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Production variations of nutritional composition of commercial meat products

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ABSTRACT

Changes in nutrient composition that habitually occur in commercial meat products in the course of production need to be considered for purposes of production systems control, consumer safety, nutritional information, labelling, official regulations or quality of food composition databases. This paper reports a study of production time variations in the nutritional composition of commercial meat products with different characteristics such as composition (protein and fat levels) and processing conditions (lean-only cuts, ground meat, fresh, cooked, brined, etc.). Proximate composition, fatty acid profile, cholesterol concentration, energy value and mineral content were evaluated. Over the year variability in nutrient composition were generally observed in meat products. The variability of composition (proximate analysis and fatty acid proportion) was greater in lean-only cut products as compared with ground meats. The relationship between fat and cholesterol contents of meat products presented correlation coefficients of 0.809 ($P<0.001$) and 0.859 ($P<0.001$) for the relationship between cholesterol and the sum of fat and protein contents. Several of the products considered are significant sources of Fe, Zn and K. Production variations in nutritional profiles observed in various meat products can affect the dietary assessment of some components, and also the product's nutritional labelling.

1. Introduction

In the course of production, the nutritional composition of commercial meat products undergoes changes due to variations in the meat and non-meat ingredients and the processing conditions. Animal production practices (genetic and dietary strategies) play an important role in the nutritional quality of meat raw materials (Jiménez-Colmenero, Reig, & Toldrá, 2006). The composition (e.g. fat content and composition, mineral content) of pork is expected to reflect the variability of feeding management (time of feeding and type of feed), animal characteristics (breed, age, sex, weight, etc.) and environmental conditions, which depend on cultural practices, season and geographical factors. In the last few years there have been reports of changes in the nutritional composition of red meat as determined by various different factors (Higgs, 2000; Williamson, Foster, Stanner, & Buttriss, 2005; Jiménez-Colmenero et al., 2006). Meat products are generally made from various meat raw materials (from different origins and suppliers), which are combined at the formulation stage in obedience to criteria of composition, technological factors, sensory characteristics, legal regulations and also economics. The varying protein, fat, water or pigment contents of the various cuts of meat used mean that sometimes it is difficult to establish a high degree of control over the composition of the final product. Final products characteristics are conditioned not only by quantitative aspects but also by technological properties of muscle protein. Protein functionality is responsible for determining the aptitude of meat proteins to yield product with specific characteristics (including composition) when subjected to certain processes (Nakai & Li-Chan, 1988).

Many non-meat ingredients (from animal and plant sources) are used in the manufacture of products essentially for purposes of economy, functionality and composition. Characteristics and/or processing variations in these materials influence the processing and the physicochemical properties of meat products, and that affects their composition. Obviously various factors (including cost, production method, etc.) must be considered when choosing non-meat ingredients. Meat industry must sometimes choose its ingredient and formulate its products to suit the requirements (composition, cost, etc.) of certain customers (e.g. hypermarket chains) which are able to market them as "own brands".

In addition to the previous considerations, meat processing steps like grinding, cooking, smoking, brining, pickling, etc. have a considerable impact on processing (e.g. fat and water binding properties) and the characteristics of final meat products, including the composition. Changes in processing conditions can ensue from hitches in the production system or the need to adapt them to innovative technological developments (e.g. healthier meat products formulation). To address these considerations, meat processor can apply some strategies to control the quality of processed meat products in the presence of high variability of ingredients (Nakai & Li-Chan, 1988).

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Production time variability in the nutrient composition of commercial meat products need to be considered for several reasons including production system quality control, consumer safety, nutritional information, labelling, official regulations or quality of food composition databases. This is especially important in that such changes may be great enough to produce a significant difference between the actual and the original target composition of the product. Regulation of food composition is essential for purposes of labelling, presentation and advertising of foods. Although consumer attitudes to meat are influenced by a number of factors (price, availability, culture, etc.), in recent years information about nutrient composition (labelling) has become increasingly important, especially for health-conscious consumers. The healthiness of a food product is not directly observable to the consumer so nutritional labelling is needed to make a healthy choice. However, production variations in nutrient composition mean that product won't meet consumer's nutritional expectation. This induces mistrust and may constitute financial fraud or even have negative effects on health. This will be the case if such changes affect compounds with implications for health (calories, saturated fatty acids, cholesterol, sodium, presence of allergens, etc.). Such changes are also extremely important with respect to food composition databases, which must reflect the real characteristics of the product. This is an essential aspect for the programming of food policies based on knowledge of energy and nutrient requirements and of the concentrations of these in foods. For a more realistic estimation of nutrient intake, we need to know the exact amount and final composition of the products consumed. There are numerous food composition tables and databases, including meat products, although with different nutrient values. These variations can be due to a variety of factors relating to product manufacture, sample preparation or analytical methodology (Williamson et al., 2005). They have a decisive influence on programmes recommending a healthy food.

Food composition information on labels is subject to strict legal regulation in order to assure compliance with the law and protect consumers, including those aspects of food that affect health. In this respect, legal requirements relating to the use of nutrient profiles are regulated at the European level through the Regulation on Nutritional Labelling, 90/496/ECC (EC, 2008) and Regulation on Nutritional and Heath Claims made on Foods (Regulation 1924/2006) (EC, 2007). This Regulation lays down harmonized rules for the use of nutrition and health claims labelling. Food composition plays a central role in product optimization, product positioning and claim substantiation. There is an obvious need for good quality data on nutrient content (Roodenburg & Leene, 2007).

As far as the authors are aware, there have been no studies that analyse (quantify) variation in the nutrient composition of different commercial meat products made by the meat industry at different times of year. The aim of the present work was therefore to examine the proximate composition, fatty acid profile, cholesterol, energy and mineral contents of several commercial meat products made and marketed at different times of year. In order to obtain a general overview, products with different composition (protein and fat levels) and processing conditions (lean-only cuts, ground meat, fresh, cooked, brined, etc.) and widely accepted by Spanish consumers were selected. This study paid special attention to over the year variability in nutritional properties and the consequences for labelling.

2. Materials and methods

2.1. Meat products

Various commercial pork products with different characteristics and widely accepted by Spanish consumers were selected. These products were: "chorizo" (CH, Spanish fermented sausage), "long-aniza" (LONG, fresh sausage); "lomo sajonia" (LSA, brined, pickled, smoked and cooked loin), "cinta de lomo" (CLO, brined and pickled loin), and "morcilla" (MOC, Spanish cooked blood sausage with onion). An innovative product was also studied, in this case a healthy cooked blood sausage (HBS, made with rice and olive oil).

These commercial meat products were made by a meat processor (EMCESA, Toledo, Spain). To consider variation of meat product composition over the year, the study was carried out in three different months: April, June and September. They were selected from among the more representative of the different production levels taking into account the seasonal demand for some of these meat products. Upon arrival at our laboratory they were stored (2 °C ± 1) until the time came to prepare them for analysis (less than 24 h). Following removal of all non-edible parts, each type of product were homogenized to produce a representative sample and ensure the representativeness of subsample taken for analysis. In every case the homogenate was stored (2 °C ± 1) until analyzed (within 48 h of preparation). At least three commercial presentations (from different production runs) of each type of product were analyzed in each production time (month) studied.

2.2. Proximate analysis and energy values

Moisture fat and ash contents were determined (AOAC, 2000) in triplicate. Protein content was measured in triplicate with a LECO FP-2000 Nitrogen Determinator (Leco Corporation, St Joseph, MI, USA). Carbohydrates were estimated by difference. Starch was measured in triplicate (AOAC, 2000). Energy value was estimated from protein (×4 kcal/g), carbohydrate (×4 kcal/g) and fat (×9 kcal/g) contents for each product.

2.3. Fatty acid profile

Fatty acids were determined by gas chromatography in three lipid extractions (Bligh & Dyer, 1959) of each sample. Boron trifluoride/methanol was used for fatty acid methyl ester (FAME) preparation (Sánchez-Muniz, García Linares, García Arias, Bastida, & Viejo, 2003). A Shimadzu gas chromatograph (Model GC-2014, Kyoto, Japan) fitted with a capillary column SP™-2330 (60 m × 0.25 mm × 0.2 μm i.d.) (Supelco, Inc, Bellefonte, USA) and a flame ionisation detector (FID) was used. Injector and detector temperatures were 250 and 260 °C respectively, and the oven temperature was 140 °C for 5 min followed by an increase at a rate of 4 °C/min to 240 °C, which was held for 20 min. Fatty acids were identified by comparison with a known standard FAME mixture (Supelco, Alltech Associated, Inc. Deerfield, IL, USA).

2.4. Cholesterol content

Cholesterol content was determined as reported by Serrano et al. (2005). Briefly, the fatty substances were extracted (in duplicate) by chloroform–methanol. Cholesterol content was determined from unsaponifiable extract following recovery of the sterol fraction, and further transformation into trimethyl-silyl ethers. These derivates were analysed by capillary-column gas chromatography (EEC, 1991). Betulin was used as an internal standard.

2.5. Minerals

Samples were ashed in triplicate in a furnace, with temperature gradients between 105 and 500 °C. The ash was dissolved in 2 ml concentrated nitric acid and diluted to 100 ml with Milli-Q water. The minerals were determined on an atomic absorption spectrophotometer (Perkin-Elmer, Model 5100, Norwalk, Connecticut. USA). A hollow cathode lamp was used to determine Ca, Fe, Mg, Zn, Cu and Mn. Na and K were analysed by atomic emission (without a lamp). Analytical lines were selected following the criterion of maximum