Sensory characterization of meat texture in sucking lambs.

Methodology

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SUMMARY

Meat samples from m. longissimus thoracis from 24 sucking lambs of Manchega breed were tasted by six assessors. Lambs were slaughtered at 10 or 14 kg liveweight. Texture parameters (hardness, springiness and juiciness) were measured. Panelists found no differences in any parameters. Nevertheless, there was a trend to perceive the meat of the heaviest animals as less hard, juicer and less springy. Parameters and scales used are discussed. The methodology used in this trial is found convenient for describing sensory texture in sucking lambs meat.

KEY WORDS: Meat
              Lamb
              Sensory analysis
              Texture

INTRODUCTION

Since some decades ago studies have been carried out to determine and quantify the sensations perceived by consumers when tasting a certain food.
Meat industry has paid special attention to manufactured products. Nevertheless, some researchers have studied the organoleptic characteristics of fresh meat (Touraille, 1982a; Dransfield et al., 1984a). There are various publications on bovine fresh meat, either on steer meat or on bull meat (Touraille, 1982b; Dransfield et al., 1984c). Studies on lamb meat were published mainly by workers from the United Kingdom, New Zealand and Australia (Smith et al., 1970; Young and Braggins, 1993; Dransfield et al., 1984a). In the last few years, with the appraisal of protected designations of origin (PDO) and fresh meat quality labels, sensory studies on fresh meat quality have increased (Dransfield, 1980; Sañudo et al., 1992; Jaime et al., 1994; OCU, 1996). However, these papers deal with animals with a much higher liveweight than sucking lambs.

Sucking lamb meat, a great tradition in Mediterranean Europe, is produced in some Spanish regions, concerning 24 % of slaughters in Spain (MAPA, 1997). These animals have a mean carcass weight of 6.9 kg. Spanish production of sucking lambs has raised in the last few years from 22,694 Tm (metric tons) in 1988 to 31,958 Tm in 1997. Nevertheless, literature is scarce, either from carcass quality point of view (Guía and Cañeque, 1992; Ruiz de Huidobro, 1992), or from meat quality point of view (Sañudo et al., 1992; Chasco et al., 1995).

Sensory evaluation of texture is made by means of attributes, which can be established, well a priori by the sensory analyst (Brandt et al., 1963; Szczesniak et al., 1963), well a posteriori, after consensus has been reached between the assessors (Dransfield et al., 1984b). The first method uses different scales for each attribute, valid for any food, and fixes food standards that serve as references to scales divisions. However chosen foods may not be available in all countries, or may not be a part of the usual diet of the inhabitants of a country. So, these scales require an adaptation of the standards to panel habits. Moreover, as it is a method valid for every food, it is not well adapted to any one food in particular. The second method, the consensus method, by the contrary, guarantees that the rating scale used is well adapted to the nutritional habits of the assessors, but it presents the inconvenience that almost never two different panels will agree in the attributes to be used, and so the results will depend exclusively on panelists consumption habits and on the moment of the test. This makes it very difficult to compare the results obtained to those found by other panels. Moreover it may lead to confusion, because it could happen that different panels use opposite attributes for the same characteristic (hardness-tenderness, humidity-dryness, etc.).

The aim of this paper is to establish a method for the sensory assessment of the texture of meat produced by these animals. Sensory analysis has been performed on meat produced by entire male and female Manchega breed sucking lambs, using the Texture Profile method developed in Kraft Foods Company in the sixties (Brandt et al., 1963).

**MATERIAL AND METHODS**

Sucking male and female Manchega lambs, mother fed, slaughtered at 10 kg or at 14 kg liveweight, were used in this experiment. Samples were taken from 24 animals, 12 females and 12 males (6 from each slaughter weight). Samples were taken from the middle part of the right *m. longissimus thoracis et lumborum* muscle, between 6th and 13th dorsal
vertebrae, and vacuum packed (in plastic bags of Rilthene L® 20/80) and matured at 2°C for 3 days. Afterwards, samples were deep frozen at –40°C until the moment of analysis.

The sensory panel

Sensory assessment was performed by six female assessors experienced in texture assessment. Assessors were between 20 and 45 years old. They had followed some training sessions.

Firstly assessors capacity for identification of the four basic tastes and the absolute perception thresholds for the four basic tastes was determined, following Spanish recommendation (AENOR, 1979) which is concordant with ISO/DIS 3972 rule. Afterwards, a trial on recognition of secondary tastes was performed. The objectives of these trials were to get the assessors accustomed to use their own senses, to express the sensations they perceived and to understand the functioning of the tasting sessions. Thereafter specific training for descriptive trials (texture profile) was given.

A texture profile analysis is the sensory analysis of texture characteristics of a specific food, in terms of its mechanical and geometrical characteristics, and its amount of fat and humidity. For this test some of the attributes proposed by Brandt et al. (1963) and Szczesniak et al. (1963) were used (Szczesniak and Torgeson, 1965; Dransfield et al., 1984b; Dransfield et al., 1984c).

Mechanical characteristics

Hardness: The force necessary to compress a food between the molar teeth (Brandt et al., 1963). The food standards used were those described by Szczesniak et al., (1963) (see Table 5) except candy sugar. For meat hardness one does not need the whole scale.

Springiness: In mechanical terms, the extend to which a deformed material returns to undeformed condition, after the deforming force has been removed. Anglo-Saxon authors (Brandt et al., 1963) do not give a “sensory” definition because of the pointed edges and of the relative insensitivity of teeth for it, but French authors (Mioche and Touraille, 1990) define it as the quantity of reversible deformation that can suffer a product in the mouth. The food standards are given in Table 5.

Other characteristics

Juiciness: The amount of juice “liberated” during chewing (see Table 5).

Training in using scales

Assessors were firstly forced to use a structured scale, so ratings were always an integer number, and later they were allowed to use a continuous scale (a non-structured one). For that purpose, samples of standard foods (Table 5), purchased in supermarkets, were
presented to the judges. The meat samples investigated were rated compared to these standards.

Scales are always limited and that is usually a problem for those assessors which, having put a mark too low or too high, are willing to go beyond and they can not, because the scale is finite. The way to avoid this inconvenience consists in using, not an interval scale, but a relation scale as magnitude of estimation. In this work non-structured scales 100 mm long were used, anchored at 10 mm (extremely low intensity) and 90 mm (extremely strong intensity) (Poste et al., 1993). Judges were firstly trained by the procedure described by Meilgaard et al. (1987), and later they were trained in applying scales by analysing some other food (cooked hake fillets, different kinds of sausage and of cheese, etc.).

**Training in meat tasting**

Judges were offered samples of meat from different domestic species (including sucking lambs), all of them from *m. Longissimus thoracis et lumborum* muscle, grilled, wrapped in aluminium paper. Assessors were asked to rate attributes, established *a priori* by the sensory analist, according to standard scales (with food references). This procedure allowed the assessors to become accustomed to very different intensities of sensations, and it made them more discriminative.

**Samples preparation**

Samples from animals of the same sex and slaughter weight were considered as homogeneous. 2 cm thick slices were cut in deep frozen muscles (–40 °C), with a band saw. 48 samples in each sex-weight combination (8 samples from every animal) were obtained. Samples were vacuum packed and deep frozen preserved (–18 °C) until analysis. Samples were thawed by submersion in cold water and next grilled (in a double grill preheated to 160 °C), wrapped between two foils of aluminium paper, until they reached an internal temperature of 75 °C. Cooking temperature was monitored by means of thermocouple probes. No salt was added. Samples were stored in a preheated oven at 80 °C until tasting.

**Samples evaluation**

Test sessions were lasting for an hour. Four sessions were held, and every judge tasted 8 samples in a session (2 samples from each sex and weight combination). Number of samples was 192 (48 samples from each sex and weight combination). Samples presentation was monadic (one at a time), without possibility of going back. Order of presentation was randomly sorted, so that «order of presentation» effect could be counteracted. Judges had always at hand the description of the standard hardness scale, the standard springiness scale and the standard juiciness scale, so that ratings could be referred to the standard foods. Data were analysed by analysis of variance, by means of the statistical package Statistica for Windows®, release 5.0.
RESULTS

Meat texture

Assessors scores for each sex-weight combination are shown in Table 1. Analysis of variance was performed on scores to determine the importance of sex-weight combination (product), tasting session and of assessors effects. No interaction was found between assessors and products, what means that assessors used the scales in the same way despite they were scoring different products (sex-weight combinations) (Table 2). As all products were assessed in all sessions by all assessors, and as session effect did not influence any attribute, the data were analysed in each sex-weight group. As there were no meaningful differences between sessions, statistical analysis of the results was performed over the total of samples, as all tastings were made in similar conditions (no session effect). Product nature influenced the springiness (P < 0.003).

Table 1

Mean assessors scores for each sex and weight combination

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Male, 10 kg (n = 48)</th>
<th>Female, 10 kg (n = 48)</th>
<th>Male, 14 kg (n = 48)</th>
<th>Female, 14 kg (n = 48)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>34.6 0.132</td>
<td>37.2 0.149</td>
<td>33.2 0.158</td>
<td>35.3 0.136</td>
</tr>
<tr>
<td>Springiness</td>
<td>58.5 0.182</td>
<td>61.7 0.197</td>
<td>59.6 0.201</td>
<td>55.0 0.188</td>
</tr>
<tr>
<td>Juiciness</td>
<td>35.4 0.236</td>
<td>31.9 0.219</td>
<td>36.9 0.258</td>
<td>34.5 0.213</td>
</tr>
</tbody>
</table>

Table 2

Two-factor anova (product and assessor) and their interaction

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Product</th>
<th>Assessor</th>
<th>Prod. × Assessor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F (3, 168)</td>
<td>P (5, 168)</td>
<td>F (15, 168)</td>
</tr>
<tr>
<td>Hardness</td>
<td>1.69</td>
<td>NS</td>
<td>*** 1.35</td>
</tr>
<tr>
<td>Springiness</td>
<td>4.97</td>
<td>**</td>
<td>*** 1.08</td>
</tr>
<tr>
<td>Juiciness</td>
<td>1.81</td>
<td>NS</td>
<td>*** 0.98</td>
</tr>
</tbody>
</table>

F = Fisher statistics (degree of freedom between brackets). P = probability level. NS: non-significant difference. **: P < 0.01. ***: P < 0.001.

To analyse the degree of dispersion of assessors criteria for every attribute, an analysis of variance was performed on all ratings by each assessor for each attribute (Table 3). Assessor effect was highly significant (P < 0.001), showing that assessors were not agreeing on scoring. As the session effect was non-significant, the analysis was performed on
the group of all samples for every treatment, analysing sex effect and slaughter weight effect, and their interaction (Table 4).

Sex did not influence assessors ratings for each one of the attributes (Table 4). For springiness there was a qualitative and significant interaction between sex and weight (Table 1).

Correspondences between the 100 mm long structured scale, and the standard scale for each attribute, are presented in Table 5. According to the correspondence results were the following: hardness perception of sucking lamb meat had a standard scale rating of 4, similar to Kraft cheese hardness (values between 33.3 and 35.3, Table 1). Springiness varied between 55.0 and 61.7, greater than on the average. The degree of juiciness was «moist» (a rating of 2), because ratings in the non-structured scale ranged between 31.9 and 36.9.

Relations between the attributes

To verify the relation between texture attributes, a correlation analysis was performed on every assessor ratings for each attribute (Table 6).

Hardness perception was negatively correlated to juiciness perception ($P < 0.05$) and to pleasantness sensation ($P < 0.001$). Juiciness is negatively correlated to springiness ($P < 0.001$).

| Table 3 |
| Mean ratings from each assessor for each attribute |

<table>
<thead>
<tr>
<th>Assessor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>MS</th>
<th>Error</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
<td>mean</td>
<td>(5, 186)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td>33.3</td>
<td>35.1</td>
<td>27.8</td>
<td>43.3</td>
<td>36.9</td>
<td>32.5</td>
<td>0.74</td>
<td>11.42</td>
<td>P &lt; 0.0001</td>
<td></td>
</tr>
<tr>
<td>Springiness</td>
<td>67.4</td>
<td>54.5</td>
<td>66.2</td>
<td>42.7</td>
<td>54.3</td>
<td>68.9</td>
<td>0.84</td>
<td>40.28</td>
<td>P &lt; 0.0001</td>
<td></td>
</tr>
<tr>
<td>Juiciness</td>
<td>19.9</td>
<td>27.1</td>
<td>40.8</td>
<td>36.4</td>
<td>56.6</td>
<td>28.8</td>
<td>1.02</td>
<td>52.31</td>
<td>P &lt; 0.0001</td>
<td></td>
</tr>
</tbody>
</table>

F = Fisher statistics (degree of freedom between brackets). P = probability level.
Table 4
Mean data by sex (S) and slaughter weight (W)

| Sex       | Slaughter weight | | | | Anova | | | | | |
|-----------|------------------|---|---|---|---|---|---|---|---|---|---|
|           | Males n = 96     | Females n = 96 | 10 kg n = 96 | 14 kg n = 96 | MS Error | F | F | F | Sex | Weight | S x W |
| Hardness  | mean (s.e.)      | mean (s.e.)     | mean (s.e.)  | mean (s.e.)  | (1, 188) | NS | NS | NS | 0.95 | NS | NS | NS |
| Springiness| 34.0 (1.03)     | 36.3 (1.01)     | 36.0 (0.99)  | 34.3 (1.04)  | 1.70     | NS | NS | *  | 2.48 | NS | NS | NS |
| Juiciness | 59.1 (1.35)     | 58.3 (1.40)     | 59.9 (1.38)  | 57.5 (1.36)  | 1.70     | NS | NS | *  | 2.48 | NS | NS | NS |
|           | 36.2 (1.74)     | 33.2 (1.53)     | 33.6 (1.63)  | 35.7 (1.65)  | 1.70     | NS | NS | *  | 2.48 | NS | NS | NS |

NS: non-significant difference. * P < 0.05
Table 5
Correspondence between intervals in structured scale (Szczesniak, 1963) and ratings in non-structured scales for hardness, springiness and juiciness

<table>
<thead>
<tr>
<th>Non-structured scale (100 mm)</th>
<th>Standard rating scale</th>
<th>Standard food</th>
<th>Product definition (Brandt et. al., 1963)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.0-11.1</td>
<td>1</td>
<td>Soft Philadelphia cheese</td>
<td>Soft</td>
</tr>
<tr>
<td>11.2-22.2</td>
<td>2</td>
<td>Hard egg white</td>
<td></td>
</tr>
<tr>
<td>22.3-33.3</td>
<td>3</td>
<td>Frankfurt sausage (peeled)</td>
<td></td>
</tr>
<tr>
<td>33.4-44.4</td>
<td>4</td>
<td>Sandwich Kraft cheese</td>
<td></td>
</tr>
<tr>
<td>44.5-55.5</td>
<td>5</td>
<td>Olives</td>
<td>Firm</td>
</tr>
<tr>
<td>55.6-66.6</td>
<td>6</td>
<td>Apéritif peanuts</td>
<td></td>
</tr>
<tr>
<td>66.7-77.7</td>
<td>7</td>
<td>Sliced carrot (raw and peeled)</td>
<td></td>
</tr>
<tr>
<td>77.8-88.8</td>
<td>8</td>
<td>Almonds (not peeled)</td>
<td></td>
</tr>
<tr>
<td>88.9-100.0</td>
<td>9</td>
<td>Candy sugar</td>
<td>Hard</td>
</tr>
</tbody>
</table>

Springiness

<table>
<thead>
<tr>
<th>0</th>
<th>Margarine, toast bread</th>
<th>Plastic</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Shellfish, squid</td>
<td>Springy</td>
</tr>
</tbody>
</table>

Juiciness

| 0-20 | Cookie | Dry |
| 21-40 | Apple | Moist |
| 41-60 | Water melon | Watery |
| 61-80 | Orange | Juicy |
| 81-100 | | |

Table 6
Correlation coefficients matrix between attributes

<table>
<thead>
<tr>
<th></th>
<th>Hardness</th>
<th>Springiness</th>
<th>Juiciness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Springiness</td>
<td>-0.1026</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>Juiciness</td>
<td>-0.1659 *</td>
<td>-0.2854 ***</td>
<td>1.0000</td>
</tr>
</tbody>
</table>
DISCUSSION

Meat evaluation

Organoleptic characteristics that are found to be the most important ones in fresh meat are flavour, juiciness and texture (Barton-Gade et al., 1988) and appearance, specially colour (Ernst, 1980). Nevertheless texture including juiciness is the most important sensory attribute (Harries et al., 1972). Texture potential of the muscle is the main criterion for distinguishing of commercial categories, and determination of the prices of different joints (Touraille, 1982a). Consumer panels studies have shown that tenderness is the most important sensory attribute in bovine meat (AMSA, 1978). In lamb meat, hardness is not so great a problem, because it always has minimal values. Joubert (1956) state that muscle fibres in ovine meat are smaller than in bovine meat. Also, in consumer acceptability, conjunctive component of hardness is relatively unimportant, compared with cooking effects (Joubert, 1956). But hardness is always evaluated in meats description.

In present work no meaningful differences have been found between meat sensory characteristics, nor due to slaughter weight nor to sex. Though slaughter weight did not produce statistical differences in textural parameters, mathematical differences between means showed a slight trend to perceive the meat of heaviest animals as less hard, juicier and less springy. Though normally meat becomes harder with age (Touraille, 1982b), such a phenomenon could not be observed in young animals as sucking lambs. Other works have shown that meat water-binding capacity decreases in lambs between 5 and 25 kg liveweight (Blázquez et al., 2001), between sucking and fattened lambs (Onega and Ruiz de Huidobro, 1999) and even between lambs of 10 and 12 kg liveweight (Ruiz de Huidobro et al., 1998). Increased WBC makes meat more dry, which makes meat perception to be less juicy. Nevertheless, lambs take into consideration in this work are of live weights very slightly different, and they are all of them sucking lambs, so their meat characteristics must be very similar.

Differences in meat characteristics due to sex have found to decrease in lambs from 5 kg liveweight to 25 kg liveweight (Blázquez et al., 2001).

Evaluation of sensory attributes

The use of scales presents some problems. Scales must be well constructed, with equivalent intervals (Sauvageot, 1990), and panellists must very well understand the meaning of every interval.

There is no scale the best in every case, and the sensory analyst should use the most useful one for the aims of the experiment. Although assessors prefer to score on non-structured scales, for they feel more comfortable and they expressed themselves more freely, the use of non-structured scales makes the results not transferable to other circumstances, i.e., between different panels and for different criteria of scoring. To avoid these inconvenience, in the present work assessors were «calibrated» with some food standards, so the dispersion of results could be partly counteracted, what in fact allows to make smaller differences evident. «Assessor» effect was highly significant, as it happens in other works (Dransfield et al., 1984b). Hardness scores showed the least variation, and juiciness scores the most. This show that assessors used hardness scale most consistently
while they had more problems with the springiness and the juiciness scales. This stresses the need of a good training. As no significant interaction between product and assessor was present, it is evident that assessors kept the same scoring level, independently of the sample analysed. Mean differences in scoring were evident in all attributes, but this is a normal problem in this kind of works.

Attributes correlation coefficients showed that juiciness was significantly and negatively correlated to hardness and springiness. This has been found in previous works on lambs meat (Onega and Ruiz de Huidobro, 1999). Correlation between hardness and springiness has been almost nonexistent, although in other works it has been found that these two parameters are highly correlated (Onega and Ruiz de Huidobro, 1999; Onega et al., 2001). This can be due to the greater difficulty experienced by assessors in assessing springiness related to hardness, as their comments after testing sessions stated. Hardness is an attribute very easily understood by people; springiness is a more difficult attribute both to understand and to assess.

As the attributes used in this work are easy to define, and as it is easy to find the standard foods proposed here for defining the reference scales, we think that the attributes proposed in this work are convenient for defining sucking lambs meat in routine sensory analysis and they seem to be sufficiently independent to allow a good characterisation in any kind of study.

**CONCLUSIONS**

Sensory meat characteristics of sucking lambs are not very different between 10 and 14 kg liveweight, neither in males nor in females, as this weight range seems to be very small.

Sensory attributes of hardness, springiness and juiciness, assessed by means of the reference scales with the standard foods proposed in this work, seem fit for routine sensory analysis performed in research and quality control laboratories.

**ACKNOWLEDGEMENTS**

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**RESUMEN**

*Caracterización sensorial de la textura de la carne en corderos lechales*

Seis jueces degustaron muestras de carne del músculo *m. longissimus thoracis* de 24 corderos lechales de raza Manchega. Los corderos habían sido sacrificados a los 10 ó 14 kg de peso vivo. Se midieron varios parámetros de textura (dureza, elasticidad y jugosidad). Los jueces no encontraron diferencias en ningún parámetro. Sin embargo, hubo una ligera tendencia a percibir la carne de los animales más pesados como menos dura, más ju-
gosa y menos elástica. Se discuten los parámetros y las escalas utilizadas. La metodología utilizada en esta experiencia parece adecuada para describir la textura sensorial de los corderos lechales.

**PALABRAS CLAVE:** Carne
Cordero
Análisis sensorial
Textura

**REFERENCES**


