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Quality characteristics of a dry-cured lamb leg as affected by tumbling after dry-salting and processing time

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ABSTRACT

The aim of this study was to evaluate selected quality characteristics of a dry-cured lamb leg with different tumbling treatments after salting. The characteristics were measured at different processing times. Three batches of dry-cured lamb legs (nine legs per batch) were prepared with no-, short- and long-tumbling treatments, and microbial counts, NaCl, a_w, proximate composition, pH, free fatty acids, water soluble nitrogen, volatile compounds, texture and colour were evaluated at days 1, 22 and 71 of processing. Furthermore, a descriptive sensory analysis (flavour and texture) was performed in the final product (day 71). Time-related changes were observed for most of the characteristics studied. The effect of tumbling was only observed for the sensory attribute pastiness that was higher in tumbled legs. Methyl-branched butanal was only detected in tumbled legs.

1. Introduction

A number of dry-cured ruminant whole (non-comminuted) meat products are highly demanded in different parts of the world. These are usually made from beef, e.g., cecina (García, Zumalacárregui, & Díez, 1995; Molinero, Martínez, Rubio, Rovira, & Jaime, 2008), bresaola (Paleari, Moretti, Beretta, & Caprino, 2008) or pastirma (Kaban, 2009), following traditional processes. Moreover, although less frequently, dry-cured meat products are made from small ruminant meat such as mutton or sheep meat (Håseth, Thorkelsson, & Sidhu, 2008; Texeira, Pereira, & Rodrigues, 2011).

Sheep meat is widely consumed in European Mediterranean countries where it has a strong traditional component (Bernués, Ripoll, & Panea, 2012). Actually, dry-salted sheep meat is considered as a traditional product with a long history of use, which at present is still produced, although only in small quantities, in specific rural areas (Cattaneo, 1994). However, nowadays, the development of high-quality air-dried salted sheep meat products adapted to meet consumer demands can represent an interesting option in the Mediterranean region (and other regions around the world with tradition in sheep meat production and consumption) in order to favour sheep sector. This statement is based on increased interest of consumers in traditional and local food and how local food can help in maintaining and developing local markets (McIntyre & Rondeau, 2011). Moreover, traditional food can meet the market for people who have migrated from their place of origin (Jamal, 2013).

Tumbling of meat has been described as a feasible technique to be used in the making process of dry-cured meat products (Arnau, Serra, Comaposada, Gou, & Garriga, 2007). This treatment results in structural damages of fat and muscle tissues (Cheng & Ockerman, 2003). Studies on tumbling effect on the quality of dry-cured meat have been mainly focused in the salting diffusion process and, thus, tumbling has been suggested as a mean to accelerate the dry-salting step (Hayes, Kenny, Ward, & Kerry, 2007). However, to the best of our knowledge, the effect of tumbling on the presence of substances derived from the biochemical processes taking place during ripening of salted meat products, i.e., proteolysis, lipolysis, lipid oxidation and amino acid degradation has not been reported.

In this context, the first aim of this study was to describe selected physicochemical, microbial and sensory characteristics of a dry-cured lamb leg at different processing times, and the second aim was to evaluate the effect of the inclusion of a vacuum tumbling process just after salting on those quality characteristics.

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2. Materials and methods

2.1. Animals

Fourteen Merino lambs (6–8 week old and mean body weight of 14 ± 0.2 kg at the beginning of the experiment) were used in this study. After weaning, lambs were housed in individual pens, where they remained during the entire experimental period, and were fed a commercial total mixed ration (18% crude protein; 15:85 barley straw:concentrate feed) *ad libitum*; fresh drinking water was provided. All handling practises followed the recommendations of the Directive 2010/63/EU of the European Parliament and of the Council on the protection of animals used for scientific purposes, and all of the animals used were able to see and hear the other sheep.

When an animal reached the intended body weight (27 kg), feed and water were withdrawn, and after 1 h the lamb was weighed again, stunned and slaughtered by exsanguination from the jugular vein, eviscerated and skinned. The dressed carcass was obtained from the whole body of each lamb and after chilling the carcass at 4 °C for 24 h, the legs were obtained (Colomer-Rocher, Morand-Fehr, Kirton, Delfa, & Sierra-Alfranca, 1988).

2.2. Manufacture and design of the dry-cured legs

The present study was carried out with 27 legs from the 14 lambs. The legs were immediately frozen (−18 °C) and kept frozen for 4–6 months. Afterwards, legs randomly assigned to three batches of nine, each batch of legs being processed in a different day.

For each batch (nine legs per batch), once thawed at 8 °C for 24 h, the tailbone and hip bone were removed from the legs, the upper part of the leg was trimmed in order to give it a round shape, and legs were then weighed (mean weight ± standard deviation of 1380 g ± 81 g). Salting was carried out in two steps, the first one by manually rubbing the legs with a curing mixture (45 g/kg of leg) containing NaCl (89.3%), potassium nitrate (1.8%), sodium ascorbate (2.2%) and dextrose (6.7%), followed by a 6-h chilling in a cold chamber at 4 °C. In the second step, legs were covered with a layer of coarse salt and kept for 12 h at 4 °C. Afterwards, legs were washed with running water, and hung for up to 5 h at room temperature (15 °C). Salted legs were divided in three groups (3 legs per group) and each group was subjected to a different tumbling treatment: no tumbling (Control), short tumbling (ST; 100 min at 10 rpm) and long tumbling (LT; 200 min at 10 rpm). The tumbling was carried out with the legs packaged under vacuum, at 8 °C using a 200-l capacity SM-Pulmax tumbler (Technical, Girona, Spain). The legs were then removed from the bags. All legs were hung in a ripening chamber at 9.5 °C and 78% relative humidity (RH) for 40–43 days, during the time needed for the moisture loss of legs on drying to reach the targeted value of 32.5% ± 0.5%. Then, the legs were vacuum packaged to stop the drying process and maintained at 15 °C for 30 additional days (a total of 71-day ripening period from the day of salting).

2.3. Sampling and sample preparation

The sampling had a completely randomised design with three replicate batches of nine legs each (three legs per tumbling treatment). From each batch, one leg per tumbling treatment group was sampled at day 1 of ripening, other at day 22 and the other at the end of the ripening period (day 71). After sampling, several muscles were extracted by dissection from the legs for further analysis. M. *Biceps femoris* was used for sensory evaluation and M. *Adductor* for texture profile analysis. M. *Semimembranosus* was transversely cut in two halves and the colour was measured in the cut surfaces. This muscle was used afterwards for the analysis of pH, moisture, protein, fat, ash, free fatty acids, water soluble nitrogen and volatile compounds. M. *Quadriceps femoris* (*M. rectus femoris, M. vastus intermedius, M vastus lateralis* and *M. vastus medialis*) was cut into three sections perpendicular to the long axis: proximal (1 cm), central (the largest) and distal (2 cm). The proximal and distal section were discharged and the central section was transversely halved, with the distal part being used for microbiological analysis, just after cutting, and the proximal part for NaCl, moisture and water activity (a_w) analyses. Before analysis, both halves were subsequently cut into two portions (external and internal), with the external portion (a surface layer) being 1 cm thick. This last division was carried out to assess eventual differences in the characteristics analysed between the inner and outer part of the muscle. Finally, muscle samples, except for the portion of M. *Quadriceps femoris*, used for microbial analysis, and M. *Abductor*, were individually packed on aluminium foil and plastic bags and frozen and stored at −47 °C until the analyses were performed. Prior to analysis, the muscles were thawed at 4 °C overnight and then minced in a food processor.

2.4. Microbial and chemical analysis

Samples from internal and external layers of the distal part of M. *Quadriceps femoris* were aseptically prepared. Twenty five grammes of each layer were taken and homogenised with 225 ml of peptone water (0.1% peptone and 0.85% NaCl; w/v) for 2 min in a plastic bag using a Stomacher-400 circulator equipment (Seward, West Sussex, UK). The counts of Gram-positive catalase-positive cocci and lactic acid bacteria, which are the principal bacterial groups in dry-cured whole (not-comminuted) meat products (García et al., 1995), were determined. Serial decimal dilutions were prepared and plated out in duplicate on relevant media (Oxoid Ltd. Basingstoke, UK; Merck, Darmstadt, Germany) and incubated as follows: de Man-Rogosa-Sharpe (MRS; CM 0361) agar in double layer at 30 °C for 72 h, and Mannitol Salt Agar (MSA; CM 85) at 35 °C for 48 h.

The a_w value was determined at 25 °C using an Aqualab CX-2 hygrometer (Decagon Devices Inc., Pullman, WA, USA). Chloride content was analysed in duplicate by tritation (ISO, 1996) using a 719 S Titrino titrator coupled with a combined silver-ring electrode and a 728 stirrer (Metrohm Ltd., Herisau, Switzerland). Moisture, fat, protein and ash were determined according to the Official Methods 950.46, 991.36, 981.10, and 920.153, respectively (AOAC, 1999). Furthermore, pH was determined in duplicate using a pH metre model (Crison Model GLP 22, Barcelona, Spain) equipped with a glass electrode, on a homogenate with 3 g of sample and 7 ml of distilled water. For analysis of free fatty acids (FFA), fat was first extracted as described by Bligh and Dyer (1959) from 30 g of minced sample, FFA were then extracted from the fat using solid phase extraction columns, and then methylated (García-Regueiro, Gibert, & Díaz, 1994). Afterwards, FFA methyl esters were extracted with 2 ml of hexane, and analysed by gas chromatography (Osorio, Zumalacárregui, Figueira, & Mateo, 2007).

For water soluble nitrogen (WSN) determination, 5 g of sample were homogenised in 40 ml of distilled water with an Ultraturrax T18 (IKA, Labortechnik, Stafen, Germany) at 9500 rpm for two min and, then, the mixture was centrifuged at 3000 rpm for 15 min. The supernatant was collected, the residue was washed with 35 ml distilled water and the mixture was centrifuged again. A total of 25 ml of the combined supernatants were analysed for nitrogen content (Method 981.10; AOAC, 1999).

2.5. Volatile compounds

Volatile compounds were determined by static headspace-gas chromatography coupled to mass spectrometry. Extraction of volatile compounds was done using solid phase microextraction (SPME; Supelco, Bellefonte, PA, USA) with a 75 μm carboxen/polydimethylsiloxane-coated fused silica fibre. Four g of minced sample were weighed into a 15-ml vial, sealed with polytetrafluoroethylene lined silicone septa. The vial was placed in a 200-W ultrasonic water bath (JP Selecta, Barcelona, Spain) for 30 min at 40 °C for equilibration. Then ultrasounds were switched off and the SPME fibre was exposed to the sample for