

EFFECT OF PARTIAL REPLACEMENT OF PORK MEAT WITH OLIVE OIL ON THE SENSORY QUALITY OF DRY-RIPENED VENISON SAUSAGE

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ABSTRACT

Six assays of low-fat venison salchichon were produced using varying proportions of olive oil to replace the traditional pork meat added. The control contained 75% lean venison and 25% pork meat; in the other assays, 15, 25, 35, 45 and 55% of the pork meat was replaced by olive oil. Samples were evaluated by quantitative descriptive sensory analysis and consumer testing. Descriptive sensory analysis revealed significant differences for most of the attributes studied. The replacement of 35% or more of pork meat by olive oil, prompted a decrease in odour intensity, spicy odour, hardness and an increase of fat mouthfeel, together with the olive oil perception. By contrast, the replacement of 25% of pork meat by olive oil yielded a salchichon not greatly different to the control. Consumers accepted all assays, but preferred those in which no more than 25% of the pork meat was replaced by olive oil. From a sensory standpoint, therefore, it is recommended that the replacement of pork meat by olive oil in this product should not exceed 25%.

- Keywords: dry-ripened venison sausage, olive oil, acceptance test, preference test, quantitative descriptive sensory analysis -

INTRODUCTION

Though the production of venison in Spain is high, its economic value is relatively low because it is considered to be simply a by-product of hunting, oriented to obtain flashy awards. The autonomous community of Castilla-La Mancha is also the main venison exporter in Spain, accounting the 80% of the total exportation, being Germany its primary destination. Despite the large venison production, its consumption in the region – an indeed in Spain generally – is fairly limited; venison is mainly consumed in certain rural areas and some restaurants.

Cynegetic venison is a highly nutritive meat, characterized by a high protein and heme iron content and a low presence of subcutaneous and intramuscular fat (ZOMBORSZKY *et al.*, 1996; HOFFMAN and WIKLUND, 2006). In addition, this meat has distinctive organoleptic properties, differing from those of other meats, such as its intense and attractive red colour, tenderness and variety of flavours, reflecting the fact that deers are raised in the wild and feed on natural pastures.

A wide range of ripened products is obtained from hunted deer, including cecina (dry-ripened 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 get a healthy diet.

On the other hand, olive oil is a staple of the Mediterranean diet, and its main source of fat. It is remarkable for its characteristic fatty acid composition, and particularly for its high oleic acid content, ranging between 55 and 83% (Codex Stan 33-1981). Virgin olive oil is a natural juice that can be consumed unrefined, thus retaining its original composition; this makes it a prime source of mainly-antioxidant micronutrients, including phenol compounds, vitamin E, carotenes and squalene (OWEN *et al.*, 2000).

Several investigations have been carried out on the partial replacement of pork meat by olive oil in pork and/or beef dry sausages (BLOUKAS *et al.*, 1997; MUGUERZA *et al.*, 2001, 2002, 2003; SEVERINI *et al.*, 2003; KAYAARDI and GÖK, 2003; DEL NOBILE *et al.*, 2009; BERIAIN *et al.*, 2011); however, there is not studies to address the use of olive oil in making venison salchichon.

The aim of this study was to elaborate cynegetic venison salchichon with the highest percentage of replacement of pork meat by olive oil, that allow to maintain sensory characteristic of the traditional salchichon sausage. It is also hoped

to increase the venison products consumption and subsequently to raise the economic value of cynegetic venison.

MATERIALS AND METHODS

Raw materials

Lean venison was obtained from hind legs of male deer (*Cervus elaphus*) 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 was used. Pork meat was obtained from castrated male pigs (progeny of a Pietrain male x Dalain female cross) raised intensively and slaughtered at the age of seven months. 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. The soy protein concentrate used, ArconTMS, is practically tasteless and guarantees high protein solubility. Its chemical composition was: ≤ 6% moisture, ≥ 72% protein, ≤ 3% fat and 20% fibre. Finally, a commercial salchichon formula (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).

Venison salchichon production

Six assays of venison salchichon were made taking into account the findings of a previous study aimed at reducing the pork meat content of this product (UTRILLA *et al.*, 2014). All assays contained 75% lean venison. The original 25% pork meat was partially replaced by 0% (control), 15, 25, 35, 45 and 55% extra virgin olive oil, in Assays 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 (ArconTMS) and mineral water, at a ratio of 10:1:8, respectively (Table 1).

Venison and pork meat were minced separately in an Unger W-98 mincer (Andher, Cam-

Table 1 - Relative percentages of lean venison, pork meat and organogel (olive oil + water + soy protein) in different assays of venison salchichon.

| Assays | Lean venison (%) | Pork meat (%) | Organogel (%) |
|--------|------------------|---------------|---------------|
| 1 | 75 | 25.00 | 0.00 |
| 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 |

po de Criptana, Spain) with an 8 mm plate. Venison was then mixed with on the appropriate proportion of pork meat and the olive oil as organogel (to join a total of 15 kg), and the commercial salchichon mixture (Salchichón Casero 933, Manufacturas Ceylan S.L., Valencia, Spain). An amount of 33 g mixture/kg, previously dissolved in 1 l of cold mineral water, was used. All ingredients were minced in an AV-80 vacuum mixer (Andher, Campo de Criptana, Spain). The mixture was covered with a cotton cloth and left to settle for 20 h at 0° C, in order to the whole mass could involve the spices and additives. 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 casings, 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 cured at 11°-12°C and a relative humidity of 75% for 28 days, in a Zanotti curing chamber (Grupo Momplet, Valencia, Spain). After ripening, salchichon sausages were vacuum-packed and stored at 8°-10°C for 45 days until its evaluation. Two replicates of the six assays of salchichon sausages were done.

Samples

To determine physicochemical characteristics (moisture, fat and protein content) in salchichon, the casing 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.

The samples for sensory analysis were presented to the panellists and consumers in 3 mm thick slices without skin, at 20°-22° C (room temperature) and tagged (number-letter-number). Samples were presented randomized at each tasting session in order to minimise any effects due to order of presentation. Unsalted crackers and mineral water were provided to the panellist and consumers to cleanse the mouth between samples. The trained panel evaluated three samples per session, however consumers tasted the six assays of sausages in the same session. The trained panel evaluated each sample in duplicated.

Physicochemical composition

Moisture content was measured in accordance with the standard ISO R-1442 (1973). Total fat was extracted with petroleum ether (40°-60°) following the standard ISO R-1443 (1973). Total nitrogen was measured using the Kjeldahl method (method 16245, AOAC 1980). Protein nitrogen content was obtained by multiplying total nitrogen by a factor of 6.25.

Quantitative descriptive sensory analysis

The quantitative descriptive sensory analysis was carried out in a tasting room equipped in accordance with UNE-EN ISO 8589:2010, by a 9 member sensory panel (6 women, 3 men, ages 25-52 years) with previous experience in fermented sausages. Three training sessions were held, employing three different commercial venison salchichon sausages, elaborated with cinegetic venison and pork meat. The qualification of the panel members was based on reproducibility verification and concordance between the tasters. Attributes intensities were rate on non-structured scales of 10 cm and in accordance with UNE-ISO 4121:2006. All the scales were anchored at the extremes with the terms "weak" and "very intense," except for the colour intensity scales in which the colour was indicated at the extremes. The visual attributes evaluated were: amount of fat (fat particles), fat colour (0=white; 10=yellow) and lean colour (0=pink; 10=black). The odour attributes studied were: black pepper, spices, cured and olive oil odour as well as odour intensity. The attributes that defined the texture profile of the samples were: hardness (strength to breakdown the product), juiciness (amount of juice released during chewing), chewiness (attribute related to the cohesiveness of the product) and fat mouthfeel (attribute related to the perception of the fat quantity of the product). Finally, the taste attributes (including retronasal perceptions) evaluated were the following: intensity of the taste, salty, pungent (nasal and oral mucosa irritation), pepper and olive oil taste and intensity of the aftertaste.

Consumer tests

The consumer tests were carried out in a tasting room equipped in accordance with UNE-EN ISO 8589:2010. An untrained group of 44 habitual consumers of pork salchichon participated in the study, 15 men aged between of 22 and 45 (mean age 31) and 29 women aged between of 21 and 52 (mean age 30). Consumers were recruited from students, staff and faculty of the Food Science and Technology Area of the University of Castilla-La Mancha. Consumers were instructed to express their evaluation for overall acceptability considering the external appearance, odour, taste and texture of the slices. In the same session they evaluated their acceptance and preference of the six assays of samples.

Acceptance test

To grade the acceptability of each sample, consumers used a non-structured or linear hedonic scale of 10 cm, anchored at either end by the phrases "strongly like" (left end) and "strongly dislike" (right end), enabling consumers to mark the point which best represented their satisfaction with the sample.

Preference test

A hedonic ranking test was used (UNE-ISO 8587:2010), whereby each consumer was presented with a sample from each assay and asked to order the samples by degree of preference, giving 1 point to the least preferred and 6 to the most preferred.

Statistical Analysis

One-way ANOVA was performed to study the influence of the olive oil amount in physicochemical parameters, and attributes evaluated by the quantitative descriptive sensory analysis and by the acceptance test. When the interaction was significant, the means were compared using the Student-Newman-Keuls test. The Friedman test was performed to check the significance of differences between consumer preferences. When significant differences were found, the Fisher's Least Significant Difference (LSD) test was calculated following standard UNE-ISO 8587:2010, to compare the means. All statistical procedures were carried out using SPSS 19.0 statistical software for Windows XP (SPSS, Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

Physicochemical composition

Results (mean±standard deviations) for moisture, fat and protein content of six salchichon assays at the end of ripening are shown in Table 2. Moisture values at the end of ripening were between 30.4-32.1 g/100 g, similar to those reported in other dry sausages varieties containing olive oil (BLOUKAS *et al.*, 1997; MUGUERZA *et al.*, 2002; BERIAIN *et al.*, 2011). Significant differ-

ences in fat content were found between assays, directly reflected the varying proportion of olive oil, whose fat content is higher than that of pork meat. Values at the end of ripening (21.1-40.2 g/100 g DM) were lower than those reported in pork and or beef sausages made with a partial replacement of pork backfat with olive oil (41.4-59.0 g/100 g DM) (BLOUKAS *et al.*, 1997; MUGUERZA *et al.*, 2001; MUGUERZA *et al.*, 2002; BERIAIN *et al.*, 2011), probably because the lean venison and pork meat used contains less fat than the raw materials used in those studies. On the other hand, significant inter assay differences in protein content were recorded at end of ripening process. The higher the olive-oil content, the lower the protein nitrogen content, as it was expected a significant inverse correlation being recorded between the two parameters ($r=-0.948$; $P<0.001$). Protein nitrogen values at the end of ripening (43.6-59.6 g/100 g DM) were higher than those reported by other authors (25.8-44.7 g/100 g DM) (BLOUKAS *et al.*, 1997; MUGUERZA *et al.*, 2001; MUGUERZA *et al.*, 2002; BERIAIN *et al.*, 2011), since venison salchichon had a lower fat content than those made with pork and/or beef.

Quantitative descriptive sensory analysis

Significant inter-assay differences were found for all the sensory attributes studied, except for fat colour, salty taste and taste intensity. Therefore, in all assays, the fat were white, presented scores ranged between 0.89 and 1.63 (0=white; 10=yellow), the salty taste was considered medium, approached 5.0, while taste intensity was judged to be moderate-to-high, scoring between 6.86 and 7.60.

Mean scores (± standard deviation) assigned by the tasting panel for each of the visual attributes studied are shown in Table 3. Assays

Table 2 - Physicochemical parameters (means±standard deviations) of venison salchichon with different percentage replacement of pork meat by olive oil.

| | Assay 1 | Assay 2 | Assay 3 | Assay 4 | Assay 5 | Assay 6 |
|----------------------|--------------------------|----------------------------|--------------------------|--------------------------|----------------------------|--------------------------|
| Moisture (g/100 g) | 31.69±2.29 | 32.07±1.64 | 31.15±0.46 | 30.79±0.73 | 32.02±0.26 | 30.40±0.09 |
| Fat (g/100 g DM) | 19.04 ^a ±2.14 | 21.11 ^a ±0.06 | 29.91 ^b ±0.67 | 36.29 ^c ±1.09 | 37.88 ^{c,d} ±0.52 | 40.24 ^d ±1.58 |
| Protein (g/100 g DM) | 59.57 ^d ±1.54 | 56.58 ^{c,d} ±1.97 | 54.19 ^c ±0.62 | 49.76 ^b ±1.39 | 48.06 ^b ±0.82 | 43.62 ^a ±0.55 |

Different superscripts (a,b,c,d) in the same row denote significant differences ($P<0.05$). Assay 1 (0% replacement); Assay 2 (15% replacement); Assay 3 (25% replacement); Assay 4 (35% replacement); Assay 5 (45% replacement); Assay 6 (55% replacement). DM: dry matter.

Table 3 - Visual attributes (means±standard deviations) of venison salchichon with different percentage replacement of pork meat by olive oil.

| | Assay 1 | Assay 2 | Assay 3 | Assay 4 | Assay 5 | Assay 6 |
|---------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Amount of fat | 6.07 ^c ±0.93 | 6.00 ^c ±0.61 | 5.91 ^c ±0.75 | 4.65 ^b ±0.82 | 4.52 ^b ±0.88 | 3.28 ^a ±0.74 |
| Fat colour | 0.89±0.64 | 1.16±0.46 | 1.31±0.52 | 1.27±0.67 | 1.63±0.90 | 1.46±0.68 |
| Lean colour | 7.44 ^b ±0.50 | 6.81 ^b ±0.95 | 6.56 ^b ±0.70 | 7.41 ^b ±1.06 | 7.16 ^b ±0.89 | 5.84 ^a ±0.90 |

Different superscripts (a,b,c) in the same row denote significant differences ($P<0.05$). Assay 1 (0% replacement); Assay 2 (15% replacement); Assay 3 (25% replacement); Assay 4 (35% replacement); Assay 5 (45% replacement); Assay 6 (55% replacement).

Table 4 - Odour attributes (means±standard deviations) of venison salchichon with different percentage replacement of pork meat by olive oil.

| | Assay 1 | Assay 2 | Assay 3 | Assay 4 | Assay 5 | Assay 6 |
|--------------------|-------------------------|---------------------------|---------------------------|-------------------------|-------------------------|-------------------------|
| Odour intensity | 7.95 ^b ±0.64 | 8.04 ^b ±0.58 | 7.83 ^b ±0.74 | 7.05 ^a ±0.87 | 6.58 ^a ±0.74 | 6.85 ^a ±0.62 |
| Black pepper odour | 5.15 ^c ±0.63 | 5.09 ^c ±0.62 | 3.74 ^b ±0.75 | 3.64 ^b ±0.63 | 3.30 ^b ±0.75 | 2.33 ^a ±0.74 |
| Spicy odour | 4.99 ^a ±0.77 | 4.35 ^{c,d} ±0.58 | 4.45 ^{c,d} ±0.78 | 3.96 ^c ±0.99 | 3.30 ^b ±0.86 | 2.44 ^a ±0.88 |
| Cured odour | 6.08 ^c ±0.87 | 6.79 ^c ±0.81 | 5.97 ^c ±0.54 | 6.13 ^c ±0.65 | 4.91 ^b ±1.06 | 4.16 ^a ±0.88 |
| Olive oil odour | 0.00 ^a ±0.00 | 0.00 ^a ±0.00 | 2.56 ^b ±0.78 | 3.33 ^c ±0.81 | 4.04 ^d ±1.20 | 6.01 ^e ±1.01 |

Different superscripts (a,b,c,d,e) in the same row denote significant differences (P<0.05). Assay 1 (0% replacement); Assay 2 (15% replacement); Assay 3 (25% replacement); Assay 4 (35% replacement); Assay 5 (45% replacement); Assay 6 (55% replacement).

Table 5 - Texture attributes (means±standard deviations) of venison salchichon with different percentage replacement of pork meat by olive oil.

| | Assay 1 | Assay 2 | Assay 3 | Assay 4 | Assay 5 | Assay 6 |
|---------------|-------------------------|-------------------------|-------------------------|---------------------------|-------------------------|-------------------------|
| Hardness | 6.05 ^d ±0.66 | 5.74 ^d ±0.80 | 4.91 ^c ±0.55 | 4.03 ^b ±0.79 | 3.12 ^a ±0.54 | 2.79 ^a ±0.91 |
| Juiciness | 4.63 ^b ±0.61 | 5.18 ^b ±0.79 | 6.05 ^a ±0.77 | 6.80 ^a ±0.83 | 6.68 ^a ±0.57 | 6.03 ^a ±1.15 |
| Chewiness | 6.17 ^b ±0.40 | 4.95 ^a ±0.42 | 5.20 ^a ±0.53 | 5.00 ^a ±0.00 | 5.00 ^a ±0.00 | 5.07 ^a ±0.27 |
| Fat mouthfeel | 4.86 ^a ±0.75 | 4.88 ^a ±0.70 | 6.06 ^b ±0.86 | 6.64 ^{b,c} ±0.88 | 7.02 ^c ±0.98 | 7.34 ^c ±0.98 |

Different superscripts (a,b,c,d) in the same row denote significant differences (P<0.05). Assay 1 (0% replacement); Assay 2 (15% replacement); Assay 3 (25% replacement); Assay 4 (35% replacement); Assay 5 (45% replacement); Assay 6 (55% replacement).

made without or with smaller amounts of olive oil (Assays 1, 2 and 3) displayed larger amounts of visible fat; as the proportion of olive oil increased, the amount of visible fat declined. Lean venison was dark brown in all except Assay 6, where it was pinker. Similar findings were reported by MUGUERZA *et al.* (2001) in a study of Pamplona-style chorizo made with lean pork (75%) and pork meat (25%) partially replaced by olive oil (0, 10, 15, 20, 25 and 30%) and in a later study (MUGUERZA *et al.*, 2002) of salchichon made with lean pork, lean beef and varying proportions of pork backfat (10, 20 and 30%) partially replaced by olive oil (0 and 20%). These authors recorded significant inter-assay differences in colour, noting that colour intensity decreased as the amount of olive oil increased. By contrast, BERIAIN *et al.* (2011), in another study of Pamplona-style chorizo in which pork backfat was partially replaced by olive oil emulsified with alginate, found no significant difference between appearance profiles. However, in that study 71.4% of the tasting panel expressed a preference for chorizo in which 50% of pork backfat had been replaced by olive oil, on the grounds that its appearance was more appealing than that of the control, due to its effective imitation of the rice-grain effect typical of this type of chorizo (BOE, 1980).

Mean scores (± standard deviation) assigned by the tasting panel for odour attributes are shown in Table 4. Assays containing the lowest amounts of olive oil (Assays 1, 2 and 3) were judged to display the greatest odour intensity (7.83-8.04). The black pepper odour characteristic of salchichon weakened as the proportion of olive oil increased, being most intense in Assays

1 and 2 (5.09-5.15). Spicy and cured odour also decreased with increasing proportions of olive oil; the lowest intensity for both attributes (2.44 and 4.16, respectively) was recorded in Assay 6 (55% replacement). Finally, olive oil odour was identified from Assay 3 onwards, becoming more intense as the proportion of olive oil increased. MUGUERZA *et al.* (2002) also reported greater oil odour intensity with rising proportions of olive oil in place of pork backfat.

Scores for the attributes defining the texture profile are shown in Table 5. The replacement of 35% or a high amount of pork meat by olive oil (Assays 4, 5 and 6) was considered to give rise to excessive softness (hardness scores below 5). The control scored highest for chewiness (6.17), whereas the assays containing varying proportions of olive oil received scores of around 5. Assays 1 and 2 (0 and 15% substitution) scored lowest for juiciness (4.63-5.18), the remainder received scores of between 6 and 6.8 points. Finally, fat mouthfeel increased with higher proportions of olive oil, scores rising from 4.86 (Assay 1) to 7.34 (Assay 6); the panellist judged the mouthfeel of Assays 5 and 6 (7.02 and 7.34, respectively) to be over-fatty. So, addition of olive oil to venison salchichon prompted an increase in juiciness and fat mouthfeel and a decrease in both hardness and chewiness. Similar findings were reported by MUGUERZA *et al.* (2001) who noted that types containing larger amounts of olive oil were too soft, although they recorded no difference in juiciness among types. BLOUKAS *et al.* (1997), in a study of salchichon made with lean pork, lean beef and pork backfat partially replaced by olive oil, with or without added soy protein,

found significant differences as a function of the way oil was added: salchichon to which oil was added in liquid form was judged to be too soft, and obtained lower scores for odour and flavour intensity, whereas scores for salchichon made with olive oil combined with soy protein were similar to those of controls.

Finally, scores for taste attributes are shown in Table 6. Significant inter-assay differences were recorded for most taste-related attributes. Olive oil taste was identified from Assay 3 (25%) onwards, increasing as a function of the proportion of added olive oil, to a maximum score of 6.96 for Assay 6 (55% substitution). Spicy taste decreased with rising proportions of olive oil, which masked the black pepper taste characteristic of salchichon. By contrast, BERIAIN *et al.* (2011) found no significant difference in taste between Pamplona-style chorizo types made with and without olive oil.

To summarise, variation in the percentage replacement of pork meat by olive oil had a marked influence on the results of descriptive sensory analysis. The replacement of 35% or more, of pork meat by olive oil, resulted in a reduction of the fat particles visibility. It also prompted a decrease in odour intensity, spicy odour, hardness and an increase of fat mouthfeel, together with the olive oil perception (odour and taste). By contrast, the replacement of 25% of pork meat by olive oil yielded a salchichon not greatly different in appearance, texture, odour and taste to the control.

Consumer tests

Acceptance test

The scores awarded by the consumers for different assays of venison salchichon sausage with different percentage of olive oil added are shown in Table 7. From these results, it can be concluded that all the samples were accepted because the average score was above 5.0 (satisfaction threshold). Significant inter-assay differences were recorded for appearance and odour, but not for the rest of the attributes studied. Assays 1, 2 and 3 received the highest scores for odour (7.10-7.60). Therefore, the replacement of up to 25% of pork meat by olive oil yields a product as acceptable to the consumer, in terms of all sensory parameters, as controls containing no olive oil.

Preference test

Consumers ordered samples by degree of preference, giving 1 point to the least preferred and 6 to the most preferred (Table 8). The preference order was Assay 3 > Assay 2 > Assay 1 > Assay 4 > Assay 5 > Assay 6. The Friedman test showed significant differences ($P < 0.05$) between assays. After having applied the Fischer method to calculate the Least Significant Difference (LSD), it can be affirmed that the samples from Assay 6 were significantly different from the rest as the least preferred. On the other hand, the samples from Assays 4 and 5 were not significantly different from each

Table 6 - Taste attributes (means±standard deviations) of venison salchichon with different percentage replacement of pork meat by olive oil.

| | Assay 1 | Assay 2 | Assay 3 | Assay 4 | Assay 5 | Assay 6 |
|----------------------|-------------------------|---------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Taste intensity | 7.26±0.78 | 7.06±0.78 | 7.50±0.84 | 7.50±0.78 | 7.60±0.93 | 6.86±0.91 |
| Salty taste | 5.07±0.27 | 5.00±0.00 | 5.00±0.00 | 5.00±0.00 | 5.00±0.00 | 5.04±0.13 |
| Pungent taste | 2.86 ^c ±0.80 | 2.69 ^{b,c} ±0.78 | 1.93 ^b ±0.90 | 2.00 ^b ±0.81 | 2.11 ^b ±0.79 | 0.93 ^a ±0.48 |
| Pepper taste | 4.06 ^c ±0.67 | 3.15 ^b ±0.90 | 2.66 ^b ±0.78 | 2.71 ^b ±0.72 | 2.58 ^b ±0.70 | 1.53 ^a ±0.74 |
| Olive oil taste | 0.00 ^a ±0.00 | 0.00 ^a ±0.00 | 3.04 ^b ±0.78 | 3.51 ^b ±0.90 | 4.63 ^c ±0.82 | 6.96 ^d ±1.25 |
| Aftertaste intensity | 7.42 ^b ±0.76 | 7.20 ^b ±0.73 | 8.02 ^b ±0.59 | 7.49 ^b ±0.85 | 7.59 ^b ±0.79 | 6.49 ^a ±0.94 |

Different superscripts (a,b,c,d) in the same row denote significant differences ($P < 0.05$). Assay 1 (0% replacement); Assay 2 (15% replacement); Assay 3 (25% replacement); Assay 4 (35% replacement); Assay 5 (45% replacement); Assay 6 (55% replacement).

Table 7 - Means and standard deviations of the scores obtained for different assays of venison salchichon with different percentage replacement of pork meat by olive oil in the consumers acceptance test.

| | Assay 1 | Assay 2 | Assay 3 | Assay 4 | Assay 5 | Assay 6 |
|--------------------|-------------------------|-------------------------|-------------------------|---------------------------|---------------------------|-------------------------|
| Appearance | 6.86 ^b ±1.96 | 7.01 ^b ±1.47 | 7.25 ^b ±1.71 | 6.63 ^{a,b} ±1.83 | 6.47 ^{a,b} ±1.67 | 5.84 ^a ±2.27 |
| Odour | 7.60 ^b ±1.40 | 7.20 ^b ±1.46 | 7.10 ^b ±1.87 | 6.18 ^a ±2.39 | 6.06 ^a ±1.99 | 5.63 ^a ±2.43 |
| Taste | 6.42±1.78 | 6.33±1.67 | 6.29±2.02 | 5.88±2.19 | 5.58±2.13 | 5.27±2.43 |
| Texture | 5.91±2.09 | 6.30±2.06 | 6.39±2.19 | 5.93±2.26 | 5.83±2.40 | 5.31±2.43 |
| Overall acceptance | 6.34±1.84 | 6.47±1.93 | 6.58±1.86 | 5.91±2.26 | 5.75±2.30 | 5.42±2.34 |

Different superscripts (a,b) in any row denote significant differences ($P < 0.05$). Assay 1 (0% replacement); Assay 2 (15% replacement); Assay 3 (25% replacement); Assay 4 (35% replacement); Assay 5 (45% replacement); Assay 6 (55% replacement).

Table 8 - Total scores obtained for different assays of venison salchichon with different percentage replacement of pork meat by olive oil in the consumers preference test.

| | Assay 1 | Assay 2 | Assay 3 | Assay 4 | Assay 5 | Assay 6 |
|--|---------|---------|---------|---------|---------|---------|
| Total scores | 169 | 172 | 183 | 148 | 144 | 108 |
| Assay 1 (0% replacement); Assay 2 (15% replacement); Assay 3 (25% replacement); Assay 4 (35% replacement); Assay 5 (45% replacement); Assay 6 (55% replacement). | | | | | | |

other. The samples from Assays 1, 2 and 3 were not significantly different from each other as the most preferred by consumers. The samples from Assays 1, 2 and 3 were the most preferred mainly for six reasons (good flavour, proper texture, pleasant odour, good aspect and attractive colour). Among the reasons for preferring the sausage from Assay 6 the least, 36.4% of consumers thought the texture were not right and 31.8% highlighted the bad flavour. They also stressed the bad aspect, disagreeable odour and unattractive colour.

CONCLUSIONS

In sensory terms, low-fat venison salchichon in which equal or more than 35% of pork meat had been replaced by olive oil presented a lower acceptance than products containing less olive oil. Its appearance was deemed less favourable due to poorer visibility of fat particles, the texture was regarded as over-soft, and the mouth-feel was considered excessively fatty. There was also a decrease in odour quality and intensity, as well as in cured and spicy odour, together with an unfavourable taste and odour of olive oil. The trained panel found that replacement of 25% of pork meat by olive oil yielded a salchichon not greatly different to the traditional product. Consumers also preferred salchichon in which no more than 25% of the pork meat had been replaced by olive oil, largely because of its good taste and acceptable texture.

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