sodium content in fermented sausages has not been explored. Thus, the aim of this paper is to evaluate the effect of KCl use with the addition of yeast extract on the quality of fermented sausages with reduced sodium content.

2. Material and methods

2.1. Treatments

Treatments that replaced 25% and 50% of the NaCl content with KCl were tested. Concentrations of 1% and 2% of commercial yeast extract produced from *Saccharomyces cerevisiae* (Bionis YE GMX 18, Biorigin, Lençois Paulista, SP, Brazil) were added to the fermented sausages with reduced NaCl content (Table 1).

2.2. Preparation of fermented sausages

Samples of fermented sausages were prepared using pork (*M. longissimus dorsi*) (650 g/kg), beef (*M. semitendinosus*) (200 g/kg) and pork back fat (150 g/kg). A portion of pork (50 kg) was ground using a 12 mm disk, and a portion of beef (20 kg) was ground using an 8 mm disk. The portion of pork back fat (15 kg) was cut in cubes of approximately 1 cm^3. The raw materials were mixed with the following ingredients; glucose (5 g/kg), sucrose (5 g/kg), sodium nitrate (0.15 g/kg), sodium nitrite (0.15 g/kg), sodium ascorbate (0.25 g/kg), white pepper (2 g/kg), garlic (3 g/kg), nutmeg (0.02 g/kg) and starter culture Floracarn SPX (Chr. Hansen) (0.25 g/kg). After mixing, the mass of meat was divided into portions of 10 kg, resulting in seven treatments. Each treatment was mixed with the proper quantity of NaCl, KCl and yeast extract (Table 1). Next, the treatments were stuffed in collagen casings of 60 mm diameter and cut in slices of approximately 15 cm in length. In total, 50 pieces of approximately 200 g each were prepared for each treatment. After being stuffed, the samples were subjected to a bath in a 20% solution of potassium sorbate and ripened in a laboratory ripening cabinet (Menoncin, Erechim, Brazil) programmed to give the following conditions: 24 h at 25 °C and a relative humidity (RH) of 95%, followed by 15 °C and a RH 75%, until the end of the experiment (23 days).

2.3. Physical and chemical analysis

The determination of pH was performed by homogenizing 10 g of each sample with distilled water in a 1:10 sample:water ratio. The homogenate was subjected to a pH test using meter electrodes (DM 22, Digimed, São Paulo, Brazil) for 5 min while the pH readings were performed. The determination of pH was performed on days 0, 3, 7, 14 and 23 postproduction. The water activity (Aw) was determined at days 0, 7, 14 and 23 postproduction using an Aqua lab CX-2 water-activity meter (Decagon Devices, Inc., Pullman, WA). Three sausages per batch were used to evaluate the pH and Aw. The color determination was performed at the beginning and end of sausage production, with a Minolta Chroma Meter CR-300 machine (Minolta Câmera Co. Ltda, Osaka, Japan) with D65 illuminant. CIELAB L^*, a^* and b^* values were determined as indicators of lightness, redness and yellowness. Color variables were measured at four points on the central part of the cut surface of three slices of the five sausages per batch. Before each series of measurements, the instrument was calibrated using a white ceramic tile. The weight loss was determined by the weight difference among ten sausages per batch just after the stuffing process and after the end of sausage production. At the end of fermented sausage production, three sausages per batch were used to evaluate the concentration of sodium using an inductively coupled plasma optical emission spectrometer (ICP OES) (Vista MPX, Varian, Mulgrave, Australia), according to the methodology described by the AOAC (2005). The operating conditions of the ICP OES equipment were: potency, 1000 W; nebulizing rate, 0.9 L/min; flow rate of argon and the auxiliary gas, 1.5 and 15 L/min; integrating and reading times, 10 and 3 s; and number of replicates, 3. The wavelength (nm) used was: Na, 589.592.

2.4. Microbiological analysis

Three sausages per batch were used to evaluate the microbiological characteristics on days 0, 3, 7, 14 and 23 postproduction according to the methodology described by Vanderzant and Splittstoesser (1992). Aliquots of 25 g were collected and homogenized with 225 mL of 0.1% peptone water (Oxoid Unipath Ltda., Basingtoke, Hampshire, UK). Then, they were serially diluted on a decimal scale. Lactic acid bacteria (LAB) were quantified using agar of De Man Rogosa Sharpe (Oxoid) at 37 °C for 48 h. Micrococaceas were quantified using manitol salt agar (Oxoid) at 37 °C for 48 h. Total coliforms were quantified in crystal agar neutro-bile violet-red (Oxoid) at 37 °C for 24 h. Fecal coliforms were quantified in EC broth (Oxoid) at 45 °C for 48 h.

2.5. Volatile compounds analysis

From each treatment, three pieces of fermented sausage were separated and frozen (−18 °C) soon after 23 days of ripening. Thus, a significant portion of each sample was cut into small cubes and ground in a domestic processor. After processing, a 5 g portion of the homogenized sample was weighed in a 20 mL flask that was immediately sealed with a septum of an internal face of PTFE. It was then subjected to extraction.

The solid-phase microextraction method described by Wagner (2008) was used to extract volatile compounds from the headspace of the fermented sausage samples. The fiber used was the mixed covering, Carboxen-PDMS (75 μm; Supelco, Bellefonte, PA, USA). During the stage of volatile compound isolation, the needle of the SPME system was introduced into a flask containing the sample (via the septum) and then exposed to the headspace. The fiber was exposed in the headspace of the sample for 45 min at a temperature of 50 °C. After this period, the fiber was collected and removed from the flask. Before the fiber's exposure to the headspace, the flask containing the samples was immersed into a water bath at the same

Table 1
Percentages of NaCl, KCl and yeast extract used in the formulation of fermented sausage treatments.

	Treatments (%)						
	Control	$LS_{25\%}$	$LS_{50\%}$	$LS_{25\%}+YE_{1\%}$	$LS_{50\%}+YE_{1\%}$	$LS_{25\%}+YE_{2\%}$	$LS_{50\%}+YE_{2\%}$
NaCl	2.5	1.875	1.25	1.875	1.25	1.875	1.25
KCl	–	0.625	1.25	0.625	1.25	0.625	1.25
Y.E.[a]	–	–	–	1.0	1.0	2.0	2.0

[a] Yeast extract (Bionis YE GMX 18): **Physico-chemical characteristics (%): moisture (Max.: 6.0), carbohydrates (Max.: 10.0), ashes (Max.: 30.0), fat (0.0–0.3), proteins (Min.: 55.0). Average free amino acid composition (expressed in 100 g of raw proteins): alanine (3.10), arginine (1.87), aspartic acid (1.42), glycine (0.74), isoleucine (1.42), leucine (2.42), glutamic acid (8.61), lysine (1.28), cystine (0.31), methionine (0.74), phenylalanine (1.41), tyrosine (1.01), threonine (1.01), proline (0.96), valine (1.71), histidine (0.36) and serine (1.20). **Provided by the manufacturer (Biorigin, Lençois Paulista, SP, Brazil).