ACCEPTANCE OF IBERIAN HAM FROM PIGS FATTENED UNDER DIFFERENT REARING CONDITIONS

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ABSTRACT

The objective of this study was to investigate the effect of the rearing conditions during the fattening period of Iberian pigs on the acceptance of the dry-cured hams, and to research into the relationship between acceptance and sensory characteristics, chemical composition and physical-chemical parameters. The duration of the fattening period in Montanera (outdoor system based on acorns and grass) affected significantly ham acceptance, the long (75 days)-Montanera group reaching higher scores than the short (50 days)-Montanera group. Only slight differences between the short-Montanera and the Cebo (indoor system based on concentrate feedings) groups were found. Otherwise, ham acceptance was not significantly affected by intramuscular fat content and marbling. The sensory variables were more closely related to acceptance than the chemical and physical-chemical ones. The best linear regression model confirms that descriptive sensory data contains valuable information to predict acceptance of hams from pigs fattened under different rearing conditions.

Keywords: Iberian ham, acceptance, rearing conditions, sensory analysis, dry-cured meat, intramuscular fat content.

INTRODUCTION

Iberian ham is a highly appreciated dry-cured meat with well-defined commercial categories according to the rearing conditions during fattening, the use of outdoor or indoor systems and the use of natural and typical resources from South-western Spain (grass and acorns) or/and concentrate feedings [1] being critical. The most usual Iberian ham categories include hams from pigs finished in a Montanera system (outdoor system based on acorns and grass, without concentrate feedings) and hams from pigs finished in a Cebo system (indoor system based on concentrate feedings), which are respectively the most expensive and the cheapest Iberian hams. The effect of rearing conditions on Iberian ham has been researched, and most studies compared the effect of Montanera and Cebo systems, marked differences in the chemical composition [2-4] and the sensory characteristics [5, 6] being reported. Although the duration of the fattening period in the Montanera system is also taken into account in the commercial grading of Iberian hams, with a minimum of 60 days for the best grade [1], it has attracted less attention and scarce scientific information is available. A significant effect of Montanera duration on the productive carcass quality and chemical composition of fresh meat [7, 8] and also on the chemical composition [6, 9] and on the sensory characteristics of the dry-cured hams [6] has been reported.

Although the rearing system and the duration of the Montanera period influence ham characteristics, there are not previous studies about their effect on the perception of consumers. Although the effect of other factors on the affective response towards Iberian ham has been researched: the acceptance of Iberian and non-Iberian dry-cured hams [10], the convergence between trained panellists and Spanish consumers [11], the relation between consumers’ acceptability and actual choice
[12], the effect of pig line on acceptance [13], and the preferences for Iberian and Serrano hams, the effect of designation of origin, price and purchasing format [14] have been investigated. For other dry-cured Iberian meat products, information about the affective response is also scare. The preference for Iberian loins with different fat content from pigs with different genetics reared under two different rearing systems was researched [15]. With regard to the acceptance of non-Iberian dry-cured hams, the effect of several factors have been investigated: the effect of chilling the raw hams and keeping the finished hams under different atmospheres [16], the influence of ripening time [17], the influence of Duroc line sires [18], the influence of the preservation system [19] and the effect of accelerated methods for ham processing [20].

Otherwise, there is scarce information about the relation between the acceptance of dry-cured meats and the sensory and non-sensory variables. With regard to the relationship between acceptance and the chemical composition, intramuscular fat content (IMF) has attracted most of the attention. For Iberian ham the relation between IMF and acceptance has not been researched, although a weak relation between marbling and acceptance was found [21]. For Iberian dry-cured loin, a significant influence of intramuscular fat content on preference was found [15], although the effect depended on consumer’s age and a general consumer trend could not be defined. The effect of fat content on acceptance was researched also in dry-cured products made with meat from non-Iberian breeds [22]. However, there are more chemical and physical-chemical parameters that could influence the sensory characteristics, and therefore they could influence acceptance, but no information about that is available.

The objective of this study was to investigate the effect of the rearing conditions during the fattening period of Iberian pigs on the acceptance of the dry-cured Iberian hams, and to research into the relationship between acceptance and the sensory characteristics and physical-chemical parameters of those hams.

MATERIALS AND METHODS

Samples

Forty Iberian pigs were reared indoors in similar conditions up to the fattening period. Then, 15 pigs were kept indoors and were offered a concentrate diet (Cebo group), and the remaining pigs were finished outdoors on acorns and pasture but were not offered a concentrate diet (Montanera system)(see [6] for details). Outdoor rearing lasted for 50 days for the short-Montanera group (6 pigs) and for 75 days for the long-Montanera group (19 pigs). The right leg from each animal was processed into dry-cured hams in a local company following the use of a traditional method [23]. Hams were kept in piles of salt for a period depending on weight (one day per kg raw ham). The salting and postsalting stages (at 0-3 °C and 80-90% relative humidity) lasted for 4-6 months (depending on ham weight), and then the hams were ripened for 15 months in a cellar at 10-27 °C and at 58-80% relative humidity. Then the hams underwent an acceptance test. They also underwent further analyses [6].

Acceptance Test

An acceptance test was performed to evaluate each ham as described previously [13]. One extremely thin slice (about 1 mm) from the front of each ham was obtained by the traditional way (using a knife) and was immediately presented on a glass plate to the consumers. Consumers evaluated each sample on a 10 cm unstructured hedonic scale [24], and a comment about the liking for each sample was asked.

Four hams were evaluated in each session, sample order being randomised. Teen sessions were needed to evaluate the 40 hams. Sessions were carried out at 20-22° C in a 6 booth sensory panel room with white fluorescent lighting. The FIZZ (version 1.01, Biosystemes, Couternon, France) program was used to register the scores and comments. To select consumers, people were asked and those who declared to dislike dry-cured ham or not to be an actual or potential consumer were rejected [24]. About 25 consumers (mean number) were used per session, which is in accordance with recommendations by Stone and Sidel [25] for laboratory testing with consumers. The mean of the consumers’ scores for each ham was calculated, and dependence and interdependence statistical tests were performed on the mean acceptance for each ham [24].

Data Analysis

Shapiro-Wilk and Levene tests were performed to check data for normality and variance similarity respectively, since they are required to perform some statistical tests [26]. A one-way
analysis of variance by the General Linear Model (GLM) procedure, using the type III sum-of-squares method (which is useful for unbalanced models, [27]), and the Scheffé test were used to compare acceptance among the three groups of hams. The GLM procedure was used to perform an analysis of covariance on IMF content (covariable), and also on marbling. Spearman correlation and factor analysis (principal components analysis was the method for factor extraction) were applied to evaluate the relationships among the variables [24]. Linear regression using the forward stepwise procedure was performed. The p-value of F to enter was set to 0.05 and to remove was set to 1. Statistical analyses were performed by means of the SPSS (version 19, SPSS Inc., Chicago, USA).

RESULTS AND DISCUSSION

Influence of Rearing Conditions on Acceptance of Iberian Ham

The acceptance of dry-cured hams obtained from Iberian pigs reared on different conditions was researched for the first time. After checking that the data were normally distributed and variance was similar within the three groups of hams, a type III analysis of the variance by the GLM model was performed. Results showed that the effect of rearing conditions was significant on acceptance (p < 0.001), hams from pigs fattened outdoors for 75 days on acorns and grass (long-Montanera system) reaching the largest scores, and hams from pigs fattened indoors on a usual concentrate feeding (Cebo system) the lowest ones (Figure 1).

As it is shows in Figure 1, the Scheffé test revealed that the duration (50 vs. 75 days) of the Montanera finishing period affects the acceptance of Iberian ham. Scarce studies about the effect of the Montanera duration have been performed, but results for acceptance are in line with those from a previous study on the same hams, which reported marked differences between the sensory profiles of both ham groups [6].

With regard to the effect of the type of fattening system (Montanera vs. Cebo systems) on acceptance, only slight but no significant differences appeared between the Cebo hams and the hams from pigs fattened in Montanera for 50 days (p = 0.080), and significant differences appeared between the Cebo hams and hams from pigs fattened in Montanera for 75 days (p < 0.001), so differences in ham acceptance increase as Montanera duration increases. Results confirm the convenience of keeping a minimum time for the outdoor-fattening period for the best Iberian ham grade over 50 days to ensure the highest quality to consumers. No previous information is available about differences in ham acceptance between Iberian hams from Montanera and Cebo systems, but the lack of differences in acceptance matches the results reported in dry-cured Iberian loin [15]: preference was not significantly different when the pigs were fattened in a Montanera system or in a Cebo system with a high oleic acid feeding [15], although it should be noted that feeding on high oleic acid concentrates provides Cebo hams with relatively scarce sensory [28] and chemical [29] differences from Montanera hams. For cooked pork different results were reported: no effect of rearing system was found [30], but also a better overall acceptance of fresh pork from pigs reared outdoors than from pigs reared indoors was reported [31].

The slight differences found between the acceptance of Cebo and short-Montanera hams are not consistent with the marked differences in the sensory profile (descriptive test) previously reported.
for those hams [6] and also with the marked differences reported in other studies in the sensory profile and in some physical-chemical parameters [2-6, 32] of Cebo and Montanera hams. A similar lack of coincidence between affective and descriptive data is in line with results by Jonsäll et al. [30] in fresh meat: loins from organically (outdoors) and conventionally (indoors) reared pigs were not different in a preference test although significant differences were found in a sensory descriptive test. That could be due to the fact that differences are more easily found using trained panellists than consumers because the formers have a fixed criterion to evaluate the samples, whereas liking could be related to different criterions and is complex for meat [33, 34]. In fact, consumer liking followed different behaviours: most consumers scored long-Montanera hams (the most expensive and least usual in the market) as the best, and the Cebo hams (the cheapest and most usual in the market) as the worst, but a few had a completely different liking. Those few consumers indicated that they disliked the texture of long-Montanera hams because it was too soft, which could be probably due to fact that they were not familiar with this commercial grade. People included in the study were actual consumers of Iberian ham, as it is advisable [24], but this fact does not mean that all of them were used to all the Iberian ham commercial grades, and even in that case different trends in liking are possible. It was not possible to research consumer clusters because sample availability (and therefore consumer number) was limited since a homogeneous area of each ham was individually evaluated and also underwent a descriptive analysis.

Influence of Intramuscular Fat (IMF) Content and Marbling on Acceptance

To investigate the effect of intramuscular fat content and marbling (visible IMF) on acceptance, data about both variables for each ham were taken from a previous study which included those hams [6]. IMF content (99% confidence intervals) was in the 5.2-7.2% range for the long-Montanera group, 3.8-7.3% for the short-Montanera group, and 3.4-5.6% for the Cebo group. 99% intervals of confidence for marbling (measured in a 10 cm scale) were 2.7 - 3.3 for the long-Montanera group, 1.7 - 2.7 for the short-Montanera group, and 2.2 - 2.9 for the Cebo group.

To check the effect of the IMF content on acceptance, this variable was included as covariable in a one-way (rearing conditions) analysis of covariance. No significant effect was found for the covariable \( (p = 0.199) \), so IMF content did not influence acceptance. In addition, results from the Spearman test revealed that IMF content and acceptance data were not correlated in any of the three ham groups \( (p > 0.586 \text{ for all the cases}) \). Similar results were found for marbling: an analysis of covariance showed no effect of marbling \( (p = 0.231) \), and correlation with acceptance was not significant for any of the three ham groups \( (p > 0.243 \text{ from the Spearman test for the three data sets}) \). Results show that variability in acceptance was not influenced by IMF content or marbling, at least not for the range of variation found in the IMF content and marbling in each group. Although the number of hams included in each group is not large enough to conclude that the relationship does not exist, results show that IMF content and marbling are not greatly involved in Iberian ham liking and also that they are not related to the differences in liking among the three groups of hams from pigs fattened on different conditions, at least not to a great extent. With regards to previous studies, a weak relation between marbling and acceptance has been reported [21], but there is no available information about the relation between Iberian ham acceptance and IMF content. In any case, the absence of effect of IMF on acceptance matches with previous results for other type of dry-cured ham [18]. In a similar way, for Iberian loin, a general consumer trend could not be defined: for three similar experiments three different results were found (the medium IMF content loins being the best and the worst rated and no effect) [15]. Different consumer’ clusters according to the affective response to fat content could explain the absence of effect on acceptance even when the effect on the sensory characteristics of meat products is marked. Although fat content affects to a great extent the characteristics [22, 35] and flavour [36, 37] of meat products, it is also know that for consumers fat content of meat is a dysfunctional cue and is not a good predictor of the quality perceived by consumers [38]. In fact, different preference patterns of consumers for fat content in fermented sausages was reported [22], and Cilla et al. [18] showed that a high fat (subcutaneous, inter and intramuscular) content caused rejection for a significant group of consumers but it had the opposite effect on others, total consumers’ trend resulting in a lack of difference in the acceptance.

The lack of significant relationships between acceptance and IMF is also in line with results from most studies on meat and meat products. Although some studies showed a significant effect of IMF (for
example [39], most studies reported no significant effect. For example, no differences between the preference of low (about 1%) and high (about 1.6%) IMF content pork chops was reported [40], and a similar overall acceptance for low (6%) and high (18%) fat content frankfurters was also reported [41].

### Relationships among acceptance and sensory and physical-chemical variables

The relationships between acceptance and other variables (sensory characteristics, chemical and physical-chemical variables) from a previous study on the same hams [6] were also researched. Results for the Principal Component Analysis (PCA) focused on acceptance for the long (Figure 2) and short Montanera (Figure 3) groups showed a similar behaviour in the relationships among variables: acceptance was closely and positively related to flavour intensity and persistence, oiliness, juiciness, sweetness, brightness, and it was also negatively related to fat hardness and bitterness.

For the Cebo group, however, acceptance was negatively related to flavour intensity and persistence, and the strongest positive relationships appeared with moisture and 20:1 (Figure 4). In any case, significant bivariate correlations inside each ham group were scarce: the smallest p-values appeared for fat hardness (-0.595, \( p = 0.007 \)) and juiciness (0.547, \( p = 0.015 \)), both in the long-Montanera group, and no significant correlations between acceptance and the individual fatty acids or other physical-chemical variables were found.

However, large correlations involving acceptance were found when the three set of data were analysed together. The largest bivariate correlations appeared between acceptance and the sensory characteristics, especially between acceptance and brightness (0.848, \( p < 0.001 \)), fat oiliness (0.851, \( p < 0.001 \)) fat hardness (-0.861, \( p < 0.001 \)), dryness (-0.846, \( p < 0.001 \)) and juiciness (0.833, \( p < 0.001 \)). Acceptance was also correlated to other non-sensory variables: the largest correlations...
appeared between acceptance and water activity of lean (0.812, p < 0.001) and some subcutaneous fatty acids such as 18:1 (0.756, p < 0.001) and 16:0 (0.740, p < 0.001). All these variables were greatly affected by rearing system [6] and therefore samples belonged to different statistical populations, so the appearance of these correlations just confirms the great influence of rearing conditions during fattening on acceptance, and also indicates they could be predictors for pig rearing condition, but that does not prove these variables really influence acceptance. To know the usefulness of sensory and non-sensory variables to predict acceptance, linear regression using the forward stepwise procedure was performed. When all the variables were available, the model included five of them (fat hardness, juiciness, lean redness, salty taste, and $b^*$ of fat) and reached $R^2 = 0.894$. A model explaining acceptance with only the sensory descriptive variables included four variables (fat hardness, juiciness, lean redness, and salty taste) and explained satisfactory the acceptance scores ($R^2 = 0.866$), although a simpler model including only fat hardness reached a not much smaller value ($R^2 = 0.741$). The performance did not improve when acceptance was predicted by using only fatty acid data ($R^2 = 0.734$) (percentages of 18:1, 17:1, 20:1, 18:0). A model including other chemical and physical-chemical variables was not satisfactory ($R^2 = 0.659$) and included only $a_w$ of biceps femoris. Therefore, data from the descriptive test rather than chemical or physical-chemical variables would be more useful to predict Iberian ham acceptance, and also they reflect to a greater extent the ham variations that influence acceptance.

REFERENCES


33. [1] Real Decreto 4/2014, de 10 de enero, por el que se aprueba la norma de calidad para la carne, el jamón, la paleta y la caña de lomo ibérico.


