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Sensory acceptability of slow fermented sausages based on fat content and ripening time

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ABSTRACT

Low fat dry fermented sausages were manufactured using controlled ripening conditions and a slow fermented process. The effect of fat content and ripening time on the chemical, colour, texture parameters and sensory acceptability was studied. The fat reduction in slow fermented sausages produced an increase in the pH decline during the first stage of the process that was favoured by the higher water content of the low fat sausages. Fat reduction did not affect the external appearance and there was an absence of defects but lower fat content resulted in lower sausage lightness. The sausage texture in low fat sausages caused an increase in chewiness and at longer ripening times, an increase in hardness. The sensory acceptability of the fermented sausages analyzed by internal preference mapping depended on the different preference patterns of consumers. A group of consumers preferred sausages with high and medium fat content and high ripening time. The second group of consumers preferred sausages with low ripening time regardless of fat content except for the appearance, for which these consumers preferred sausages of high ripening time. Finally, the limit to produce high acceptability low fat fermented sausages was 16% fat content in the raw mixture that is half the usual content of dry fermented sausages.

1. Introduction

Dry fermented sausages are meat products with high fat content. Commercial sausages have fat contents around 32% directly after manufacture, but as a result of drying this rises to about 40–50% (Wirth, 1988). Fat is responsible for various properties of dry fermented sausages. Firstly, from a physiological point of view, fat acts as a source of essential fatty acids and fat soluble vitamins and constitutes the most concentrated source of energy in the diet (9 kcal/g) (Mela, 1990). Secondly, fat contributes to the flavour, texture, mouthfeel, juiciness and lubricity, which determine the quality and acceptability of dry sausages. Finally, the granulated fat has a technological function in the manufacture of dry fermented sausages as it helps to loosen up the sausage mixture to facilitate the continuous release of moisture from the inner layer of the sausage; a process necessary for undisturbed fermentation and flavour development (Wirth, 1988).

In recent years, increased concerns about the potential health risks associated with the consumption of high fat foods has led the food industry to develop new formulations or modify traditional food products to contain less fat (Mendoza, Garcia, Casas, & Selgas, 2001). One of the strategies for the development of low-fat fermented sausages was the reduction of fat content and the simultaneous addition of non-lipid fat replacers to minimize texture defects (Muguerza, Gimeno, Ansorena, & Astiasarán, 2004). In this regard, the addition of inulin, cereal and fruit fibres, and short-chain fructooligosaccharides gave satisfactory results for the reduction of fat content in dry fermented sausages (Mendoza et al., 2001; García, Dominguez, Galvez, Casas, & Selgas, 2002; Salazar, García, & Selgas, 2009). Other strategies were focused on the replacement of pork back fat by olive oil in order to have a positive effect on consumer health (Bloukas, Paneras, & Fournitzis, 1997; Muguerza, Fista, Ansorena, Antiasarán, & Bloukas, 2002; Muguerza, Ansorena, Bloukas, & Antiasarán, 2003; Koutsopoulos, Koutsimanis, & Bloukas, 2008; del Nobile, Conte, Incoronato, Panza, Sevi, & Marino, 2009).

Dry fermented sausages are one of the most difficult meat products as far as fat reduction is concerned. Excessive fat reduction leads to harder or rubbery products due to higher weight losses (Keeton, 1994) and also, unacceptable appearance produced by the presence of wrinkled surfaces and case hardening (Muguerza et al., 2002). However, these defects can be avoided if appropriate processing or climatic conditions are applied as suggested Wirth (1988). Wirth suggested that fat reduced fermented sausages of acceptable standard can be made with fat contents in the raw material of about 15%, which rises to 20–30% in the finished product. Liaros, Katsanidis, and Bloukas (2009) have proposed the use of vacuum packaging during ripening as an effective technique to improve external appearance in low fat fermented sausages. However, high fat sausages still had the highest acceptability scores (Mendoza et al., 2001), not only due to their appearance but also to other sensory characteristics such as texture and flavour. So, it is necessary to determine the effect of fat reduction on consumer

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acceptability in order to elucidate the limit of fat reduction. Moreover, processing conditions should be controlled to avoid the appearance of case hardening therefore; it is proposed to use a slow fermented process to obtain low fat fermented sausages of high organoleptic quality.

The aim of this study was to determine the limit of fat reduction based on consumer acceptability and taking into consideration the ripening process.

2. Materials and methods

2.1. Dry fermented sausages

Three batches of dry fermented sausages (20 kg meat batter for each batch) with different pork back fat contents (10%, 20% or 30%) were manufactured; low fat (LF), medium fat (MF) and high fat (HF) respectively. The lean pork and the pork back fat were ground through a 10 mm diameter mincing plate and vacuum minced with the following additives (g/kg): sodium chloride (27), lactose (20), dextrin (20), sodium caseinate (20), glucose (7), sodium ascorbate (0.5), sodium nitrite (0.15) and potassium nitrate (0.15). Also, a commercial starter culture (0.1) SP-318 was added (Danisco, Cultor, Madrid, España) containing *Lactobacillus sakei*, *Pediococcus pentosaceus*, *Staphylococcus xylosus*, and *Staphylococcus carnosus*. The meat mixture was maintained at 3–5 °C for 24 h and then was stuffed into collagen casings (Fibran, S.A., Girona, España, 75–80 mm diameter) the final weight of each sausage was 700 g. Approximately 30 sausages were made in each batch. The sausages were dried for 42 d at 10 °C and 80–90% relative humidity (RH). After 42 d of processing, the temperature was increased to 12 °C for 4 d and finally, was mantained for 17 d at 10 °C and 75–85% RH. The total drying time was 63 d (Fig. 1). Temperature and RH of the ripening chambers were continuously recorded. In order to control the ripening process, two sausages from each treatment were weighed almost every day to control weight losses that were expressed as a percentage of the initial weight. Also, two sausages from each batch were used to control the pH by introducing a pH meter HI 99163 (Hanna Instruments Inc., Hoonsocket, USA) into the centre of the sausage as described by ISO 2917 (1999).

From each batch (LF, MF and HF), 200 g of the minced meat mixture were collected and at days 9, 18, 42 and 63, four sausages from each batch were randomly chosen to study the effect of ripening time and fat content. In each sample colour analyses were done and then, 150 g of the sample were minced and used for moisture, water activity and pH analyses. The remaining minced sample was vacuum packed and frozen at −20 °C for subsequent analyses (protein and lipid contents). All the results were expressed as the mean of four replicates at each sampling time. Finally, at 42 and 63 d of the drying process four sausages from each batch were taken for sensory and texture analyses.

2.2. Chemical analyses (pH, water activity, moisture, protein, and total lipids)

The pH was measured as described by ISO 2917 (1999) by introducing a portable pH meter (HI 99163, Hanna Instruments Inc., Hoonsocket, USA) into a mixture of sausage and water (1:1). Water activity was determined using a FAst-lab (Gbx, Romans sur Isère Cédex, France) water activity meter, previously calibrated with sodium chloride and potassium sulphate.

Moisture content was determined according to the official method for analysis of meat products BOE (1979) by drying at 100 °C to constant weight. Nitrogen content was determined by the Kjeldahl method and protein estimated by multiplying the nitrogen content by 6.25. Total lipids were extracted from 5 g of minced sausage according to Folch et al. (1957), using dichloromethane:methanol (2:1) instead of chloroform:methanol (2:1) as solvent. The extracts were dried in a rotating vacuum evaporator and weighed to determine the total lipid content.

2.3. Colour measurement

Colour measurements were carried out using a CR-410 colorimeter (Minolta Chroma Meter Measuring Head, Osaka, Japan) with D65 illuminant. Each sausage was cut and the colour of the slices was measured three times for each analytical point. L^*, a^*, and b^* scale coordinates were obtained: L^* (lightness), a^* (redness) and b^* (yellowness). Before each series of measurements, the instrument was calibrated using a white ceramic tile.

2.4. Texture profile analysis (TPA)

Instrumental texture was measured with a TA-XT.plus Texture Analyzer using the Texture Exponent software (version 2.0.7.0. Stable Microsystems, Godalming, UK). Dry fermented sausage slices (4 × 1.5 cm) and cubes (2 × 2 × 1.5 cm) were evaluated. The speed was 1 mm s^{-1} with a strain of 50% of the original cube height for samples stored 42 d and a strain of 25% of the original cube height for samples stored 63 d with a 5 s interval between compression cycles. A trigger force of 5 g was selected. The compression was performed using a 75 mm diameter aluminium plate (P/75). The samples were compressed twice to give a TPA from which the three primary textural parameters (Pons & Fiszman, 1996) were obtained: hardness (the peak force during the first compression cycle), springiness (the height that the food recovers during the time that elapses between the end of the first bite and the start of the second bite) and cohesiveness (the ratio of the positive force area during the second compression portion to the positive force area during the first compression), as well as the secondary parameter chewiness (the product of hardness, cohesiveness and springiness). Twelve samples per batch (LF, MF, and HF) and ripening time (42 and 63 d) were measured.

2.5. Sensory analysis

Seventy-five consumers, 45 female and 30 male, who consumed dry fermented sausages on a regular basis, were used. Testing was carried out in a sensory laboratory equipped with individual booths (ISO 8589, 1988). The casing was removed and the sausages were cut into slices of approximately 4 mm thickness and served at room temperature on white plastic dishes. Water and unsalted toasts were provided to cleanse the palate between samples. Consumers tasted, in two different sessions, three samples (HF, MF and LF) at each ripening time (42 and 63 d) identified with random, three-digit codes, following a balanced complete block experimental design. For each sample, consumers scored the overall acceptability as well as the acceptability of

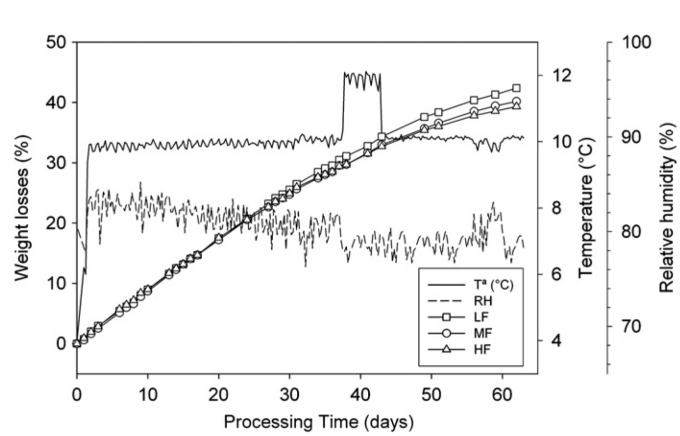

Fig. 1. Processing conditions (Tª and RH) applied in the manufacture of the slow fermented sausages. Weight losses of the different batches are shown as LF (□), MF(○) and HF(△).