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Effect of the addition of tomato paste on the nutritional and sensory properties of mortadella

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ABSTRACT

The aim of this study was to evaluate the effect of the addition of tomato paste (TP) to sausage mortadella in order to improve the nutritional properties and reduce the lipid oxidation associated with the content of lycopene. First, three different mortadellas without colourant were made with 2, 6 and 10% of TP, to optimise technologically the amount of this ingredient. Then, commercial product was compared with 10% of TP mortadella; both products were made with natural colourant. After a proximate analysis only total protein decreased due to the addition of TP. Lycopene content in mortadella and the total antioxidant activity were proportional to the amount of TP added. The presence of TP provided stability during meat grinding, cooking and storage of mortadella by reducing the lipid oxidation. In addition, TP provided yellowness and softness; however, when TP was added together with red colourant, the redness remained constant in the mortadella without effects on the consumer overall acceptance.

1. Introduction

Nowadays, consumers demand natural and healthy food products, including meat products, with better nutritional properties. To design healthy products, the food industry modifies the formulations and common ingredients of the meat products including additives. In this sense, some synthetic colourants are considered responsible for allergenic or adverse reactions (Larsen, 2008), and EU regulations on their use in foodstuffs have been taken into account (Regulation, 1333/2008). Therefore, consumers' preference for naturally derived colourants is associated with their image of being healthy and of good quality. However, the list of natural colours is small, and only few are available in sufficient quantities to be useful to food manufacturers.

Carotenoids are one of the most important natural pigments, providing attractive colour in vegetables and several animal foods. In addition, carotenoids are recognised as excellent antioxidants and as beneficial compounds for human health due to their pro-vitamin-A activity and their ability to quench oxygen and peroxyl radicals (Maiani et al., 2009). Thus, an inverse association between the consumption of carotenoid-rich products and the risk of certain forms of chronic diseases including several types of cancer and cardiovascular disease has been described (Maiani et al., 2009). Lycopene is the most abundant carotenoid in the ripened tomato, accounting for approximately 80–90% of the total pigments. It mainly accumulates in the final period of ripening, and it is higher in processed products (*e.g.* tomato juice, tomato paste (TP) *etc.*) than in raw tomatoes (Giovanelli, Lavelli, Peri, & Nobili, 1999). Tomatoes are the most highly consumed vegetable in Spain, and they are an important source of these antioxidants in the Spanish diet due to their content of different bioactive compounds such as carotenoids, phenolic compounds and vitamins (García-Valverde, Navarro-González, García-Alonso, & Periago, 2011; Periago et al., 2009). In a recent study on dietary sources of vitamin C, vitamin E and specific carotenoids in Spain, tomatoes ranked first as a source of lycopene (71.6%), second as a source of vitamin C (12.0%) and β-carotene (17.2%) and third as a source of vitamin E (6.0%) (Garcia-Closas et al., 2004). Moreover, tomato consumption has been considered beneficial in reducing the risk of prostate cancer (Gann et al., 1999; Weisburger, 1998) and cardiovascular disease (Mordente et al., 2011) mainly due to the content of lycopene (Krinsky, 1989). More recent studies have revealed the radiation-protective activity of lycopene (Andic, Garipagaoglu, Yurdakonar, Tuncel, & Kucuk, 2009; Srinivasan et al., 2007; Srinivasan, Devipriya, Kalpana, & Menon, 2009) and the protective activity against aggressive drugs such as cyclosporine, adriamycin and doxorubicin (Atessahin, Ceribasi, & Yilmaz, 2007; Ferreira et al., 2007; Jamshidzadeh, Baghban, Azarpira, Bardbori, & Niknahad, 2008; Yilmaz, Atessahin, Sahna, Karahan, & Ozer, 2006).

Considering the colour properties of tomato products and the beneficial effects on human health, their addition to meat products could reduce the necessity of synthetic colourants and yield products with a better nutritional profile due to the increase of plant-derived bioactive compounds (lycopene and phenolic compounds). Indeed, these compounds could exert an antioxidant effect on meat products, avoiding the oxidation processes of the fat and increasing the product's shelf

Abbreviations: TP, tomato paste; MDA, malondialdehyde; TAA, *in vitro* total antioxidant activity; ABTS, 2,2′-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid); TEAC, Trolox Equivalent Antioxidant Capacity assay.

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life. Hence, many studies have suggested using TP, tomato powder, tomato peels and lycopene in raw meat and meat products such as beef patties (Candogan, 2002; Sanchez-Escalante, Torrescano, Djenane, Beltrán, & Roncalés, 2003), minced meat (Østerlie & Lerfall, 2005), hamburgers (García, Calvo, & Selgas, 2009; Selgas, Garcia, & Calvo, 2009), fermented sausages (Calvo et al., 2008), fresh sausages (Mercadante, Capitani, Decker, & Castro, 2010) and frankfurters (Deda, Bloukas, & Fista, 2007; Eyiler & Oztan, 2011). In general, these studies have shown that the presence of lycopene from different tomato matrices leads to a better colour in the meat products, improved nutritional quality, reduced lipid oxidation and increased stability during the shelf-life period, all while retaining overall acceptability.

In different cultures, meat and meat products in the diet are presented in various ways and produced using different technological processes. However, their consumption has been associated with an increased risk of coronary heart disease and hypertension (Ashaye & Gaziano, 2011); hence, their presence in the human diet must meet nutritional guidelines. Nowadays, numerous studies have sought to demonstrate the possibility of changing the image of meat and meat products from the traditional image to one of healthy living thanks to the addition of vegetable extracts and fibres, the elimination of fats and the reduction of additives. Mortadella is a sausage of Italian origin, made of finely hashed or ground pork meat, which incorporates at least 15% small cubes of delicately flavoured pork fat. Mortadella is also enhanced with plant-food ingredients such as pepper, garlic and olives. It is a semi-cooked meat product with a commercial shelf life of 60 days at 4 °C. Considering that the primary quality parameters of meat and meat products for consumers are colour, appearance and texture, any modification of the ingredients of mortadella could change its properties and affect consumer acceptance. The aim of this study has been to evaluate the effects of the addition of TP as an ingredient in mortadella in order to improve the quality of this cooked meat product by increasing the nutritional properties and reducing the lipid oxidation process associated with the content of lycopene.

2. Materials and methods

2.1. Experimental design

To carry out this study, different mortadellas were designed and produced in two consecutive phases. In the first phase, three new mortadella products were developed (group 1) with different concentrations of TP (2%, 6% and 10%). Mortadella samples were elaborated with the addition of mixture of additives but not antioxidant neither colourants, in order to determine the effect of the addition of TP on the colour parameters and to optimise technologically the amount of added TP. In a second phase, two products were developed (group 2): regular mortadella (R) and mortadella with 10% of TP (R + 10%). These products were formulated with similar additives but this time including a natural colourant (E-120), according to the standard commercial formulation for these sausages. The five experimental samples of mortadella (2%, 6%, 10%, R and R + 10%) were manufactured by the company *Embutidos Campos de San Juan* (Campo de San Juan, Moratalla, Murcia, Spain). TP (14–16° Brix) was provided by *Conservas Vegetales de Extremadura* S.A. (CONESA, Villafranca del Guadiana, Badajoz, Spain).

All mortadella samples were analysed to determine the nutritional composition, lycopene content, *in vitro* total antioxidant activity (TAA), lipid oxidation expressed as malondialdehyde concentration (MDA) and instrumental parameters of texture and colour. All the analyses were conducted immediately after manufacture, and the stability of lycopene, TAA, MDA and colour parameters was also evaluated during the shelf-life period (at 1 and 2 months of storage). In addition, the overall acceptance of mortadella with 10% TP was determined in comparison with the regular product. Three replications were performed for each analysis.

2.2. Production of mortadella

Raw meat (38.5 kg of first-class lean pork and 38.5 kg of second-class lean pork) was minced and then mixed with 19 l of water, forming a stable matrix to which other commercial ingredients (mix of spices and additives) were added to make the mortadella according to the experimental groups. The group 1 mix (without colourants) contained salt, soy protein, potato starch, skimmed milk, spices, dextrose, sodium polyphosphate (E-452i), monosodium glutamate (E-621), trisodium citrate (E-331iii), sodium ascorbate (E-301) and sodium nitrate (E-250). The group 2 mix (with colourant) contained salt, dextrose, soya protein, spices, corn dextrin, sodium polyphosphate (E-452i), monosodium glutamate (E-621), trisodium citrate (E-331iii), sodium ascorbate (E-301), sodium nitrate (E-250) and cochineal (E-120) as a dye. TP was added as an ingredient in the formulation using the following concentrations: 2%, 6% and 10% in group 1 and 10% in one product of group 2. All ingredients were mixed under pressure for 20 min, and the mixture was then stuffed into a synthetic casing. Samples were heat processed at 100% RH until they reached an internal temperature of 72 °C. The mortadella samples were then rinsed for cooling with cooled water and stored at 4 °C for 60 days.

The two groups were manufactured at different times, according to the two phases described above in the Experimental design section. The mixes added during manufacture were also different, because in group 1, samples were made without colourant, and the commercially available product differed slightly from the mix used in the mortadella of group 2 (mix with cochineal).

2.3. Nutritional composition

The proximate composition of the mortadella samples was determined according to the AOAC standard methods (2011). Moisture was determined by desiccation until constant weight, total nitrogen and protein using the micro-Kjeldahl method, total fat by the Soxhlet method and ash by incineration of the samples at 525 °C for 24 h. Total carbohydrates were not determined due to their low expected presence in mortadella.

2.4. Lycopene analysis

Lycopene extraction and quantification were carried out according to the method described by Sharma and Le Maguer (1996). One gram of mortadella was weighed into a 125-ml flask wrapped with aluminium foil to exclude light. Next, 50 ml of a mixture of hexane–acetone–ethanol (2:1:1) was added to the flask to solubilise the carotenoids. Samples were shaken for 30 min, and then 10 ml of distilled water was added. The solution was left to separate into distinct polar and non-polar (containing lycopene) layers. Lycopene concentration was determined by molecular absorption spectrophotometry at 472 nm, and the results were expressed in mg/100 g using the molar extinction coefficient of lycopene in hexane (3450). Three measures were taken for each sample, one within the first week of manufacture and the other two at 1 and 2 months during the shelf-life storage at 4 °C.

2.5. Colour analysis

Colour measurements, including L* (lightness), a* (redness), and b* (yellowness) of the samples, were performed with a Konica Minolta R-400 colorimeter (Minolta Co., Osaka, Japan). Lab* values were taken from the surface of each mortadella sample calculating the hue angle and chroma metric. Three measures were taken for each sample, one within the first week of manufacture and the other two at 1 and 2 months during the shelf-life storage at 4 °C. Total colour difference during storage was determined by Delta E, for each mortadella sample.