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Aminogenesis control in fermented sausages manufactured with pressurized meat batter and starter culture

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Abstract

The application of high hydrostatic pressure (200 MPa) to meat batter just before sausage fermentation and the inoculation of starter culture were studied to improve the safety and quality of traditional Spanish fermented sausages (fuet and chorizo). Higher amounts of biogenic amines were formed in chorizo than in fuet. Without interfering with the ripening performance in terms of acidification, drying and proteolysis, hydrostatic pressure prevented enterobacteria growth but did not affect Gram-positive bacteria significantly. Subsequently, a strong inhibition of diamine (putrescine and cadaverine) accumulation was observed, but that of tyramine was not affected. The inoculated decarboxylase-negative strains, selected from indigenous bacteria of traditional sausages, were resistant to the HHP treatment, being able to lead the fermentation process, prevent enterococci development and significantly reduce enterobacteria counts. In sausages manufactured with either non-pressurized or pressurized meat batter, starter culture was the most protective measure against the accumulation of tyramine and both diamines.

Keywords: Fermented sausages; High hydrostatic pressure; Starter culture; Biogenic amines; Enterococci; Enterobacteria

1. Introduction

Food quality and safety are of paramount importance to health and research organisations worldwide. The improvement of food products in relation to quality attributes arises from the requirement of good manufacturing practices and the need for minimizing the risks, while ensuring the desired sensory traits of food products. Biogenic amines have been classically regarded as potentially hazardous microcomponents of food that may cause disorders to consumers, although the toxic doses and the mechanisms of such effects are not well established. Besides the toxicological implications, biogenic amines are of concern in relation to food hygiene (Mariné-Font, Vidal-Carou, Izquierdo-Pulido, Veciana-Nogués, & Hernández-Jover, 1995). Biogenic amines accumulate in food as a consequence of bacterial amino acid-decarboxylase activity. Food produced through a fermentation process is described as particularly rich in biogenic amines. Indeed, the growth of a wide variety of bacteria potentially harbouring decarboxylase activity, the mild acidification and the proteolysis taking place during fermentation, are favourable conditions for biogenic amine accumulation. Fermenting microorganisms, mainly non-starter lactic acid bacteria, seem to play a significant role in the amine accumulation, especially tyramine. The contaminant microbial population (such as enterobacteria) also contributes largely to the occurrence of certain amines (such as diamines putrescine and cadaverine) being indicative of improper hygienic conditions. Therefore, the optimization

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of hygienic conditions of both raw materials and processing is one of the key measures that enable the control of the aminogenesis during food processing and storage (Bover-Cid & Holzapfel, 1999; Bover-Cid, Izquierdo-Pulido, & Vidal-Carou, 2001; Halász, Báráth, Simon-Sarkadi, & Holzapfel, 1994).

The hygienic quality of raw materials may be improved by decreasing microbial loads through sterilization or pasteurization, which is a common practice in the cheese making industry. However, in the case of fermented meat products, high temperatures cause detrimental changes in the raw materials, and thus, it is not possible to apply conventional heat treatments. Alternative non-thermal technologies show challenging possibilities in this connection. For instance, high hydrostatic pressure (HHP) is getting popularity especially in relation to the so-called hurdle technology. Thanks to its advantages in comparison to thermal treatments to inactivate microorganisms with minimal sensory changes to the product, HHP has promising applications to satisfy consumer demand for high quality and safe meat products (Hugas, Garriga, & Monfort, 2002). Some works have been published dealing with the effect of HHP on the stability of meat products and its biogenic amine content during storage (Garriga et al., 2005; Ruíz-Capillas & Jiménez-Colmenero, 2004). To the best of our knowledge, within the field of biogenic amines, the effect of HHP applied to raw materials has only been studied in milk used for cheese production as an alternative to pasteurization, with equivalent effects on aminogenesis (Novella-Rodríguez, Veciana-Nogués, Trujillo-Mesa, & Vidal-Carou, 2002). However, no research has been carried out in relation to fermented sausages.

Traditional Spanish low-acid ripened sausages are manufactured following traditional procedures, which are based on a spontaneous fermentation process at a relatively low temperature of approximately 10–15 °C. The ripening and drying process ensures low water activity values, but these slightly fermented products are characterized by a relatively high pH (over 5.3). Microflora contaminating raw materials (Gram-negative bacteria) may not be totally inhibited during the manufacture, compromising the safety and stability of the final product. The inoculation of competitive and decarboxylase-negative starter culture has been shown to be a useful tool to inhibit spontaneous aminogenic microflora and thus considerably reduce aminogenesis (Bover-Cid, Hugas, Izquierdo-Pulido, & Vidal-Carou, 2000). However, the selection of appropriate strains is needed to keep the typical sensory characteristics of particular artisanal products (Di Maria, Basso, Santoro, Grazia, & Coppola, 2002).

In this frame, the present work deals with the study of the potential application of mild HHP treatments on meat batter just before fermentation to improve the safety and quality of the final product. Moreover, decarboxylase-negative starter cultures, accurately selected from the indigenous microflora of traditional sausages showing optimal technological properties, were assessed in order to investigate their resistance to HHP and their ability to inhibit aminogenesis in two different types of traditional Spanish fermented sausages: fuet and chorizo.

2. Materials and methods

2.1. Sausage manufacture and sampling

The experiment was carried out with two types of traditional low-acid fermented sausages: fuet and chorizo. A total of eight batches of fermented sausages were manufactured in parallel (following the experimental design of Fig. 1) from the same lot of raw materials consisting of 50% of lean pork meat and 50% pork back fat. Meat raw materials were minced at −1 °C in a meat cutter (Tecmap, Barcelona, Spain), with an adjustable plate set at a hole diameter of 6 mm, and then mixed with other ingredients in a mixer machine (model 35P, Tecnotrip S.A., Terrassa, Spain). For fuet sausages the ingredients were 20 g/kg sodium chloride, 2.5 g/kg black pepper, 1.0 g/kg dextrose, 0.5 g/kg sodium ascorbate 0.1 g/kg potassium nitrate and 0.1 g/kg sodium nitrite. Chorizo sausages contained 20 g/kg sodium chloride, 15 g/kg cayenne pepper, 15 g/kg paprika, 3.0 g/kg powdered garlic and 1.0 g/kg dextrose. Cayenne pepper and paprika supplied 0.05 g/kg nitrate and 0.04 g/kg nitrite as curing agents for chorizo sausage (Garriga et al., 2005).

The mixture for each type of product was divided in two further parts. To one of them a mixture of bacteria consisting of two strains of *Lactobacillus sakei* (CTC6469 and CTC6626) and two strains of *Staphylococcus xylosus* (CTC6013 and CTC6169) was inoculated to achieve 4×10^5 CFU/g of sausage for each specie. These strains had previously been isolated from traditional low-acid fermented sausages and had demonstrated a proper performance as starter cultures for both fuet and chorizo (Garriga et al., 2005). The other part was not inoculated in order to proceed with a spontaneous fermentation. Sausages were stuffed into collagen casings (4 cm diameter; Colex 32 mm, Fibra S.A., Girona, Spain). For each type of product, either without or with starter culture, half of the stuffed sausages were vacuum packaged in polyamide-polyethylene bags (Sacoliva, Castellar del Vallès, Spain) and submitted to a high hydrostatic pressure treatment of 200MPa for 10 min at 17 °C, using an industrial high hydrostatic pressurization unit (Alstom, Nantes, France); whereas the other half were not pressurized. Packaging was removed after the high pressure processing. All sausages were hung in a climate chamber MLR.350 H (Sanyo Electric Co., Ora-Gun, Japan) at 12 °C and with a relative humidity of >95% for 10 days and reduced to 80% till the end of the ripening process (21 days). Three sausages from each batch were sampled during the ripening process at selected times: just after stuffing (time 0) and after 1, 2 and 3 weeks. The analytical determinations were performed in triplicate.