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Quality evaluation of low fat bologna-type meat product with a nutritional profile designed for the elderly

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ABSTRACT

The objective of this work was to evaluate the quality of a bologna-type meat product designed for the elderly. Treatments were: control, without addition of cranberries (C), prunes (P), pecan nuts (N) or flaxseed (F); NP, with 5% N + 5% P; FC, with 5% F + 5% C; NC, with 5% N + 5% C; FP, with 5% F + 5% P. These formulations resulted in a product with high protein, low SFA and high antioxidant activity. Treatments with pecan nuts had higher MUFA while those with flaxseed had higher polyunsaturated fatty acids (PUFA). Treatments with pecan nuts and flaxseed had higher PUFA/SFA ratios, but only those with flaxseed had very low n6/n3 ratios when compared to the control. Although treatments showed acceptable scores (> 5.4), they were lower than the control. A combination of these non-traditional ingredients could be used to develop a meat product for older adults to provide a better nutritional profile with acceptable sensory properties.

1. Introduction

Among the major problems associated with aging are changes occurring in body composition, including muscle atrophy, loss of muscle strength and decrease of lean mass, which leads to sarcopenia (Houston et al., 2008). The main causes of sarcopenia or skeletal muscle loss include a sedentary lifestyle (Janssen, Heymsfield, & Ross, 2002) and poor nutrition, particularly low dietary protein intake and non-homogeneous dietary protein distribution at each meal time (Vetta, Ronzoni, Taglieri, & Bollea, 1999). This condition is strongly associated with impaired physical performance and physical disability, decreasing the life quality of those suffering from it (Dawson-Hughes, 2008; Fielding et al., 2011). At the cellular level, oxidative stress and inflammation processes are two important factors that affect the balance between synthesis and protein degradation (Narici & Maffulli, 2010) and cause mitochondrial dysfunction and induce apoptosis (Meng & Yu, 2010).

Because of the public health impact of sarcopenia among the older adult population (Bruyère et al., 2016), several strategies have been proposed to reduce its incidence including treatments with drugs (Morley & Malmstrom, 2013; Sakuma & Yamaguchi, 2012), physical resistance exercises (Hassan et al., 2016; Phu, Boersma, & Duque, 2015) and nutritional interventions such as protein supplementation (Morley et al., 2010), the latter being of major impact (Arango-Lopera, Arroyo, Gutiérrez-Robledo, & Pérez-Zepeda, 2012; Malafarina, Uriz-Otano, Iniesta, & Gil-Guerrero, 2013; Von-Haehling, Morley, & Anker, 2010).

There is a close relationship between a diet rich in quality proteins, amino acids and omega-3 fatty acids with the decrease of sarcopenia and preservation of muscle mass (Borst, 2004; Houston et al., 2008; Malafarina et al., 2013; Paddon-Jones & Rasmussen, 2009; Smith et al., 2011). In addition, it has been shown that the consumption of antioxidants protects the cells from the damage caused by free radicals (Semba, Lauretani, & Ferrucci, 2007; Sinha-Hikim et al., 2013), while omega-3 fatty acids reduce inflammation processes and increase the rate of protein synthesis (Smith et al., 2011). According to Volkert (2011), a high-quality protein diet is important for optimum stimulation of muscle protein synthesis. She also concluded that consumption of natural antioxidants and omega-3 fatty acids contribute to the conservation of the muscle function. The previous statement implies incorporating multiple foods into the diet of the elderly in order to meet all their nutritional requirements; the problem is that their diet is not usually varied or abundant. This raises the need to design products with particular characteristics that include a variety of ingredients with

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nutritional components that meet the needs of the elderly.

The commercial products that can be found in stores to prevent sarcopenia are nutritional supplements which lack flavor, texture and acceptance by consumers. The design of a special food product to aid in sarcopenia prevention represents a challenge for the industry. The design of new products should include ingredients with bioactive compounds involved in the preservation of muscle mass like high quality proteins, natural antioxidants and omega-3 fatty acids. Meat and meat products are excellent source of high quality protein with potential to stimulate protein synthesis and help in the gain of muscle mass and strength when combined with an exercise program (Phillips, 2012). Cranberries and prunes are rich sources of antioxidants (Kim, Jeong, & Lee, 2003; Wang & Stretch, 2001), while pecan nuts and flaxseed are high in polyunsaturated fatty acids (Kim et al., 2003; Ros & Mataix, 2006). All of these products have the potential to be used as ingredients in the development of new meat products. For their incorporation, it is necessary to take into account their impact on the physicochemical, sensory and nutritional qualities of the new product. Assurance of these quality parameters in the product would provide the beginning of an effort by researchers and industry to propose alternatives for better nutrition of the elderly. Therefore, the objective of this study was to develop a bologna-type meat product using cranberries, prunes, pecan nuts and flaxseed as ingredients, and to evaluate the physiochemical, sensory and nutritional qualities of the product.

2. Materials and methods

2.1. Experimental design

The quality of a bologna-type meat product with added natural ingredients rich in antioxidants (cranberries and prunes) and polyunsaturated fatty acids (pecan nuts and flaxseed) was studied. Treatments were: control, without the addition of cranberries (C), prunes (P), pecan nuts (N) or flaxseed flour (F); NP, with 5% N + 5% P; FC, with 5% F + 5% C; NC, with 5% N + 5% C; FP, with 5% F + 5% P. All treatments included a source of antioxidants and of polyunsaturated fatty acids and also included 2% each of isolated soy protein and of whey protein. Three replications of the experiment were performed on different days. In each replication, physicochemical analysis (objective color, pH, TPA), proximate composition, sensory analysis, DPPH, total phenols, fatty acid profile and amino acids content were determined in triplicate.

2.2. Raw materials and ingredients

Fifteen post-rigor *Semimembranosus* pork muscle (90:10) per replicate were obtained from a local pork slaughter facility. Whey protein (Hilmar Ingredients®, Hilmar, CA, USA), isolated soy protein (Profarm®, Archer Daniels Midland Company, Chicago, IL, USA), prunes (Sunsweet Growers Inc., Yuba, CA, USA), dried cranberries (Ocean Spray, Lakeville-Middleboro, MA, USA), peeled pecans (Kirkland Signature, Costco Wholesale Corporation, Issaquah, WA, USA), and Canadian ground flaxseed (Natural Health, Guanajuato, Gto, Mexico) were used as added ingredients. Also included were salt (Salt Bay®, Mexico), sodium polyphosphate (Piasa®, Apodaca, N.L., Mexico), curing salt (6.25% nitrite) (Fabpsa®, Ciudad de Mexico, Mexico), sodium erythorbate (Fabpsa®, Ciudad de Mexico, Mexico) and bologna seasoning (Excalibur Seasoning Company, Ltd., Pekin, IL, USA).

2.3. Bologna preparation

Our objective was to start with a low-fat bologna as one of the nutritional goals for this product. At the same time, it would permit the inclusion of polyunsaturated fatty acids in compliance with the Mexican legislation (NMX-F-065-1984) that allows a maximum of 30% fat content in emulsified meat products. Pork meat was cut into pieces of 5 × 5 cm and transferred to a previously chilled cutter (Kilia Fleischereimaschinenfabrik, Kiel, Germany) where particle size was reduced to obtain a fine paste. Then salt, polyphosphates, curing salt and sodium erythorbate were added and homogenized for 1 min. Then water, whey protein concentrate, isolated soybean protein, and seasoning were added and homogenized for 1 more min, after which dried cranberries, prunes, pecan nuts and flaxseed were added and homogenized under vacuum for an additional 3 min. The entire emulsion process was carried out in the shortest possible time (not > 6 min for each treatment) and without exceeding a final temperature of 10 °C. The resulting fine paste was stuffed (Omet ICS60-B, Siena, Poggibonsi, Siena, Italy) into collagen casings (14.2 cm in diameter), and cooked in an EnviroPak oven (CVU350E, Clackamas, OR, USA) until an internal temperature of 71.1 °C was reached (monitored via a thermocouple inserted in the center of a bologna). After heat treatment, product was placed in ice water (2 °C) for 10 min, vacuum packed (Supervac GR-185, Vienna, Austria) in pouches (3.3 cm^3/100 sq. in/24 h) and stored at 0 ± 2 °C for evaluation.

2.4. Product quality determinations

Quality parameters studied were: proximate composition (moisture, fat, protein and ash), *L**, *a**, *b** color, pH, texture profile analysis (TPA; hardness, cohesiveness, springiness and chewiness), 1,1-diphenyl-2-picrylhydrazyl ($DPPH^{\cdot}$) radical-scavenging activity, total phenols, fatty acids profile, amino acids content and sensory analysis.

2.4.1. Proximate composition

Moisture, ash, protein (N × 6.25) and fat content were determined on a bologna product according to AOAC methods (AOAC, 2000). Moisture was determined according to AOAC Method 950.46. Protein content was determined by estimating the nitrogen content using the Kjedahl method (AOAC Method 920.152). Ash content was determined by incineration at 525 °C (AOAC Method 940.26) while fat was determined by the Soxhlet method (AOAC Method 963.15).

2.4.2. Objective color, pH and texture profile analysis

Surface color was measured with a Minolta colorimeter using the D65 illuminant and 10° and 8 mm of aperture in the observer (Chroma meter CR-400, Konica Minolta Sensing, Inc., Osaka, Japan) recording *L**, *a** and *b** values. For pH measurement, a portable pH meter (Hanna, Model HI 98140, Woonsocket, RI, USA) equipped with a puncture-type combination pH electrode was used, and the reading was taken once stabilized. The textural properties of the bolognas were evaluated using a Texture Analyzer TA-XT2 (Stable Micro Systems, Surrey, UK). Cubic samples (1 × 1 × 1 cm) were cut from the bolognas and subjected to a two-cycle compression test. Samples were compressed to 50% of their original height with a 7.5 cm diameter cylindrical probe attached to a 50 kg compression cell with a cross-head speed of 1 mm/s. Texture profile parameters were determined according to (Bourne, 1978) and interpreted as follows: hardness (kg), maximum force required to compress the sample; cohesiveness, extent to which sample could be deformed prior to rupture (A2/A1), being A1 the total energy required for the first compression and A2 the total energy required for the second compression; springiness (cm), ability of the sample to recover its original shape after the deforming force is removed, and chewiness (kg × cm), work needed to masticate the sample for swallowing (hardness × cohesiveness × springiness).

2.4.3. 1,1-diphenyl-2-picrylhydrazyl ($DPPH^{\cdot}$) radical-scavenging activity, and total phenols content

The capacity of the extracts to inactivate radical $DPPH^{\cdot}$ was calculated according to the method by Brand-Williams, Cuvelier, and Berset (1995). Radical reduction was determined at 518 nm on a FLUOstar Omega (BMG Labtech Inc., Durham, NC, USA) microplate reader. The activity was expressed as micromoles of Trolox Equivalent/100 g fresh

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