PAPER

DETERMINATION OF THE OPTIMAL FAT AMOUNT IN DRY-RIPENED VENISON SAUSAGE

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ABSTRACT

Six types of salchichon sausage were made using cynegetic venison lean and different amounts of pork meat (40, 30, 25, 20, 15 and 10%) in order to choose the lowest fat content without decreasing the sensory quality of the traditional salchichon sausage. All samples were evaluated using quantitative descriptive sensory analysis, finding significant differences; as the amount of pork meat increased, sausages exhibited a lighter colour and an intense spice and cured odour, as well as being juicier and easier to chew. Furthermore, consumer tests were carried out. All types of sausages were accepted by consumers (scores > 5.5 for all attributes) finding significant differences in the preference test.

- Keywords: consumer test, fat content, quantitative descriptive sensory analysis, venison salchichon sausage -

INTRODUCTION

The production of cynegetic deer in Spain is high, accounting 148195 animals hunted in 2011 (MAGRAMA, 2014); however, its economic value is relatively low because it is considered to be simply a by-product of hunting, oriented to obtain flashy awards. In the autonomous community of Castilla-La Mancha (central Spain), the area designated for hunting spans more than 7 million hectares of which almost 2 million are designated for big game hunting, mainly venison and wild boar (JCCM, 2010). Castilla-La Mancha is also the main venison exporter in Spain, constituting 80% of the total exportation, being Germany its primary destination. Despite the large venison production, its consumption is fairly limited in the region and in Spain generally. Venison is mainly consumed in certain rural areas and restaurants.

Cynegetic venison is a highly nutritive food 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 specific organoleptic properties that differ from other species such as its intense and attractive red colour, tenderness and variety of flavours (SORIANO *et al.*, 2009), reflecting the fact that the animals live in the wilderness and nourish on naturally occurring feed.

A wide range of cured products are obtained from cinegetic 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. To make venison salchichon, an appropriate amount of pork fat has to be added to obtain gradual drying as well as sensory characteristics such as juiciness, tenderness and flavor. In the traditionally produced cynegetic venison salchichon, the fat content is around 40-50% (habitual practices of local manufacturers in Castilla-La Mancha region). Today, this fat amount is considered excessive in terms of the WHO recommendations for a healthy diet (WHO, 2004), which suggest the consumption of low-fat foods. These recommendations are followed by meat manufacturers that are producing meat products containing smaller amounts of fat. On the other hand, an excessive amount of fat can cause an excessive oxidation of the lipids or rancidity (SORIANO *et al.*, 2010).

Several studies have been carried out to characterise the physicochemical and sensory quality of venison (STEVENSON *et al.*, 1992; PEÑA *et al.*, 1993; ZOMBORSZKY *et al.*, 1996; WIKLUND *et al.*, 2001 and 2003). However, very few studies have been reported on microbiological, physicochemical and sensory characteristics of dry sausages made with venison (VIOQUE *et al.*, 2003; SORIANO *et al.*, 2006; GARCÍA RUIZ *et al.*, 2010; SORIANO *et al.*, 2010; UTRILLA *et al.*, 2014). Until now, no study has focused on the reduction of fat in cured sausages made with meat from cynegetic species. However, several scientific studies have been carried out to reduce the fat content in dry-ripened sausages made with pork and/or beef (PAPADIMA and BLOUKAS, 1999; MENDOZA *et al.*, 2001; MUGUERZA *et al.*, 2002; LIAROS *et al.*, 2009; OLIVARES *et al.*, 2010; OLIVARES *et al.*, 2011), foal and pork meat (LORENZO and FRANCO, 2012).

The objective of this study was to obtain a healthier venison salchichon with the lowest fat content that at the same time maintains sensory characteristics of the traditional salchichon.

MATERIAL AND METHODS

Raw materials

Lean venison (*Cervus elaphus*) was obtained from hind legs of male deer obtained during the 2008-2009 hunting season on three neighbouring reserves in Ciudad Real (central Spain). Vegetation in the three reserves was very similar, comprising pine forests, woodlands and scrub. A total of 69 kg of venison was used for each replicate of the experiment. Pork meat with a high fat content 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 21 kg of pork meat was used for each replicate of the experiment. A commercial salchichon formula (Ceylamix 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).

Cynegetic venison salchichon sausage production

Six types of venison salchichon were made, each containing a different proportion of pork meat (40, 30, 25, 20, 15 and 10%) and lean venison (60, 70, 75, 80, 85 and 90%, respectively). Types were labelled from Type 1 (40% pork meat and 60% lean venison) to Type 6 (10% pork meat and 90% lean venison) (Table 1). Venison and pork meat were minced separately in an Unger

Table 1 - Percentages of raw meats used to elaborate the different types of cynegetic venison salchichon.

Type	Venison (%)	Pork meat (%)
1	60	40
2	70	30
3	75	25
4	80	20
5	85	15
6	90	10

W-98 mincer (Andher, Campo de Criptana, Spain) with an 8 mm plate. Venison was then mixed with the appropriate proportion of pork meat and the Ceylamix commercial formula (33 g/kg mixture) previously 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 settle for 20 h at 0°C, in order to the whole mass could get 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 skins, with a 38-40 mm diameter. Horseshoe-shaped salchichon sausages were then tied off at 60 cm intervals. Average weight of sausages was 737 g. 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 the 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. The six types were made in duplicate, so the same experiment was repeated on two different dates, in order to maximize reproducibility of the results.

Quantitative descriptive sensory analysis

The quantitative descriptive sensory analysis was carried out in a tasting room that was equipped in accordance with UNE-EN ISO 8589:2010.

Judges

The evaluation of the samples was carried out by a panel test formed by 9 panellists (6 women, 3 men, ages 25-52 years). The panel was previously trained in the evaluation of the attributes and scales employing different commercial venison salchichon. The qualification of the panel members is based on reproducibility verification and concordance between the tasters.

Attributes

A focus group was organized to discuss and choose the most apropiate attributes. The sensory evaluation of the attributes was carried out using 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 colour (0=white; 10=yellow) and lean colour (0=light pink; 10=black). The colour scales used were photographs of different types of venison salchichon sausages. The olfactory attributes studied were: black pepper, spices and cured odour as well as odour intensity. The attributes that defined the texture profile of the samples were: hardness, juiciness, chewiness and fat mouth-feel. Finally, taste attributes evaluated were the following: intensity of the taste, salty and pepper taste and intensity of the aftertaste. Data collection was organized on paper.

Preparation of the samples

The samples were presented to the panellists in 3 mm thick slices without skin, at 20°-22°C (room temperature) and tagged (number-letter-number). Three samples were evaluated per sesión at a time. Unsalted crackers and mineral water were provided to the panellists to cleanse the mouth between samples. Samples were presented in all possible orders at each tasting session in order to minimise any effects due to order of presentation. All samples were evaluated in duplicate.

Consumer tests

The consumer tests were carried out in a tasting room equipped in accordance with UNE-EN ISO 8589:2010.

Consumers

A group of 138 habitual consumers of salchichon sausage was used: 42 men aged between 20 and 49, and 96 women aged between 19 and 54. Consumers were recruited from students, professors and staff of the Food Science and Technology Area of the University of Castilla-La Mancha.

Preparation of the samples

Samples were presented at 20°-22°C (room temperature) in 3-mm slices, without skin, using a 3-character alphanumeric code. Samples were presented in all possible orders at each tasting session in order to minimise any effects due to order of presentation. Unsalted crackers and mineral water were provided to the panellists to cleanse the mouth between samples. Consumers were instructed to carry out their evaluation for overall acceptability considering the cross section external appearance, odour, taste and texture of the slices. In one session, consumers evaluated the six samples corresponding to the six different types of venison salchichon sausage.

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" and "strongly dislike", enabling consumers to mark the point which best represented their satisfaction with the sample. Attributes were evaluated in the order: odour,

aspect, texture, taste and overall acceptance. Data collection was organized on paper.

Preference test

A hedonic ranking test was used (UNE-ISO 8587:2010), whereby each consumer was presented with a sample from each type 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 analysis of variance (ANOVA) was performed to study the influence of the amount of fat in the attributes evaluated in the quantitative descriptive sensory analysis and the acceptance test. When the interaction was significant, the averages were compared using the Student-Newman-Keuls test. Friedman's (non-parametric) test was performed, following standard UNE-ISO 8587:2010, to check the significance of differences between consumer preferences, and differences between particular sample means were analysed according the Fisher's least significance difference (LSD). All statistical procedures were carried out using the SPSS 19.0 statistical software package for Windows XP (SPSS, Inc, Chicago, Il, USA) with updating rights (License UCLM 7876875).

RESULTS AND DISCUSSION

Quantitative descriptive sensory analysis

Visual attributes of the cynegetic venison salchichon sausage with different amount of pork meat added are shown in Table 2. Significant differences were found for the three studied attributes. The types with the highest fat content exhibited the pinkest colored lean while the types with the lowest fat content were dark brown. The fat colour in all samples was white except for samples bellowing Type 6 (10% fat), which exhibited a more yellowish colour. This was possibly influenced by the darker colour of the lean. Furthermore, all samples showed an amount of visible fat that was directly proportional to the pork meat added during the elaboration.

Attributes that defined the olfactory profile are shown in Table 3. Significant differences were found for all studied attributes. Samples with the highest amount of fat, Types 1, 2 and 3 (40-25%), exhibited a higher intensity of odour (7.6-8.0) and a more pronounced spice, black pepper and cured odour in comparison to Types 4, 5 and 6 (20-10%) which despite having elevated odour intensity (6.8-7.1) exhibited less intensity in all of the attributes studied. These results do not coincide with those obtained by MENDOZA *et al.* (2001), which did not find significant differences in the intensity of odour, obtaining scores between 6.5-7.5 (in a scale of 1-10) with regard to the fat content (6.3, 12.5 and 25% of fat). It should be noted that the authors obtained scores slightly lower than those obtained in this study, possibly due to the higher olfactory intensity of venison in comparison to beef and pork. On the other hand, odour intensity, spice and ripened odour presented similar scores than those obtained by GARCÍA RUIZ *et al.* (2010) in a study about sensory properties of venison sausages made with 50% venison lean and 50% pork meat.

Table 4 organizes the scores awarded by the panellists for the attributes that defined the texture profile of the cynegetic venison salchichon sausage with different quantities of pork meat added. Samples bellowing Type 1 exhibited the lowest

Table 2 - Visual attributes (means ± standard deviations) of the cynegetic venison salchichon with different pork meat added.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Amount of fat	7.19^{a}±0.78	6.58^{b}±0.93	5.95^{c}±0.96	5.07^{d}±0.92	3.86^{e}±0.77	2.32^{f}±0.59
Fat colour	2.03^{a}±0.73	2.28^{a}±0.73	2.26^{a}±0.85	2.23^{a}±0.67	1.98^{a}±0.65	2.85^{b}±1.06
Lean colour	3.12^{a}±0.60	4.36^{b}±1.10	3.92^{b}±0.85	6.02^{c}±1.07	5.76^{c}±0.84	7.24^{d}±1.06

Different superscripts (a, b, c, d, e, f) in the same row denote significant differences (P<0.05).
Type 1 (40% pork meat); Type 2 (30% pork meat); Type 3 (25% pork meat); Type 4 (20% pork meat); Type 5 (15% pork meat); Type 6 (10% pork meat).

Table 3 - Odour attributes (means ± standard deviations) of the cynegetic venison salchichon with different pork meat added.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Odour intensity	7.96^{a}±0.72	7.67^{a}±0.57	7.62^{a}±0.64	6.78^{b}±0.55	6.98^{b}±0.98	7.10^{b}±1.20
Black pepper odour	6.29^{a}±0.74	6.07^{a}±1.06	5.90^{a}±0.72	5.02^{b}±1.29	5.09^{b}±1.48	4.86^{b}±1.93
Spices odour	6.60^{a}±0.73	6.33^{a}±1.03	6.33^{a}±0.87	5.32^{b}±1.66	5.35^{b}±0.93	5.45^{b}±1.20
Cured odour	7.12^{a}±0.75	6.76^{a}±0.91	6.81^{a}±0.96	6.01^{b}±1.71	5.67^{b}±1.40	5.96^{b}±0.98

Different superscripts (a, b) in the same row denote significant differences (P<0.05).
Type 1 (40% pork meat); Type 2 (30% pork meat); Type 3 (25% pork meat); Type 4 (20% pork meat); Type 5 (15% pork meat); Type 6 (10% pork meat).

Table 4 - Texture attributes (means ± standard deviations) of the cynegetic venison salchichon with different pork meat added.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Hardness	4.59^{a}±0.71	5.16^{b}±0.72	5.19^{b}±0.88	5.61^{b}±0.84	5.27^{b}±0.74	5.39^{b}±1.11
Juiciness	6.55^{a}±0.86	5.82^{b}±0.56	6.09^{b}±0.60	4.98^{c}±1.03	4.18^{d}±0.98	3.72^{e}±1.13
Chewiness	4.99^{a}±0.44	4.96^{a}±0.23	5.26^{a}±0.67	5.12^{a}±0.52	6.07^{b}±0.86	6.28^{b}±0.47
Fat mouthfeel	6.43^{a}±0.85	5.81^{b}±1.23	5.76^{b}±1.11	4.46^{c}±1.16	3.32^{d}±0.78	1.80^{e}±0.97

Different superscripts (a,b,c,d,e) in the same row denote significant differences (P<0.05).
Type 1 (40% pork meat); Type 2 (30% pork meat); Type 3 (25% pork meat); Type 4 (20% pork meat); Type 5 (15% pork meat); Type 6 (10% pork meat).

Table 5 - Taste attributes (means ± standard deviations) of the cynegetic venison salchichon with different pork meat added.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Taste intensity	7.46^{a}±0.84	7.32^{a}±0.66	7.76^{a}±0.86	7.50^{a}±0.84	6.71^{b}±0.77	6.52^{b}±1.00
Salty taste	5.10±0.31	5.09±0.67	5.33±0.62	5.14±0.36	5.04±0.57	5.04±0.54
Pepper taste	4.90±1.05	4.23±0.59	4.84±1.09	4.74±1.19	4.27±1.17	4.69±1.21
Aftertaste intensity	7.38^{a}±0.86	7.26^{a}±0.45	7.68^{a}±0.89	7.55^{a}±0.90	7.27^{a}±0.77	6.67^{b}±1.00

Different superscripts (a,b) in the same row denote significant differences (P<0.05).
Type 1 (40% pork meat); Type 2 (30% pork meat); Type 3 (25% pork meat); Type 4 (20% pork meat); Type 5 (15% pork meat); Type 6 (10% pork meat).

hardness (4.59). Samples from Types 2-6 showed values between 5.16-5.61, indicating a good texture for those sausages. Therefore, the reduction in the addition of pork meat to levels below 30% did not negatively affect this attribute. However, samples from Types 5 and 6 presented the lowest juiciness and were more difficult to chew. So the addition of pork meat below 20% to venison salchichon negatively influenced those attributes. Moreover, as the amount of fat increased the juiciness and the fat mouthfeel also increased, highlighting that samples from Types 2 and 3 presented similar values for those attributes. The scores for both attributes were more different between Type 1 with more fat content (6.5 for juiciness and 6.4 for fat in the mouth) and Type 6 with less fat content (3.7 for juiciness and 1.8 for fat in the mouth). Other varieties of dry-fermented sausages evaluated by a trained panel, showed higher scores for texture attributes (mainly hardness and juiceness) as the fat level increased (PAPADIMA and BLOUKAS, 1999; LIAROS *et al.*, 1999; MENDOZA *et al.*, 2001; LORENZO and FRANCO, 2012). In addition, the values found in this study for juiciness, chewiness and fat mouthfeel were similar to those reported by GARCÍA RUIZ *et al.* (2010) in venison sausages (50% lean venison-50% pork meat).

Table 5 shows the means and standard deviations of the taste attributes of the different types of cynegetic venison salchichon sausages. Significant differences were not found for the salty and black pepper taste attributes; all of the samples exhibited a proper salty taste with scores ranging between 5.0 and 5.3 and a pepper taste with scores from 4.2 to 4.9. On the other hand, significant differences were found for the taste intensity which was slightly lower for the Types with the least fat content (5 and 6), and for the aftertaste intensity which was lower for Type 6, with the lowest fat content, owing to the fact that lipids experiment lipolysis and lipid oxidation during the curing process that contributes the flavour (SAMELIS *et al.*, 1993). MENDOZA *et al.* (2001) also found significant differences in the taste intensity of the dry sausages in accordance with the fat content. The samples with the lowest fat content (6.5% and 12.5%) received lower scores ranging between 5.5 and 5.9 while the samples with the highest fat content (25%) received a score of 7.3. These scores are slightly lower than those obtained in this study (6.5-7.8) possibly due to the intense taste of cynegetic venison and its special organoleptics properties. GARCÍA RUIZ *et al.* (2010) found in its study of venison sausages elaborated using 50% lean venison and 50% pork meat, scores of 7.77 for taste intensity, 5.10 for salty taste and 7.38 for aftertaste intensity.

In summary, results obtained in the quantitative descriptive sensory analysis were highly influenced by the fat content of the samples even though all samples were accepted by the tasting panel (whitout sensory defects). These results do not coincide with those obtained by MUGUERZA *et al.* (2002) which determined that the cured sausages made with 10% pork backfat were unacceptable from a sensory point of view because of its winkled surface and excessive hardness.

Consumer tests

Acceptance test

The scores awarded by the consumers for different types of cynegetic venison salchichon sausage with different pork meat added are shown in Table 6. From these results, it can be concluded that all the samples were accepted

Table 6 - Means and standard deviations of the scores obtained for different types of cynegetic venison salchichon in the acceptance test.

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Aspect	7.18^{a}±2.04	6.84^{a}±1.89	7.19^{a}±1.79	5.80^{b}±2.16	5.91^{b}±2.01	5.47^{b}±2.28
Odour	7.39^{a}±1.80	6.66^{b}±2.08	7.25^{a}±1.75	$6.22^{b,c}$±2.06	$6.47^{b,c}$±2.09	6.01^{c}±2.23
Taste	7.12^{a}±1.80	6.82^{a}±1.90	7.14^{a}±1.78	6.32^{b}±2.07	6.08^{b}±2.25	5.94^{b}±2.17
Texture	7.22^{a}±1.96	$6.86^{a,b}$±1.82	7.14^{a}±1.94	$6.36^{b,c}$±2.12	$6.34^{b,c}$±2.19	6.22^{c}±2.06
Overall acceptance	7.16^{a}±1.93	$6.93^{a,b}$±1.85	7.20^{a}±1.81	$6.48^{b,c}$±2.00	6.11^{c}±2.21	5.90^{d}±2.12

Different superscripts (a,b,c,d) in any row denote significant differences (P<0.05).
Type 1 (40% pork meat); Type 2 (30% pork meat); Type 3 (25% pork meat); Type 4 (20% pork meat); Type 5 (15% pork meat); Type 6 (10% pork meat).

because the average score was above 5.0 (satisfaction threshold). The consumers found significant differences for all the attributes studied. Samples from Types 1, 2 and 3 were awarded higher scores for aspect (6.8-7.2), taste (6.8-7.1) and overall acceptance (6.9-7.2). The score for odour was also higher for Types 1 and 3. An addition of fat between 25% and 40% to elaborate cynegetic venison salchichon sausage therefore appears to provide, at least in the opinion of the habitual sausage consumers, better organoleptics characteristics than a lower addition. OLIVARES *et al.* (2011) found high consumer acceptability for aroma and overall quality in dry-ripened pork sausages elaborated with 20% and 30% pork meat than those with 10% pork meat.

Preference test

After having applied the Fischer method to calculate the Least Significant Difference (LSD), the consumer preference scores for each of the samples yielded the following order of preference: Type 3 > Type 1 > Type 2 > Type 4 > Type 5 > Type 6. The samples achieving the greatest consumer preference were those from Types 1, 2 and 3, scores differing significantly from those awarded to Types 4 and 5, which achieved a lower degree of consumer preference; Type 6 samples received the lowest scores. Samples from Types 1, 2 and 3 were preferred over the rest for six reasons: good flavour, appropriate texture, pleasant odour, acceptable fat content, good appearance and attractive colour; Type 6 was the least preferred, due to poor flavour and inappropriate texture.

The results obtained from the preference test coincide with those of the acceptance test leading the authors to conclude that the quantity of fat added to venison salchichon sausage should be at least 25% to achieve a good sensory quality similar to that of the traditional product.

CONCLUSIONS

The results obtained in the quantitative descriptive sensory analysis and the consumer tests perfectly coincide revealing that, from a sensory point of view, using 25% of pork meat and 75% of venison lean is enough. Such a quantity of fat assures proper texture for this type of product helping to attain a satisfactory odour, taste and appearance for the consumer as well as similar attributes to those of traditionally made salchichon sausage with a higher fat content.

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