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Effect of partial replacement of pork meat with an olive oil organogel on the physicochemical and sensory quality of dry-ripened venison sausages

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ABSTRACT

A venison salchichon was made using varying proportions of olive oil to replace the traditional pork meat and to obtain a healthier product. Six types of salchichon were produced. The control type contained 75% lean venison and 25% pork meat; in the other types, 15%, 25%, 35%, 45% and 55% of the pork meat were replaced by olive oil introduced in the form of an organogel (olive oil emulsified with soy protein and water). All types were satisfactory in terms of physicochemical characteristics (pH, a_w, moisture loss) and instrumental colour throughout ripening, and displayed acceptable levels of lipolysis (acidity index) and lipid oxidation (TBARS). Higher proportions of olive oil prompted an increase in monounsaturated fatty acid content (mainly C18:1). All six types of salchichon were judged acceptable by consumers, the highest scores being given to those in which no more than 25% of the pork meat was replaced by olive oil.

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1. Introduction

Venison is produced in Spain because hunting is a major rural activity, in various areas of Spain. Castilla–La Mancha is the Spain's biggest venison-producing autonomous community, and also the main exporter, accounting for the 80% of total Spanish venison exports, mainly to Germany. Despite this large output, venison consumption in the region – and indeed in Spain generally – is fairly limited; venison is mainly consumed in certain rural areas and restaurants. Castilla–La Mancha is considered throughout Europe as a paradise for game-based cuisine. The economic value of venison is relatively low, since it tends to be seen simply as a by-product of hunting. Nevertheless, venison is a meat with a considerable nutritive value, rich in proteins and heme iron, with low subcutaneous and intramuscular fat contents (Hoffman & Wiklund, 2006; Zomborszky, Szentmihály, Sarudi, Horn, & Szabó, 1996).

A wide range of cured products are obtained from deer meat, including cecina (dry-cured meat), and dry fermented sausages, as chorizo and salchichon. These are generally labelled "gourmet products" in the international market. In the production of venison chorizo and salchichon, a certain amount of pork meat has to be added to lean venison in order to ensure gradual drying, acceptable tenderness and the development of their distinctive flavour. However, consumer interests are based on low-fat foods rich in unsaturated fatty acids to achieve a healthy diet.

Investigations have been carried out to partially replace pork backfat by emulsified olive oil in fermented pork and beef sausages (Beriain, Gómez, Petri, Insausti, & Sarriés, 2011; Bloukas, Paneras, & Fournitzis, 1997; Del Nobile et al., 2009; Kayaardi & Gök, 2003; Muguerza, Ansorena, Bloukas, & Astiasarán, 2003; Muguerza, Fista, Ansorena, Astiasaran, & Bloukas, 2002; Muguerza, Gimeno, Ansorena, Bloukas, & Astiasarán, 2001; Severini, De Pilli, & Baiano, 2003). Olive oil is a staple of the Mediterranean diet, and its main source of fat. It has a highly-characteristic fatty-acid composition, containing 55–85% oleic acid and 3.5%–21% linoleic acid (Codex Standard 33-1981, Rev. 1-1989). Unlike other edible oils with a similar fatty-acid profile, such as high-oleic sunflower oil, virgin olive oil is a natural juice that can be consumed unrefined. Since its original composition remains unaltered, it is a prime source not only of highly-nutritive fatty acids, but also of hundreds of mainly-antioxidant micronutrients, including phenol compounds, vitamin E, carotenes and squalene (Owen et al., 2000).

As part of research aimed at encouraging the consumption of venison meat products, this study sought to produce a reduced fat

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salchichon with a healthier fatty-acid composition which would still be attractive to the consumer since its sensory attributes remained unimpaired. To this end, pork meat with a high fat content used in the traditional product was partially replaced by varying proportions of olive oil.

2. Materials and methods

2.1. Raw materials

Lean venison (*Cervus elaphus*) was obtained from hind legs of male deer obtained during the 2009–2010 hunting season on two neighbouring reserves in Ciudad Real (central Spain). Vegetation in the two reserves was very similar, comprising pine forests, woodlands and scrub. A total of 67.5 kg of venison were used. Pork meat with a high fat content was obtained from the backs of castrated male pigs (progeny of a Pietrain male × Dallan female cross) raised intensively and slaughtered at seven months of age. A total of 16 kg was used. Extra-virgin olive oil was produced at an oil-mill in Ciudad Real from Cornicabra olives harvested in 2008–2009. A total of 3.5 l were used. Physicochemical and colour parameters for the raw materials used in making the different venison salchichons are shown in Table 1. Both pork meat and lean venison displayed acceptable values for pH and a_w. Pork meat had a 50.5% lipid content expressed as dry matter (DM), compared with 2% for lean venison, and 47.3% protein content (DM) compared with 87.8% for lean venison. The pork meat exhibited a greater lightness (L*) and yellowness (b*), and a smaller redness (a*) than lean venison. The olive-oil peroxide index obtained, less than 20 meq of active oxygen/kg fat, ensured that non-oxidised oil was used (Codex Standard 33-1981, Rev. 1-1989). In addition, the soy protein concentrate used, Arcon™S (Lactotecnia S.L., Sardenya, Barcelona), is practically tasteless and with high protein solubility. Its chemical composition was ≤6% moisture, ≥72% protein, ≤3% fat, and 20% fibre. Finally, a commercial salchichon mixture (Salchichón Casero 933, Manufacturas Ceylan S.L., Valencia, Spain) was used, comprising salt, spices, lactose, saccharose, polyphosphates (E-450i, ii), sodium ascorbate (E-301) and potassium nitrate (E-252).

2.2. Production of venison salchichon

Taking into account the findings of a previous study aimed at reducing the pork-fat content of this product (Utrilla, 2012), six types of venison salchichon were made. All types contained 75% lean venison. The original 25% pork meat was partially replaced by 0% (control), 15%, 25%, 35%, 45% and 55% olive oil, in Types 1 to 6, respectively. Olive oil was added to the salchichon in the form of an organogel obtained by emulsifying olive oil with soy protein concentrate (Arcon™S) and mineral water in a ratio of 10:1:8, respectively (Table 2). Venison and pork meat were minced separately in an Unger W-98 table-top mincer (Andher, Campo de Criptana, Spain) with an 8 mm plate. To produce the organogel, soy protein concentrate was mixed with hot mineral water for 2 min, then emulsified with olive oil for 3 min. Venison, organogel and the appropriate proportion of pork meat were then mixed with the Ceylamix commercial mix (33 g/kg) dissolved in 1 l of cold mineral water, in an AV-80 vacuum mixer (Andher, Campo de Criptana, Spain). The mixture was covered with a cotton cloth, and left to equilibrate for 20 h at 0 °C. It was then fed through an H52 PAS hydraulic piston-based sausage stuffer connected to a VAE-10 vacuum system (Andher, Campo de Criptana, Spain), into synthetic collagen skins, with a 38–40 mm diameter. Horseshoe-shaped salchichon sausages were then tied off at 60 cm intervals. Salchichon sausages were maintained at 20–22 °C and a relative humidity of 60% for 2 h, and finally ripened at 11–12 °C and a relative humidity of 75% for 28 days, in a Zanotti ripening chamber (Grupo Momplet, Valencia, Spain). After ripening, the sausages were vacuum-packed and stored at 8–10 °C. Two replicates of the six types of salchichon sausages were done.

Table 2
Relative percentages of lean venison, pork meat and organogel (olive oil + water + soy protein, 10:8:1) in different types of venison salchichon.

Types	Lean venison (%)	Pork meat (%)	Organogel (%)
1	75	25	0
2	75	21.25	3.75
3	75	18.75	6.25
4	75	16.25	8.75
5	75	13.75	11.25
6	75	11.25	13.75

2.3. Samples

All physicochemical analysis (pH, a_w, moisture, fat and protein content, colour, acidity index and TBARS) was performed on lean venison, pork meat and salchichon immediately after stuffing (day 0), and after 7, 14, 21 and 28 days of ripening. The fatty acid profile of the raw materials (venison, pork meat and olive oil) and the finished product were determined. Olive oil was also characterised in terms of colour and peroxide index. To determine the physicochemical characteristics in salchichon, the skin was removed and the entire content was ground in a domestic blender. All analyses were carried out in duplicate in two sausages of each replicate.

Sensory analysis of salchichon sausages stored for 45 days at 8–10 °C was performed. The six types were evaluated in the same session.

2.4. Physicochemical composition

pH was measured directly using a Crison 2002 pH-meter (Crison Instruments S.A., Barcelona, Spain) fitted with an electrode probe. Water activity (a_w) was measured directly using a Decagon CX-2 dew point hygrometer (Decagon Devices Inc., Pullman, WA, USA). Moisture content was measured in accordance with standard ISO R-1442 (1973). Total fat was extracted with petroleum ether (40–60°) following the ISO R-1443 standard (1973). Total nitrogen was measured using the Kjeldahl method (method 16245, AOAC, 1980). Protein nitrogen content was obtained by multiplying total nitrogen by 6.25.

Table 1
Means and standard deviations of physicochemical and colour parameters of the raw materials used in making venison salchichon.

	Lean venison	Pork meat	Olive oil
pH	5.71 ± 0.06	5.65 ± 0.01	–
Water activity (a_w)	0.997 ± 0.001	0.998 ± 0.001	–
Moisture (g/100 g)	74.84 ± 0.51	63.85 ± 1.74	–
Fat (g/100 g DM)	2.01 ± 0.22	50.52 ± 1.25	–
Protein (g/100 g DM)	87.76 ± 0.53	47.34 ± 1.19	–
L (lightness)	38.02 ± 0.31	75.24 ± 1.09	28.80 ± 1.09
a* (redness)	11.55 ± 1.25	3.31 ± 0.11	2.49 ± 0.11
b* (yellowness)	13.05 ± 0.37	23.58 ± 0.53	6.41 ± 0.53
Peroxide index (meq active oxygen/kg fat)	–	–	4.07 ± 0.37

DM: Dry matter.

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