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Physicochemical properties, fatty acid profile and sensory characteristics of sheep and goat meat sausages manufactured with different pork fat levels

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ABSTRACT

The effect of three pork backfat levels (0% vs. 10% vs. 30%) on chemical composition, fatty acid profile and sensory properties on sheep and goat meat sausages was studied. All physicochemical parameters were affected by the addition of pork backfat in both types of sausages. Sausages manufactured with 30% of pork backfat showed the lowest moisture and protein contents and the highest total fat content. The lower a_w values in sausages manufactured with higher fat content while in pH happened the reverse situation. The addition of pork backfat modified the total fatty acid profile, prompting a significant drop in the relative percentages of C14:0, C16:0, C17:0, C17:1, C18:0 and TVA (trans-vaccenic acid), together with a marked increase in oleic and linoleic acids. Finally, in goat sausages, the fat content significantly affected sensory parameters: taste, texture and overall acceptability ($P < 0.05$). As expected, all physicochemical parameters were affected by the addition of pork backfat in both types of sausages.

1. Introduction

In Portugal, sheep and goats are extensively managed and raised for milk and meat (Teixeira, 1995). Lambs and kids produced in Mediterranean countries of the European Union are traditionally commercialized as quality brands with protected designation of origin (PDO) and protected geographical indications (PGI) (Teixeira, Delfa, & Alberti, 1998). However, there are animals that come out of these quality brands, particularly the culled ones or those with weight or age that cannot be considered as a PDO or PGI labels.

These animals have very low consumer acceptability and consequently a low commercial value and a strategy to give value to those animals would be welcome by producers as well as butchers, meat industry or supermarkets. Value may be added to final products by decreasing costs or improving relative value of the final product (McMillin & Brock, 2005). With this goal, there are several recently studies in goat and sheep meat processed products: Cosenza, Williams, Johnson, Sims, and McGowan (2003) evaluated the quality and consumer acceptability of cabrito smoked sausage, using goat meat as the sole meat ingredient; Polpara, Sornprasitt, and Wattanachant (2008) studied the quality characteristics of raw and canned goat meat in water, brine, oil and Thai curry during storage; Das, Anjaneyulu, Thomas, and Kondaiah (2009) studied the effect of different fats on the quality of goat meat patties; Teixeira, Pereira, and Rodrigues (2011) studied the effect of salting, air-drying and ageing processes in a new goat meat product "manta" and Oliveira et al. (2014) evaluated the quality of ewe and goat meat cured product mantas.

The Portuguese traditional sausages are unique products that have usually originated in geographical areas that are, in general, associated with its trade name and have a strong connection to this region and they quality is clearly influenced by breed of animals, reared system, climate and manufacturing technology. A project between a research center (Carcass and Meat Quality and Technology Laboratory of Agrarian School of Bragança), two breeder associations (ANCRAS—Serrana Goat National Association of Breed Producers and ACOB—Bragançana Sheep National Association of Breed Producers) and a meat manufacturing industry (Bísaro Salsicharia Tradicional) was developed to add value to these animals, creating two new products, a raw fresh meat sausage from Churra Galega Transmontana ewes and Serrana goats. Thus, the aim of this study was to characterize the physicochemical composition of these sausages and to study the effect of the addition of different pork backfat levels from a local breed Bísara on chemical composition,

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fatty acid profile and sensory properties of sheep and goat sausages. These sausages from meat of culled sheep and goats allow to valorize animals whose marketing value is very low by producing a product that in a future could be commercialized and consumed in halal and kosher markets.

2. Materials and methods

2.1. Sausages manufacturing and sampling

Two types of fresh sausages were manufactured, mincing and mixing sheep and goat meats with two levels of Bísaro pork backfat fat (10% and 30%) salt (2.4%), peppers (0.3 %), sugar (0.1%), water and rendimix®. A control batch without pork fat was also manufactured. Meats used for manufacturing include sheep and goat trimmings from local breeds: Churra Galega Bragançana ewes and Serrana goats aged between 5 and 7 years old, with an average 20 kg carcass weight. Pork meat was also from females weighing between 100 and 120 kg body weight of a local breed, Bísaro. Animals were slaughtered in the official slaughterhouse of Bragança (Trás-os-Montes region—northeast Portugal). Pigs were slaughtered on arrival to reduce the stress once time and distances travelled were relatively short (5 km). Animals were washed and electrically stunned in an appropriate stunning box prior to bleeding. No electrical stimulation of carcasses method was used. Carcasses of pigs were scalding in water at 60 °C. After weighing, carcasses were cooled at 4 °C for 12 and 24 h for pigs and sheep or goats, respectively. Carcasses were previously deboned and cleaned from nerves, tendons and connective tissues before raw meat was processed at the manufacturing meat industry. The mixing was then stuffed into 34–36 mm pork casings, hung and stabilized in a climate chamber at 13 °C and 80% with a relative humidity, packaged in polyamidepolyethylene bags and stored in a refrigerator at 4 °C until laboratory analysis.

For each type of sausages (sheep and goat) and the three treatments (0%, 10% and 30% pork fat), 22 samples were randomly selected from each lot of sausages, for a total of 132 sausages. Samples were divided into the following groups: S0, S10 and S30 for sheep sausages without pork fat and with 10% and 30% of pork fat, respectively; and G0, G10 and G30 for goat sausages without pork fat and with 10% and 30% of pork fat, respectively. Each group studied corresponds to an individual lot, produced in an independent day (six lots in total, six manufacturing days). Three replicates of each sample were analyzed.

2.2. Physicochemical analysis and chemical composition

The measurement of pH was performed according to the Portuguese standard NP 3441 (2008), using a portable potentiometer equipped with a specific electrode penetrator, and calibrated with standard buffers with the following pH 4, 01–7, 02. Water activity was determinated using a water activity probe (HygroPalmAw1 rotronic 8303, Bassersdorf, Switzerland) according to (AOAC, 1990). The determination of moisture was performed according to the Portuguese standard NP 1614 (2009). Three to 5 g of sample was added to 5 mL of ethanol. After that, samples were dried in a drying oven (Raypa DO-150, Barcelona, Spain) during 24 h at 103 °C ± 2 °C. Protein determination was carried out following the Portuguese standard NP 1612 (2002) using (Kjeldahl Sampler System K370 and Digest System K-437, Flawil, Switzerland). One and a half to 3 g of sample was put in mineralization tubes with two catalyst tablets and 25 mL of sulfuric acid (97%). After mineralization completion, the distillation procedure was carried out. Finally, the distillate was titrated with hydrochloric acid solution and the required volume record. For total fat content determination, samples were subjected to a liquid-solid extraction using petroleum ether in an extractor apparatus (AnkomHCI Hydrolysis System, Macedon NY, USA) at 90 °C for 60 min. The total fat content was obtained based on gravimetric difference. Ashes were assessed according to the Portuguese standard NP 1615 (2002). To 3–5 g of sample, we added 1 mL of magnesium acetate in crucibles. After that, the samples were subject to 550 °C ± 25 °C during 5–6 h in muffle furnace (Vulcan BOX Furnace Model 3-550, Yucaipa, USA).

2.3. Fatty acid composition

Total lipids were extracted from 25 g of ground meat sample, according to the Folch, Lees, and Stanley (1957) procedure. Fifty milligrams of fat was used to determine fatty acid profile. Fatty acids were transesterified following the method described by Shehata, de Man, and Alexander (1970) with some modifications; 4 mL of a sodium methoxide (2) solution were added to the fraction, vortexed every 5 min during 20 min at room temperature, then 4 mL of a H_2SO_4 solution (in methanol at 50%), vortexed a few seconds and vortexed again before adding 2 mL of distilled water. Organic phase (containing fatty acids methyl esters) was extracted with 2.5 mL of hexane. Separation and quantification of the FAMEs was carried out using a gas chromatograph (GC-Agilent 6890 N; Agilent Technologies Spain, S.L., Madrid, Spain) equipped with a flame ionization detector and an automatic sample injector HP 7683, and using a Supelco SPTM-2560 fused silica capillary column (100 m, 0.25 mm i.d., 0.2 μm film thickness). The chromatographic conditions were as follows: initial column temperature 120 °C, maintaining this temperature for 5 min, programmed to increase at a rate of 5 °C · min − 1 up to 200 °C, maintaining this temperature for 2 min, then at 1 °C · min − 1 up to 230 °C, maintaining this temperature for 3 min. The injector and detector were maintained at 260 and 280 °C, respectively. Helium was used as the carrier gas at a constant flow-rate of 1.1 mL · min − 1, with the column head pressure set at 35.56 psi. The split ratio was 1:50 and 1 μL of solution was injected. Nonadecanoic acid (C19:0) at 0.3 mg · mL − 1 was used as internal standard and added to the samples prior methylation. Individual FAMEs were identified by comparing their retention times with those of authenticated standards (Supelco 37 component FAME Mix). Data regarding FAME composition were expressed in percentage according to the weight of the total identified FAMEs.

2.4. Consumers sensory evaluation

Sensory evaluation of goats and sheep's fresh sausages was performed by a consumers' panel, in accordance with the Portuguese Norm (NP8586-1, 2001). The consumers' panel was constituted by 26 elements from the staff of the Polytechnic Institute of Bragança (aged between 19 and 64 years old) without previous training during two sessions evaluating the following sensory attributes: taste, texture, spiciness and overall acceptability. An unstructured 10 cm scale with anchors at the extremities (from 0 cm—"do not like" to 10 cm—"like very much") was used. Sausages samples were cooked in the grill until the internal temperature reached about 75 °C. Afterwards, sausages were divided into pieces 0.5 cm thick, labeled with random codes and stored at 60–70 °C. During the testing, we provided unsalted crackers and water in order to clean the mouth for each sample.

2.5. Statistical analysis

Data were analysed using the mixed model (Henderson, 1973):

$$y = X\beta + Z\gamma + \varepsilon$$

$\boldsymbol{\gamma}$ is an unknown vector of random-effects parameters with known design matrix $\mathbf{Z}$, and $\boldsymbol{\varepsilon}$ is an unknown random error vector whose elements are no longer required to be independent and homogeneous.

Statistical analysis was performed using the statistical package JMP Pro 11.1.1 by Copyright © 2013 SAS Institute, Inc. Main effects (specie, fat level) and interaction were tested in mixed models as fixed effects (PROC MIXED, SAS) of treatment and the random effects of repeated