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# The use of correspondence analysis in the study of beef quality: a case study on Parda de Montaña breed

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## Abstract

The present study shows the usefulness of a multivariate technique —correspondence analysis—- for simultaneously representing continuous and categorical variables in graphical form. A comparison was made of the results of sensory tests of beef quality performed by a trained panel and by consumers. The latter included the collection of data to produce consumers profiles and the recording of a number of consumers habits. Spearman correlation coefficients were calculated independently for the variables measured in both the panel and consumer tests. Two correspondence analyses were then performed: the first one involving the consumer profiles and the values of the variables measured in the consumer test, the second one to determine the relationships between the panel and consumer test scores. In the plot corresponding to the first analysis, the two axes accounted for 52.2% of the inertia and showed that age did not have an important effect on any measured variable. Consumers previous experience has been shown to be an important factor defining consumer liking of the product. In the plot for the second analysis the two axes accounted for 82.3% of the inertia and showed that there was no correspondence between overall consumer liking of the product and any of the panel variables. These results therefore suggest that the panel test is not a good predictor of consumer behaviour.

**Additional key words**: consumer behaviour, multiple correspondence analysis, relationships, sensory, statistics.

## Resumen

**El uso de correspondencias múltiples como herramienta para el estudio de la calidad de la carne de ternera: análisis de un caso utilizando animales de la raza Parda de Montaña**

El presente estudio muestra la utilidad de una técnica multivariante, el análisis de correspondencias múltiples, para representar gráficamente de manera conjunta variables categóricas y continuas. Para ello se compararon los resultados obtenidos por un panel entrenado con los resultados dados por un grupo de consumidores, ambos con las mismas muestras de carne de ternera. La prueba de consumidores incluyó el perfil del consumidor y una breve encuesta sobre sus hábitos de consumo. Se calcularon correlaciones de Spearman de manera independiente para las variables utilizadas con el panel entrenado y las variables empleadas en la prueba de consumidores. Se realizaron dos análisis de correspondencias: el primero incluía el perfil del consumidor y los valores de las variables medidas en la prueba de consumidores; el segundo se utilizó para determinar la relación entre las notas dadas por el panel y las dadas por los consumidores. En el gráfico correspondiente al primer análisis, los dos ejes explicaron el 52,2% de la inercia y mostró que la edad no tiene un efecto significativo sobre ninguna de las variables medidas, mientras que la experiencia previa del consumidor fue una variable importante a la hora de definir la aceptación del producto por parte del consumidor. En el gráfico correspondiente al segundo análisis, los dos ejes explicaron el 82,3% de la inercia y mostró que no hay correlación entre las notas de apreciación global dadas por los consumidores y ninguna de las variables medidas por el panel. Estos resultados sugieren que el panel entrenado no es un buen predictor del comportamiento del consumidor.

**Palabras clave adicionales**: comportamiento del consumidor, correlaciones, estadística, sensorial.

## Introduction

The fulfilment of consumer needs is the main concern of the food industry. Sensory studies performed by both trained panellists and consumers play an important role in attaining this goal. Trained panel are required to detect small differences in food properties with accuracy and consistency, whereas the goal in consumer tests is to obtain information on consumer characteristics, attitudes and preferences. Consumer tests are classified according to the place where they are held.

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Laboratory and central-location tests are somewhat artificial, although they allow test conditions to be strictly controlled. Home tests are less controlled and the results therefore more variable (Bower, 1995), but they are more realistic, the results reflecting better the consumer perceptions under real conditions (Rozin and Tourila, 1993; Miller, 2003).

To obtain more complete information on a product, consumer data need to be related to those provided by trained panel (Arditti, 1997; Muñoz and Civille, 1998). Unfortunately, the comparison between panel and consumer data is not always easy since the different methodologies provide different information, even though when the tested product is the same (Boutrolle *et al.,* 2005). The tendency in sensory analysis is to consider the investigation from a holistic point of view. Several multivariate analyses have been proposed to use with sensory tests, e.g., principal components (Bech *et al.*, 1997; Poulsen *et al.*, 1997; Tang *et al.*, 2000; Forde and Delahunty, 2004), generalised procrustes (Russell and Cox, 2004), internal preference (Qannari *et al.*, 1997), multidimensional scaling (Nishisato, 1980; Faye *et al.*, 2006), partial least squares regression (Kubberod *et al.*, 2002), perceptual maps (Arditti, 1997; Hough and Sánchez, 1998; Moskowitz, 2000), preference maps (Arditti, 1997) and correspondence analysis (Torres and Greenacre, 2002; Torres and Van de Velden, 2007). Multiple correspondence analyses allow the graphic representation of both attribute ratings and subject profiles (Torres and Van de Velden, 2007).

The present work reports the usefulness of multiple correspondence analysis in the study of meat sensory quality, using a beef case as example. This technique allows the dimensionality of the data to be reduced (McEwan and Schlich, 1992) by converting the data matrix into a graphical display in which the rows and columns of the matrix are depicted as points (Greenacre and Hastie, 1987). Correspondence analysis (also known as homogeneity analysis) tries to separate categories of variables from each other as much as possible. This implies that objects within a single category are plotted close to one another while those of different categories are plotted as far apart as possible. This analysis has two advantages: first, the simplicity in which results are interpreted, and second, it allows continuous variables (such as tenderness) and categorical variables (such as gender) to be represented simultaneously. It can, therefore, be very practical in consumer studies and in the establishment of the relationships between panel data and consumer data (Arditti, 1997). The aim of the present paper was to introduce correspondence analysis as a tool for relating the results provided by a panel of trained testers and consumers, in this case with respect to the analysis of beef quality.

## Material and methods

Eighteen Parda de Montaña steers were provided one of two winter feeding diets. A briefly description of management of animals is as follows: calves remained the first 90 days indoors and thereafter they grazed in high mountain pastures (with *Festuca rubra, Festuca skia, Bromus erects, Nardus stricta* and *Trifolium alpinum* as predominant species) with their dams. Steers were weaned on average, at 8 months of age and they were castrated. Afterwards they were distributed into two groups to be fed one of two winter feeding strategies. From December to mid-April, a group was fed lucerne hay *ad libitum* and the second group was fed a total mixed ration composed by lucerne hay, straw and barley in a proportion of 50:10:40. Thereafter, steers grazed in valley meadows until slaughter when they reached a target live weight of 500 kg. Two-centimetre-thick steaks from the muscle *longissimus lumborum,* from 1$^{st}$ to 6$^{th}$ lumbar vertebrae were collected, aged under vacuum at 4°C for 8 days, frozen at –20°C, and stored until analysis.

### Trained panel test

Before the panel test was carried out, the meat was thawed (still in its vacuum packaging) in tap water for 4 h until reaching an internal temperature of 17-19°C. It was then cooked inside aluminium paper on a pre-heated double hot-plate grill at 200°C until an internal temperature of 70°C was reached. The meat was then cut into small portions, wrapped in codified aluminium paper and stored warm (60°C) until tasted. Samples were served to a trained (ISO-8586-1) seven-member panel (with panel members in individual booths) under red lighting to mask any differences in meat colour. Panellists were asked to evaluate on a non-structured 10-point scale the following attributes: beef aroma intensity, tenderness, juiciness, beef flavour intensity, liver flavour intensity and abnormal flavour intensity, with a score of 1 the lowest and 10 the highest possible for each attribute.

### Consumer test

Samples were defrosted at 2°C overnight before being distributed to consumers. This test involved 53 families recruited from among the staff of our research centre (personnel not related to the present project). All families who took part had to be 1) made up of at least three members, and 2) be regular consumers of beef.

Paired steaks were supplied to all households, one from each type of steer. The sample packets contained steaks identified by a three-figure random number and copies of a meat evaluation questionnaire. The order of the presentation of the steaks to the households was randomised to reduced response-order effects on consumer ratings. Consumers were given no information regarding the steaks other than the species from which they came.

Accurate guidelines for storage and cooking were specified in the questionnaire. Basically, recommendations were to thaw the meat slowly and to cook it in a pan, at high temperature, during short time, using few spices or salt and no sauces. Every member of each family had to complete an independent questionnaire. The socio-demographic characteristics of the consumers (gender, age and educational level) were recorded. Consumers evaluated each steak for odour during cooking, odour on the plate, flavour liking, tenderness, juiciness and overall liking, using a 10-point scale (1 disliked very much, 10, liked very much). Consumers were also asked how many times per week they consumed beef. Finally, they were required to compare the meat usually consumed at home with the test samples; the possible answers were worse, equal or better. A total of 124 consumers completed and returned the survey.

### Statistical analysis

Statistical analyses were performed using SPSS v.13.0 software. Spearman correlation coefficients were calculated independently for the variables of both the panel and consumer tests. Consumer profiles were examined and described in terms of frequency. In the survey four groups of age were included: less than 18 years, from 18 to 35 years, from 36 to 55 years and over 55 years, being the respective proportion of each group 8.9%, 38.7%, 34.7% and 16.9%. For that reason, for statistical analysis, population was divided into two groups: less or over 35 years. The effect of consumer profile on consumer score was studied using the General Linear Model (GLM) procedure, with gender, age and education level as the main effects. Differences between means were established using the Duncan test (significance was set at $P < 0.05$). Both the panel test and consumer test scores were classified into three categories as follows: «low» for scores of 1, 2, 3 or 4; «medium» for scores of 5, 6 or 7; and «high» for scores of 8, 9 or 10. Consumer demographic characteristics were categorized as follows: for gender, males and females; for age, under or over 35 years; for educational level, primary, high school or university; for comparison to home-consumed meat, worse, equal or better. Although theoretical frequencies for consumption ranged from 0 to 14 (seven days per week, two meals per day), the highest frequency recorded was 8. Hence, frequency of consumption was classified as «low» for scores of 1, 2 or 3, «medium» for scores of 4 or 5, and «high» for scores of 6, 7 or 8; Wansick and Park (2000) used a similar classification of non-users, light users and heavy users. Once all data were categorized, two multiple correspondence analyses were performed: the first involving the consumer profiles and the values of the variables measured in the consumer test, the second to determine the relationship between the panel and consumer test scores.

## Results

### Spearman correlations

Table 1 shows the correlation between the variables measured by the trained panellists and Table 2 shows the correlations detected between the results for the variables in the consumer test. All consumers variables were closely and positively correlated, which implies that consumer liking is a holistic phenomenon.

### Consumer profile and its effect on scores

Table 3 shows the consumer profiles. Reader should take into account that used consumer panel is not representative of general population of the region; hence it should be taken like as an estimate to the general situation. The sample was almost evenly distributed across ages and gender categories, but not across educational levels being the group with university

**Table 1.** Spearman correlations between panel test variables

| | Tenderness | Juiciness | Beef flavour intensity | Liver flavour intensity | Abnormal flavour intensity |
|---|---|---|---|---|---|
| Beef odour intensity[1] | 0.144 | 0.431** | 0.391** | 0.326** | 0.309** |
| Tenderness[2] | | 0.549** | 0.345** | 0.127 | –0.083 |
| Juiciness[3] | | | 0.530** | 0.185 | 0.177 |
| Beef flavour intensity[1] | | | | 0.364** | 0.151 |
| Liver flavour intensity[1] | | | | | 0.322** |

** $P \leq 0.01$. [1] 1 = low, 10 = high. [2] 1 = very tough, 10 = very tender. [3] 1 = very dry, 10 = very juicy.

status the largest. The most commonly seen frequency of consumption was 2-3 times per week. With regard to meat quality, near half of all subjects considered their home meat to have the same quality as the tested meat; for the remaining 50% the responses were equally divided among the «better» and «worse» categories.

Table 4 shows the effect of consumer socio-demographic characteristics on the studied attributes, and Table 5 shows the mean scores for each demographic group. Age had no effect on any variable ($P > 0.05$). Gender had an effect on the liking of odour during cooking and on the plate ($P \leq 0.05$), with females giving the highest score for both variables. A trend was also noted for educational level with respect to tenderness ($P \leq 0.1$), people with high school studies tending to score higher. Frequency of consumption had a significant effect on the liking of the odour during cooking ($P \leq 0.05$) and showed a trend with respect to odour on the plate ($P \leq 0.1$); consumers with medium frequencies of consumption tended to give higher scores. Home meat quality was the most important factor, influencing all the variables studied ($P \leq 0.05$) except for the liking of the odour on the plate ($p = 0.09$). In general, those who consumed home meat of lower quality gave the highest scores for the tested meat.

A great number of interactions among effects were found (Table 4). The values for odour during cooking and overall liking were significantly affected by the interaction gender × educational level ($P \leq 0.05$). The same interaction showed a trend towards having an effect on the values for odour on the plate and tenderness, but had no effect on the values for taste. The interaction age × educational level affected taste and overall liking ($P \leq 0.05$). Older people tended to score higher scores than younger people if they had high school or university studies, but the contrary was observed for people with low educational level. The interaction frequency of consumption × gender had a significant effect on the liking of the odour during cooking ($P<0.01$). When frequency of consumption was low, females gave slightly higher scores than males, but if the frequency of consumption was high, males gave higher scores than females. Thus, among heavy consumers, females were more demanding or critical than males. Finally, the most important interaction was frequency of consumption × home meat quality, which affected all the studied variables ($P \leq 0.05$).

## Multiple correspondence analysis involving consumer profiles and values of the consumer test variables

To correctly understand the results, it should be remembered that, in a correspondence analysis plot,

**Table 2.** Spearman correlations between consumer test variables

| | Odour on the plate | Taste | Tenderness | Overall liking |
|---|---|---|---|---|
| Odour during cooking[1] | 0.700** | 0.361** | 0.298** | 0.393** |
| Odour on the plate[1] | | 0.432** | 0.416** | 0.428** |
| Taste[1] | | | 0.594** | 0.788** |
| Tenderness[2] | | | | 0.765** |

** $P \leq 0.01$. [1] 1 = very bad,10 = very good. [2] 1 = very tough,10 = very tender.

**Table 3.** Consumers profiles and habits

| Profile | Age (yr) | Gender | Educational level | % |
|---|---|---|---|---|
| | ≤ 35 | Male | Primary | 3.2 |
| | | | High School | 6.5 |
| | | | University | 16.9 |
| | | Female | Primary | 3.2 |
| | | | High School | 2.4 |
| | | | University | 15.3 |
| | > 35 | Male | Primary | 2.4 |
| | | | High School | 6.5 |
| | | | University | 15.3 |
| | | Female | Primary | 1.6 |
| | | | High School | 9.7 |
| | | | University | 14.5 |
| | No answer | | | 2.4 |
| **Frequency of meat consumption** | **No. week$^{-1}$** | | | |
| | 1 | | | 14.5 |
| | 2 | | | 27.4 |
| | 3 | | | 25.8 |
| | 4 | | | 10.9 |
| | 5 | | | 2.0 |
| | 6 | | | 4.0 |
| | 7 | | | 1.6 |
| | 8 | | | 0.8 |
| | No answer | | | 12.9 |
| **Home meat quality** | **Meat usually consumed at home is** | | | |
| | Better than tested meat | | | 29.8 |
| | Equal to tested meat | | | 45.2 |
| | Worse than tested meat | | | 23.0 |
| | No answer | | | 2.0 |

**Table 4.** Influence (GLM) of consumer profile on the studiend variables (*p* values are shown)

| Variable | Odour during cooking[1] | Odour on the plate[1] | Taste[1] | Tenderness[2] | Overall liking[1] |
|---|---|---|---|---|---|
| Age (A) | 0.174 | 0.213 | 0.300 | 0.865 | 0.237 |
| Gender (G) | 0.033 | 0.017 | 0.862 | 0.664 | 0.305 |
| Educational level (E) | 0.375 | 0.885 | 0.428 | 0.066 | 0.119 |
| Frequency of consumption (F) | 0.041 | 0.068 | 0.813 | 0.698 | 0.400 |
| Home meat quality (H) | 0.004 | 0.092 | 0.043 | 0.004 | 0.034 |
| A*G | 0.626 | 0.087 | 0.220 | 0.492 | 0.154 |
| A*E | 0.942 | 0.901 | 0.014 | 0.213 | 0.045 |
| A*F | 0.271 | 0.700 | 0.969 | 0.183 | 0.405 |
| A*H | 0.744 | 0.235 | 0.063 | 0.992 | 0.546 |
| G*E | 0.023 | 0.074 | 0.498 | 0.081 | 0.038 |
| G*F | 0.014 | 0.791 | 0.902 | 0.378 | 0.759 |
| G*H | 0.364 | 0.396 | 0.931 | 0.581 | 0.924 |
| E*F | 0.559 | 0.594 | 0.748 | 0.153 | 0.386 |
| E*H | 0.120 | 0.275 | 0.238 | 0.373 | 0.190 |
| F*H | 0.019 | 0.012 | 0.005 | 0.045 | 0.001 |

[1] 1 = very bad, 10 = very good. [2] 1 = very tough, 10 = very tender.

**Table 5.** Mean values of variables for each consumer group

| | | Odour during cooking | Odour on the plate | Taste | Tenderness | Overall liking |
|---|---|---|---|---|---|---|
| Age | < 35 | 6.75 | 6.75 | 7.02 | 5.93 | 6.69 |
| | > 35 | 6.72 | 6.82 | 7.34 | 6.61 | 7.03 |
| Gender | Male | 6.68[a] | 6.73[a] | 7.21 | 6.27 | 6.91 |
| | Female | 6.74[b] | 6.79[b] | 7.13 | 6.22 | 6.78 |
| Educational level | Primary | 6.35 | 6.27 | 7.12 | 6.58 | 7.08 |
| | High school | 6.81 | 7.08 | 7.38 | 6.72 | 7.19 |
| | University | 6.72 | 6.71 | 7.08 | 5.99 | 6.66 |
| Frequency of consumption | Light | 6.70[x] | 6.77 | 7.21 | 6.24 | 6.83 |
| | Medium | 7.34[y] | 7.28 | 7.53 | 6.53 | 7.34 |
| | Heavy | 6.63[z] | 6.69 | 6.69 | 6.50 | 6.41 |
| Home meat quality | Better | 6.38[j] | 6.41[j] | 6.43[j] | 5.05[j] | 5.84[j] |
| | Equal | 6.87[k] | 6.94[k] | 7.54[k] | 6.69[k] | 7.27[k] |
| | Worse | 6.77[k] | 6.95[k] | 7.50[k] | 7.02[k] | 7.39[k] |

[a,b] Different superscripts in the same column mean significant differences between gender ($P < 0.05$). [x,y,z] Different superscripts in the same column mean significant differences between frequency of consumption ($P < 0.05$). [j,k] Different superscripts in the same column mean significant differences between home meat quality ($P < 0.05$).

two variables are related if a small angle is formed when lines are traced from the representative points back to the origin. Coincidence in the same quadrant does not necessarily indicate a relationship, unlike in principal components analysis. A variable with score categories that are far apart discriminates better than a variable with score categories that are close together. Additionally, the further a variable lies from the origin, the more variance it explains.

Figure 1 shows a correspondence analysis plot based on the consumer profiles and the values of the variables measured in the consumer test. The two axes account for 52.2% of the inertia: the first dimension accounts for 30.5% and the second for 21.7%. Three groups of attributes can be distinguished. The first group, located in the bottom right quadrant, shows all the low category scores together; the upper right quadrant groups the medium category scores, and the bottom left quadrant the high category scores. People under 35 years of age tended to give medium category scores, whereas people over 35 gave mainly high category scores. Low category scores were equally spread over the two age groups. Age was plotted near to the origin, indicating it did not to have an important effect, which agrees with its lack of significance shown in Table 4. In the bottom right quadrant, low category scores were mainly given by women with a primary educational level, who considered home meat quality to be better than that of the tested meat.

### Multiple correspondence analysis involving values for panel and consumer test variables

Figure 2 shows a plot of the panel and consumer variable scores. Since the panel and consumer tests used the same scale for measuring variables (1 to 10) the raw —rather then categorised— data can be plotted, but at the expense of reduced clarity. Dimension 1 accounted for 45.6% of the inertia and dimension 2 for 36.7%; therefore the two axes accounted for 82.3% of the inertia.

## Discussion

### Spearman correlations

Strong relationships between beef odour intensity, tenderness, juiciness and beef flavour intensity are usual in sensory tests (Campo *et al.*, 1999; Goodson *et al.*, 2002). Regarding consumers' behaviour, it has been shown that during real food consumption each sense contributes to the overall impression of the food (Forde and Delahunty, 2004).

### Consumer profile and its effect on scores

Present results concerning frequency of consumption agree with those of Henson and Northen (2000) who,

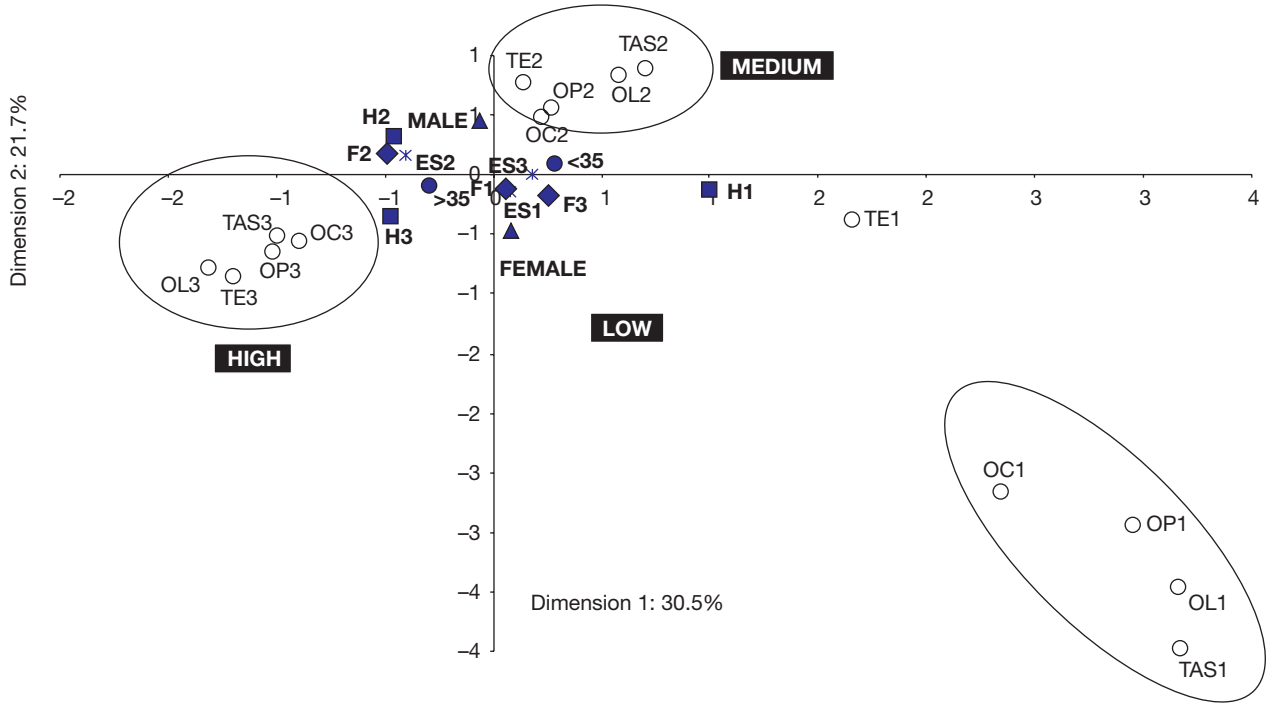


**Figure 1.** Multiple correspondence analysis between consumer profiles and scores for the different consumer test variables. Legend: H.- home meat quality (1- better than the tested meat, 2- equal, 3- worse) F- frequency of consumption (1- low, 2- medium, 3- high) OL- overall liking (1- low, 2- medium, 3- high) OC- odour during cooking (1- low, 2- medium, 3- high) OP- odour on the plate 1- low, 2- medium, 3- high) TAS- taste (1- low, 2- medium, 3- high) TE- tenderness (1- low, 2- medium, 3- high) ES- educational level (1- primary, 2- high school, 3- university) <35- age less than 35. >35- age over 35. Gender: male or female.

in a pan-European study on attitudes towards beef consumers from Germany, Ireland, Spain, Sweden, Italy and the UK, found that the majority of the 2447 respondents consumed beef once or twice per week. They also reported important differences between the six countries involved; Spain had a relatively high proportion of frequent consumers of beef (at least 3 times per week) and a relatively low percentage of infrequent consumers (less than once per week).

The great number of interactions among effects (Table 4) is testimony of the complex behaviour of consumers. In relation to that, several studies concluded differently. Kubberod *et al.* (2002) found that males showed higher scores, whereas females showed high scores in the present study. However, in both the former and the present study, males showed less variation than females. In further contrast, Robbins *et al.* (2003) reported gender to have no effect on any of the meat quality characteristics evaluated, although educational level did have a significant effect. These authors suggest that consumer quality expectations differ among educational groups. In the same sense, Meiselman *et al.* (2000) who concluded that consumers evaluated the food according to its actual properties, but also rated their expectations of food.

On the other hand, in a study involving 220 people, Destefanis *et al.* (2004) reported that the evaluation of tenderness was unaffected by consumer gender or age, although young people tended to give lower evaluations. Nevertheless, other authors (Kozlowska *et al.*, 2003; Forde and Delahunthy, 2004) describe clear differences between age groups and report that older people are less discriminatory than younger people, giving scores around the mean.

The interaction frequency of consumption × gender reported in the current study agrees with the findings regarding gender mentioned above. The interaction frequency of consumption × home meat quality shows that consumer liking is a complex, holistic process, and that preference depends not just on the intrinsic properties of a product but also on experience of it and expectations regarding it. The present results agree with those of Wansick (2003), who reported the importance of consumer experience in response to sensory stimuli. Similarly, Tepper *et al.* (1997) reported that nutrition knowledge influences food attitudes and

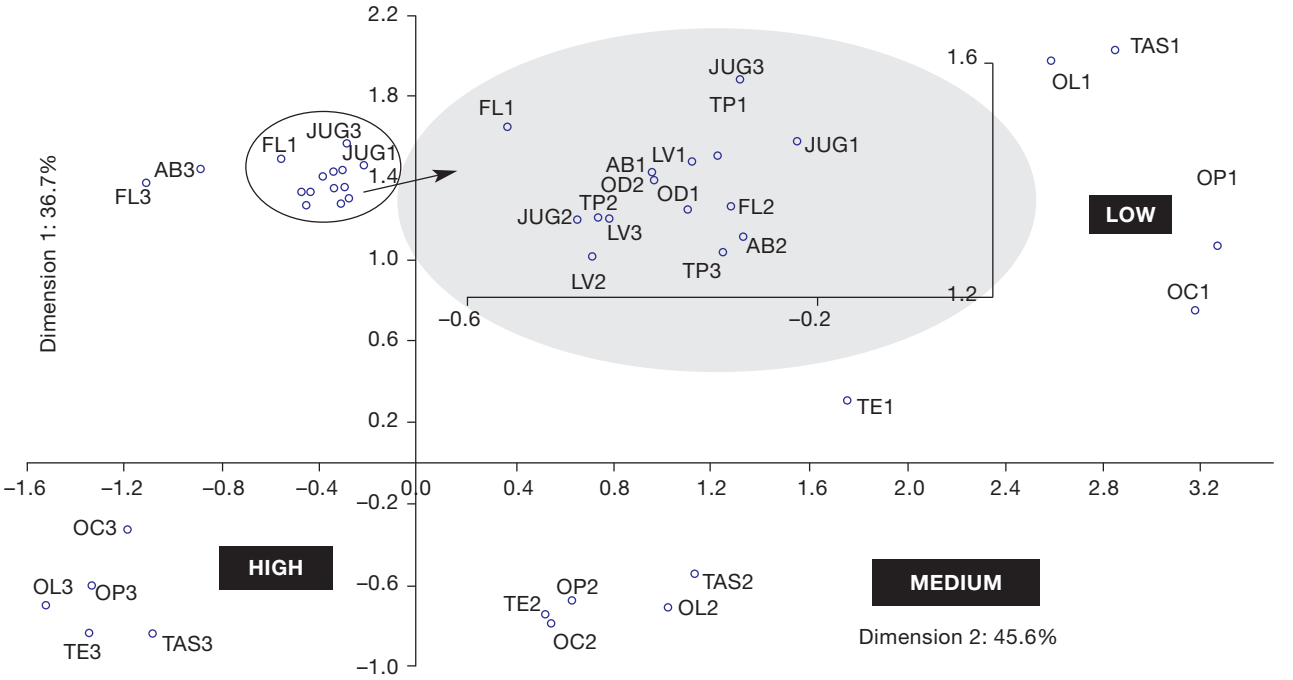


**Figure 2.** Multiple correspondence analysis between the panel consumer test scores. For all variables, 1- low, 2- medium, 3- high. Legend: Attributes from panel: OD- beef odour, TP- tenderness, JUG- juiciness, FL- beef flavour, AB- abnormal flavours, LV- liver flavour. Grey area represents an enlargement of the taste panel responses represented in the top left. Attributes from consumers: OC- odour during cooking, OP- odour on the plate, TAS- taste, TE- tenderness, OL- overall liking.

beliefs and, consequently, consumer behaviour. The difficulty in interpreting these interactions lies in the need to perform other statistical analyses.

## Multiple correspondence analysis involving consumer profiles and values of the consumer test variables

The pattern of distribution shown in Figure 1 is in agreement with the relationships between the variables described in Table 2. Since «taste» was the variable placed farther from the origin, for this group of consumers this variable was the most important attribute. The bottom left quadrant collected both men or women aged over 35 who considered their home meat to be of poorer quality than the tested meat. In this group, the variable placed furthest from the origin was overall liking, indicating that this kind of consumer valued meat in a more global way. Tenderness was also an important attribute for this group of consumers since it was plotted very near to overall liking. The results for both the above groups seem to indicate that previous experience is an important factor in determining consumer liking, as concluded from the GLM procedure (Table 4). Finally, the remaining subjects showed a less clear consumer profile. At the upper right, people aged under 35 and with a university education tended to give medium scores, but it is difficult to know their overall consumption habits. Similarly, at the upper left, people with a high school education were medium consumers of beef, but it is hard to know what scores they might give if the tests were repeated.

People in the upper part of the plot were mainly men; thus, men had greater difficulty in discriminating between samples and describing their perceptions. This agrees with the lower variability in their scores.

## Multiple correspondence analysis involving values for panel and consumer test variables

In Figure 2, four groups can be identified. The top right quadrant contains the low category scores, the bottom right quadrant contains the medium category scores, and the bottom left contains the high category scores for the consumer test. The fourth group, at the top left, encompasses the panel test responses; all the variables were closely related, as described in Table 1. This indicates that sensory experience is a holistic

phenomenon, even when people are trained panellists. Some authors suggest that scores obtained under standardised conditions are frequently lower than those obtained under more natural conditions (Boutrolle *et al.*, 2005). Context (Meiselman *et al.*, 2000; Kozlowska *et al.*, 2003; King *et al.*, 2004) and training (Bech *et al.*, 1997) have been suggested as two of the main reasons for these differences. Surprisingly, in the present study no correspondence was found between consumers overall liking of the product and any of the panel variables. Therefore, the panel test seems to be a poor predictor of consumers' behaviour, as suggested by other authors (Cardello *et al.*, 2000; Moszkowitz, 2000). Consequently, the results of these two methodologies should be considered as independent sources of knowledge.

From the present result, it can be concluded that the described methodology is able to show both quality-associated scores and additional variables (demographic traits) by categorising the values of the different variables measured. It therefore allows a complete behaviour map to be constructed. This analysis provides more information than classical ANOVA or other multivariate analyses. Finally, the panel test would not appear to be a good predictor of consumer rating. Hence, both kinds of tests should be carried out for a complete understanding of sensory characteristics of a done product.

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