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Use of acid whey and mustard seed to replace nitrites during cooked sausage production

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ABSTRACT

The aim was to determine the effects of sea salt, acid whey, native and autoclaved mustard seed on the physico-chemical properties, especially colour formation, microbial stability and sensory evaluation of non-nitrite cooked sausage during chilling storage. The cooked pork sausages were divided into 4 groups (group I — control sausages with curing salt (2.8%) and water (5%) added; group II — sausages with sea salt (2.8%) and acid whey (5%) added; group III — sausages with sea salt (2.8%), acid whey (5%) and mustard seed (1%) added; group IV — sausages with sea salt (2.8%), acid whey (5%) and autoclaved mustard seed (1%) added).

Instrumental colour (L*, a*, b*), oxygenation index (ΔR), 650/570 nm ratio, heme iron, pH value and water activity (a_w) were determined 1 day after production and after 10, 20 and 30 days of refrigerated storage (4 °C). Sensory analysis was conducted immediately after production (day 1). Microbial analysis (lactic acid bacteria, total viable count, *Clostridium* spp.) was determinated at the end of storage (30 days).

The autoclaved mustard with acid whey can be used at 1.0% (w/w) of model cooked sausages with beneficial effect on physico-chemical and sensory qualities of no-nitrite sausage. This product can be stored at refrigeration temperature for up to 30 days, in vacuum, with good acceptability. The colour, visual appearance and overall quality of samples with autoclaved mustard seed and acid whey were similar to the control with curing agent.

1. Introduction

Several studies have documented consumer preferences towards the organic foods because of the absence of antibiotics, pesticides, hormones, GMO and chemical additives especially nitrate and nitrite (Sebranek & Bacus, 2007). Nitrite is responsible for development of cured colour and flavour, for imparting antioxidant activity, extending shelf life, and suppressing the outgrowth of many pathogenic microorganisms including *Clostridium botulinum* (Honikel, 2008; Shahidi & Pegg, 2006). However, nitrite is an extremely reactive compound and under certain circumstances (lower pH, high temperature) it can act as a nitrosating agent to produce nitroso compounds (Honikel, 2008). Many of the nitrosamines formed from nitrite and secondary amines have been found to be carcinogenic not only for small children but also for adults (Cammack et al., 1999; Cassens, 1995). On the one hand, nitrite is a unique ingredient that is essential for cured meat properties and for which there is no single substitute (Cassens, 1995; Sebranek & Bacus, 2007; Sebranek, Jackson-Davis, Myers, & Lavieri, 2012), on the other hand because nitrite is categorized as a preservative, the addition of nitrite to organic processed meats is not permitted by the law in many countries because "chemical preservatives" cannot be used in products marketed as organic (Sebranek & Bacus, 2007; Sebranek et al., 2012). As a result, alternative procedures for meat curing are required to produce natural or organic processed meats that have characteristics similar to nitrite-cured meats (Bázan-Lugo, García-Martínez, Alfaro-Rodríguez, & Totosaus, 2012; Sebranek & Bacus, 2007). Numerous studies have been carried out to replace nitrite in meat products (Sebranek et al., 2012), but none of the alternatives found are as effective in colour formation or bacteriostatic action on such pathogenic species as *Listeria monocytogenes* and *C. botulinum*.

An alternative to the use of nitrite is to add naturally occurring antimicrobial spices and herbs to meat products. Among the spices, mustard seed is reported to have antimicrobial capacity due to its glucosinolate content (Amarowicz, Faustman, Liebler, & Hill, 2003; Schuster-Gajzágó et al., 2006) and biothiols, for example glutathione, cysteine, and c-glutamylcysteine (Manda, Adams, & Ercal, 2010). The glucosinolates (sinalbin, sinigrin and glucobrassicin) are claved by myrosinase in the presence of moisture, forming isothiocyanates, thiocyanates, nitriles and other compounds (Delaquis & Mazza, 1995). Apart from isothiocyanates mustard seeds produce other bioactive compounds such as phenolic acids and phytin which have antioxidant activity (Delaquis & Mazza, 1995). According to Luciano, Belland, and Holley (2011) cooking under pressure can increase the level of bioactive compounds, such as free phenolic acids and give acceptable sensory properties in the final product, in which they also have strong antioxidant activity.

Application of whey and whey proteins as an antioxidant was investigated by several authors (Lasik, Pikul, Danków, & Cais-Sokolińska, 2011; Liu, Chen, & Mao, 2007; Sakata, 2008; Tong, Sasaki, McClements, & Decker, 2000; Worobiej, Wujkowska, Drużyńska, & Wołosiak, 2008).

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Whey contains many biological compounds including lactoferrin, beta-lactoglobulin, glycomacropeptides as well as immunoglobulins and has a range of immune-enhancing properties (Elias, McClements, & Decker, 2005; Gupta, Samant, & Sahu, 2012; Liu et al., 2007). Anticarcinogenic properties of acid whey have been documented by the presence of cysteine and methionine which are the precursors of glutathione which protect human cells against free radicals (Elias et al., 2005).

The aim of the study was to determine the effects of acid whey with native and autoclaved mustard seed on the physico-chemical properties, especially colour formation, microbial stability and sensory quality of non-nitrite organic cooked sausage during chill storage.

2. Materials and methods

2.1. Materials

2.1.1. Preparation of acid whey

Fresh acid whey was obtained from cottage cheese production from a local dairy processing plant. The pH and colour parameters of the whey were respectively 4.61 ± 0.01 and $L^* = 36.28$, $a^* = -2.83$, $b^* = 0.32$.

2.1.2. Preparation of ground mustard seed and autoclaved ground mustard seed

The mustard seed (*Sinapis alba*) purchased from a local plant was ground in a coffee grinder. The autoclaved ground mustard was prepared as described by Luciano et al. (2011). The ground mustard was added to a metal tray to form a 20 mm layer, covered with aluminium foil and autoclaved for 15 min at 115 °C.

2.1.3. Sausage formulation

Meat and pork backfat were purchased from an organic meat manufacturer at 48 h *postmortem*. Pork meat (ham muscle at 80%) was first minced using a knife and chilled at 4 °C. Pork backfat (20%) was also minced using a knife. The pork meat was divided into four equal samples. The curing mixture (99.4–99.5% sodium chloride, 0.5–0.6% sodium nitrite) was added to one of the stuffings at a ratio of 2.8% of the meat (control sample). The sea salt without nitrite and nitrate was added to the remaining samples at a ratio of 2.8% of the meat (Fig. 1). The meat was then stored at 4 °C for 48 h. Next, each meat sample was minced separately using universal machine type KU2-3EK (MESKO-AGD, Poland) with 8 mm discs and mixed with minced backfat.

Four batches were prepared (Table 1): control with the curing mixture (C), with acid whey added (W), with acid whey and ground mustard added (M), and with acid whey and autoclaved mustard added (SM). The mixes were stuffed into casings (65 mm, VISCASE, Chicago, IL) and cooked to a final temperature of 72 °C. Next, the samples were cooled in cold water to 20–25 °C. After that the sausages were vacuum packed and stored in a refrigerator (4 °C) for 30 days. The first sample corresponds to the day immediately after production (day 1), and the following samples after 10, 20 and 30 days of chilling storage.

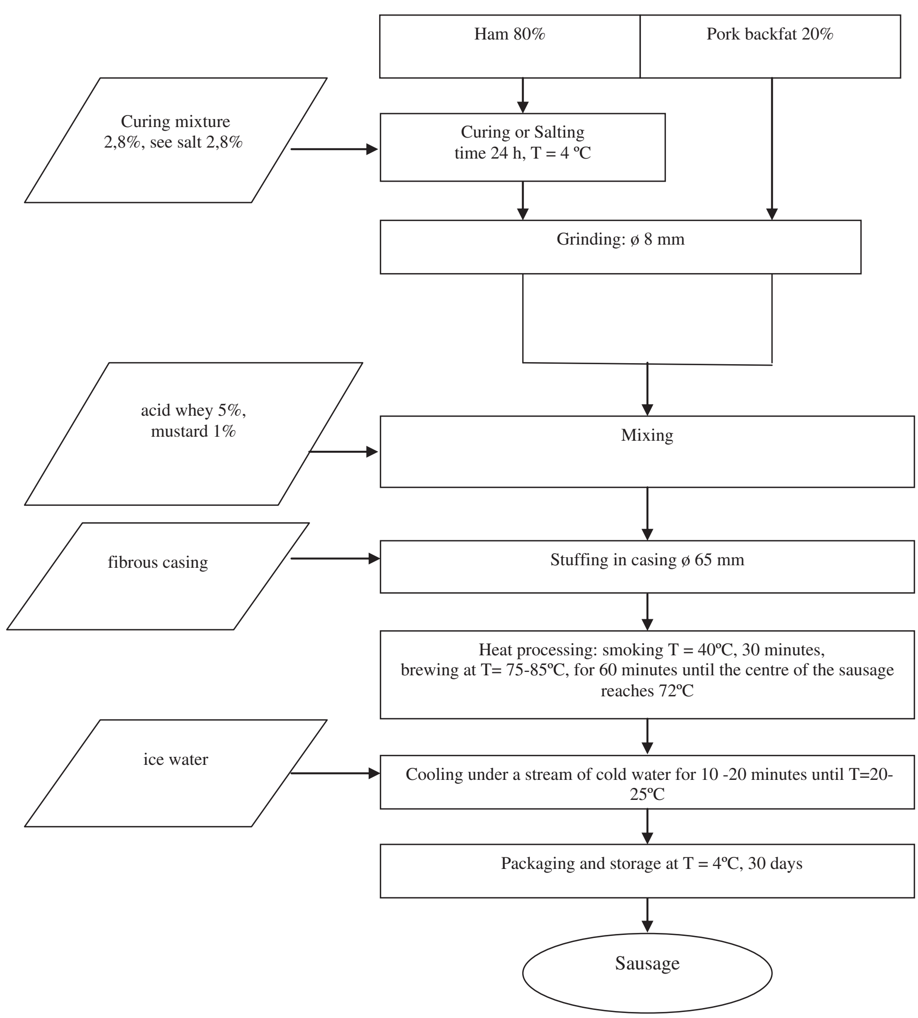

Fig. 1. Production of cooked pork sausage with whey and mustard.