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Physico-chemical and Sensory Characteristics of Dry-cured Loin from Different Iberian Pig Lines

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The influence of the line of Iberian pigs (Entrepelado, Lampiño, Retinto and Torbiscal) on dry-cured loin sensory traits and its relationship with several physico-chemical characteristics were analysed. Entrepelado and Lampiño lines showed a higher intramuscular fat content ($P=0.034$). These lines reached the highest scores for brightness ($P=0.043$), marbling ($P=0.005$), odour intensity ($P=0.010$) and flavour ($P=0.017$). Weight losses showed a positive relationship with some texture features, as hardness and dryness, and a negative one with juiciness according to the principal component analysis (PCA). Marbling was positively linked to odour intensity, juiciness and flavour intensity. These latter sensory traits have been previously linked to dry-cured meat products acceptability. Thus, dry-cured loins from Entrepelado and Lampiño Iberian pigs seem to have better sensory profiles, mainly due to their more intense marbling.

Key Words: sensory analysis, dry-cured loin, Iberian pig lines, intramuscular fat, marbling

INTRODUCTION

Dry-cured Iberian loin is one of the most valuable meat products of Spain (Samir et al., 1996). The quality of dry-cured products from Iberian pig is based on both raw material composition and processing conditions. The composition depends on the breed features, the rearing system and the metabolic type of muscles involved in each product (Antequera et al., 1992; Ruiz et al., 1998a; Andres et al., 2001).

Iberian pig breed includes a number of different lines, causing a great heterogeneity within the same breed. Several authors have reported important differences in productive, reproductive and morphologic parameters between different lines (Dobao et al., 1985; Garcia-Casco, 1993; Rodriguez et al., 1993). Differences in ham and loin weight and in carcass length and growth rate among different lines of Iberian pigs have also been reported (Benito et al., 1998). The authors' group has also observed previously a slight effect of the line of Iberian pig on the intramuscular fat content (IFC) of fresh loins (Muriel et al., unpublished data). In spite of these clear differences, studies concerning the possible influence of the line on the physico-chemical and sensory characteristics of dry-cured products of Iberian pig,

which in turn determine differences in their quality, are scarce.

The quality of dry-cured products depends also on processing factors. Dry-cured loin processing involves the addition of several spices and curing agents (sodium chloride, nitrates and nitrites) which are rubbed onto the surface of the pieces. The main ingredients of the pickling sauce are Spanish paprika (*Capsicum annum* L.) and garlic (*Allium sativum* L.). Previous researchers have established that these two spices play an important role on the flavour of dry-cured sausages due to some of their volatile compounds, which are mainly terpenes, such as alpha-pinene and limonene from paprika, and sulphide compounds such as diallyl disulphide from garlic (Edwards et al., 1999; Ansorena et al., 2001). Moreover, the antioxidant effectiveness of paprika and garlic in dry-cured sausages have been proved (Aguirrezabal et al., 2000). Thus the use of these spices would probably modulate lipid oxidation development in dry-cured loins.

One of the main characteristics contributing to the sensory quality of products from Iberian pigs is the intramuscular fat content (IFC). This characteristic has been positively correlated to juiciness (Ruiz et al., 2000) which is in turn correlated to acceptability (Ruiz et al., 2002a). Several authors have previously suggested a positive effect of IFC on marbling, flavour, juiciness and tenderness (Candek-Potokar et al., 1998; Fernandez et al., 1999; Ruiz et al., 2000; Brewer et al., 2001).

There are no studies describing the sensory profile of dry-cured loin from Iberian pig and the way the line could influence it. This study aimed to examine the influence of Iberian pig line on the sensory characteristics of dry-cured loin and the relationship between some physico-chemical features and sensory traits.

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MATERIAL AND METHODS

Samples

Forty pure Iberian pigs from four different lines (Entrepelado, Lampiño, Retinto and Torbiscal, 10 animals from each line) were free reared and fed on acorns and grass during the last 60 days before slaughter. All animals were slaughtered at 150 ± 10 kg by electrical stunning and ex-sanguination at a local slaughterhouse. Sampling was carried out within an hour following the slaughter. The right loin of all the 40 animals was taken and processed at a commercial plant. Loins were seasoned with a pickling sauce composed of (per kg of raw loin): 22 g salt, 5 g sweet paprika, 3 g hot-sweet paprika, 3 g garlic and 6 g of a commercial mixture (sodium chloride, sucrose, sodium ascorbate, sodium citrate, sodium nitrite and potassium nitrate), and subsequently kept for 3 days at 3 °C to allow seasoning mixture uptake. Thereafter, loins were stuffed into collagen casings and held for 90 days at 6 °C with a relative humidity around 85%. Finally, loins were vacuum packaged, carried to the Food Technology Laboratory at the UEX Veterinary School and analysed.

Methods

Moisture, Lipids and Weight Loss Determinations

Moisture was quantified following the AOAC (1984) method. Intramuscular total lipids were extracted and

quantified according to the method described by Bligh and Dyer (1959). Weight loss percentages were calculated by weighing the loins before and after the processing.

Sensory Analysis

Dry-cured loin slices were assessed by a trained panel of 18 members, using a descriptive analysis method (Ruiz et al., 1998b). Questions were specifically selected for Iberian dry-cured loin evaluation after revision of available literature (Garcia et al., 1996; Gou et al., 1996; Ruiz et al., 1998b). The sensory traits, their definitions and extremes are explained in Table 1. Questions were presented to assessors in the normal perception order, as follows: visual analysis, odour perception, lean texture, taste and flavour.

The panelists had previously participated in the sensory evaluation of dry-cured products. Individual flavour and aroma recognition thresholds were used to select the subjects. Selected subjects underwent further training in dry-cured product sensory characteristics, using products with different characteristics (i.e., feeding, breed, etc.). Subjects had a total of 120 h of training in preparation for descriptive analysis. Consistency of the panelists was validated using the Rasch model (Garcia et al., 1996). The mean of all panelists scores for each attribute of each Iberian pig line was calculated to perform the statistical analysis.

Three different loins randomly selected out of the four lines of Iberian pig were evaluated in each session.

Table 1. Sensory attributes, definitions and extremes. Each attribute was scored in an unstructured line of 10 cm.

Sensory Trait	Definition
Appearance	
Redness	Intensity of red colour in the lean (pale pink to dark red)
Brightness	Intensity of brightness on the lean surface (dull to very bright)
Marbling	Level of visible intramuscular fat (very lean to intense marbled)
Marbling size	Size of the fat veins (very small to very big)
Marbling shape	Shape of the fat veins (irregular to linear)
Odour	
Intensity	Level of overall odour before the sample is eaten (odourless to very intense odour)
Texture	
Hardness	Effort required to bite through lean and to convert the sample to a swallowable state (very tender to very firm)
Dryness	Amount of juices present in the mouth in the first chews (very dry to very wet)
Fibrousness	Extent to which fibres–strands are perceived on chewing (not to very fibrous)
Juiciness	Impression of lubricated food during chewing (not very juicy)
Taste	
Saltiness	Level of salt taste (not to very salty)
Sweetness	Level of sweet taste (not to very sweet)
Bitterness	Level of bitter taste (not to very bitter)
Sourness	Level of sour taste (not to very sour)
Flavour	
Flavour intensity	Level of overall flavour (flavourless to very intense flavour)
Cured	Intensity of the typical flavour from cured meat products (very low to very high)
Rancid	Intensity of the rancid flavour (very low to very high)
Pickling flavour	Intensity of the typical flavour from pickling sauce (very low to very intense)
After-taste	Intensity and duration of the flavour after the sample is swallowed (very low to very high)

Sample order was randomised. The sessions were held at 11:00 am, 3 h after breakfast. Two thin slices (1.5 mm) of each loin were given to the panelists. Slices were obtained using a commercial slicing machine and served on glass plates, both the slices and the plates were at room temperature (20–23 °C). A glass of water of about 200 mL at 12 °C was provided for each assessor. All sessions were done in a six-booth sensory panel room at 22 °C equipped with white fluorescent lighting (220–230 V, 35 W). Nineteen traits concerning sensory characteristics of Iberian dry-cured loins (Table 1), grouped under appearance, odour, texture, taste and flavour were assessed by the panelists in a 10-cm unstructured line, ranging from ‘less’ to ‘more’. FIZZ Network (version 1.01; Biosystemes, France) program was used for the session’s performance and the recording of all data obtained.

Statistical Analysis

Experimental data obtained from the lines (Entrepelado, Lampiño, Retinto and Torbiscal) were compared by a one-way analysis of variance. Pairwise comparisons between means were carried out by Tukey’s test when corresponded, for both analyses the GLM procedure of SPSS v.11.0 was used. Pearson correlations among variables were calculated by the correlations procedure of SPSS v.11.0. Principal component analysis (PCA) was applied to the sensory and chemical data using the Unscrambler software (CAMO, ASA, Oslo, Norway).

RESULTS AND DISCUSSION

Chemical Analysis and Weight Losses

Moisture content was not affected by the Iberian pig lines and ranged between 32.97 and 35.66% (Table 2). In general, IFC found in these loins were higher than that reported previously by other authors (Hernandez et al., 1998). Iberian pig lines significantly influenced IFC ($P=0.034$). Only Lampiño and Retinto lines showed significantly different means by the Tukey’s

Table 2. Moisture, intramuscular fat content (IFC) and weight losses (WL) (%) in the Iberian dry-cured loins from Entrepelado, Lampiño, Retinto and Torbiscal lines.

	Line ¹				SEM ²	P
	Entrepelado	Lampiño	Retinto	Torbiscal		
Moisture	35.66	33.07	32.97	35.43	0.506	0.095
IFC	9.39 ^{ab}	10.22 ^a	6.77 ^b	7.85 ^{ab}	0.466	0.034
WL	43.22	42.12	43.97	44.07	0.412	0.318

¹Means within the same row with different letters are significantly different ($P < 0.05$).
²SEM, standard error of the mean.

test, with higher values for the former (10.22%) than for the latter (6.77%). These results agreed with those previously observed in fresh *longissimus dorsi* muscles from animals of the same four lines of Iberian pig (data not shown) and in dry-cured ham (Jurado et al., 2003). In this sense, black varieties (Lampiño and Entrepelado among others) have shown to have higher IFC than red varieties (such as Retinto and Torbiscal). However Tejada et al. (2002) and Petron (2002) did not find differences either in moisture content or in IFC in fresh and dry-cured ham among other Iberian red and black lines. The high IFC of Iberian pig products is one of the main characteristics determining their sensory quality. There exists a relationship between lipid content, texture and appearance of Iberian dry-cured products (Ruiz et al., 2000). In a later study, these authors found hams with a higher IFC reached the highest consumer acceptability (Ruiz et al., 2002a). Thus, differences found for IFC in dry-cured loins from different Iberian pig lines could motivate differences in the sensory profile.

The dehydration process of the product took place with the same intensity in all the groups without any influence of the line. WL and IFC showed a negative relationship in the PCA (Figure 1), thus Lampiño line (black variety), which showed the highest IFC, experimenting the lowest WL values of the studied lines. The extent of the dehydration process is influenced, among several factors, by the raw material composition, especially the content and distribution of IFC, since the presence of IFC decreases moisture diffusivity coefficient (Arnau et al., 1997; Gou, 1998). This fact would explain the lower weight losses in dry-cured loins from animals of those lines showing higher IFC.

Sensory Analysis

Dry-cured loins from animals of the Entrepelado and Lampiño lines reached higher scores ($P=0.043$) for brightness (5.83) than those of the Retinto (5.75) and Torbiscal lines (5.05), though the Tukeys test could not establish these differences among groups (Table 3). Marbling was significantly affected by pig line ($P=0.005$), dry-cured loins from Lampiño showed the highest marbling level (6.29), followed by Entrepelado (5.35), Torbiscal (4.79) and Retinto (4.40). Thus, black lines (Entrepelado and Lampiño), which had higher IFC, showed a more intense brightness and marbling than red lines (Torbiscal and Retinto) with lower IFC. These results agreed with those reported by Jurado et al. (2003) for dry-cured ham. A positive influence of IFC on brightness and marbling has been previously reported (Ruiz et al., 2000). Moreover, these sensory traits had an important and positive role in consumer preference (Ruiz et al., 2002b).

Odour intensity was significantly influenced by the Iberian pig lines ($P=0.010$), it was higher in Lampiño

Table 3. Mean values for sensory traits of dry-cured loins from the different lines of Iberian pig.

	Line				SEM ¹	P ²
	Entrepelado	Lampião	Retinto	Torbiscal		
Appearance						
Redness	6.13	6.55	6.54	6.42	0.081	0.235
Brightness	5.83	5.83	5.75	5.05	0.118	0.043
Marbling	5.35 ^{ab}	6.29 ^a	4.40 ^b	4.79 ^b	0.209	0.005
Marbling size	4.60	4.70	3.75	4.45	0.140	0.064
Marbling shape	5.394	5.67	5.22	5.62	0.128	0.579
Odour						
Odour intensity	5.65 ^{ab}	6.00 ^a	5.62 ^{ab}	5.39 ^b	0.067	0.010
Texture						
Hardness	3.87	3.45	3.74	3.35	0.140	0.549
Dryness	2.94	2.60	3.10	2.82	0.094	0.293
Fibrousness	3.99	3.49	3.98	3.43	0.087	0.021
Juiciness	5.39	5.81	5.27	5.35	0.092	0.154
Taste						
Saltiness	3.76	3.77	3.63	3.65	0.068	0.846
Sweetness	1.99	1.93	2.03	1.88	0.081	0.922
Bitterness	0.77	0.76	1.01	0.85	0.053	0.332
Sourness	1.63	1.74	1.43	1.66	0.062	0.362
Flavour						
Flavour intensity	5.67	5.67	5.32	5.22	0.067	0.017
Cured	4.45	4.35	4.14	4.14	0.078	0.413
Rancidity	0.96	1.06	0.89	0.97	0.040	0.553
Pickling flavour	4.52	4.40	4.15	4.26	0.101	0.586
After-taste	5.18	5.38	5.02	5.18	0.079	0.465

¹SEM: Standard error of the mean.

²P: Effect was considered significant at $P < 0.05$. Means with different superscripts in the same row are significantly different.

line (6.00), while Torbiscal reached the lowest scores (5.39). Entrepelado and Retinto lines obtained intermediate odour intensity values (5.65 and 5.62 respectively). These results showed that Lampião line, which exhibited the highest IFC, obtained also the highest scores for odour intensity. This agreed with the lipid origin of a number of odour active compounds in meat and meat products (Carrapiso et al., 2002; Ruiz et al., 2002a).

Among textural features only fibrousness was influenced by the Iberian pig lines ($P=0.021$), with higher scores for Entrepelado and Retinto lines (3.99 and 3.98 respectively) while Lampião and Torbiscal lines yielded the less fibrous products (3.49 and 3.43 respectively). Fibrousness in dry-cured products is caused by the presence of insoluble collagen together with the insolubilization of myofibrillar proteins due to the dehydration that occurs during processing (Cordoba et al., 1994). However, moisture content of the loins from the four studied lines was in a narrow range (between 32.97 and 35.66%) and a significant correlation between moisture and fibrousness was not detected.

Iberian pig lines did not influence any of the taste descriptors evaluated. Taste is caused by the presence of a number of low-molecular weight compounds, such as sodium chloride, aminoacids, peptides and nucleotides, inorganic ions, amines, sulphide and nitrogen com-

pounds in the food (Grill and Flynn, 1987). However, the main variability factor found among the Iberian pig lines, IFC, seemed to have very little influence on taste perception.

Evaluation of flavour traits showed that only flavour intensity was influenced by the Iberian pig lines ($P=0.017$). Entrepelado and Lampião lines reached the highest values (5.67 both), while Retinto (5.32) and Torbiscal (5.22) reached the lowest, following the same trend described for odour intensity.

Principal Component Analysis was performed with the aim to study the relationships among variables considered in this work (Figure 1). Marbling degree and IFC showed positive weights in the first principal component. However, that relationship was not too evident, and in fact, correlation coefficient between both variables was significant but rather low ($R=0.381$, $P < 0.05$).

Marbling showed a positive relationship with juiciness and odour and flavour intensities, and a negative one with textural traits such as dryness, hardness and fibrousness. A similar behaviour has been described in other dry-cured meat products, although the relationship with IFC was stronger (Ruiz et al., 2000). In our study the positive effect of marbling on juiciness and flavour was always observed, which were the traits that more directly determined acceptability (Ruiz et al., 2002b).

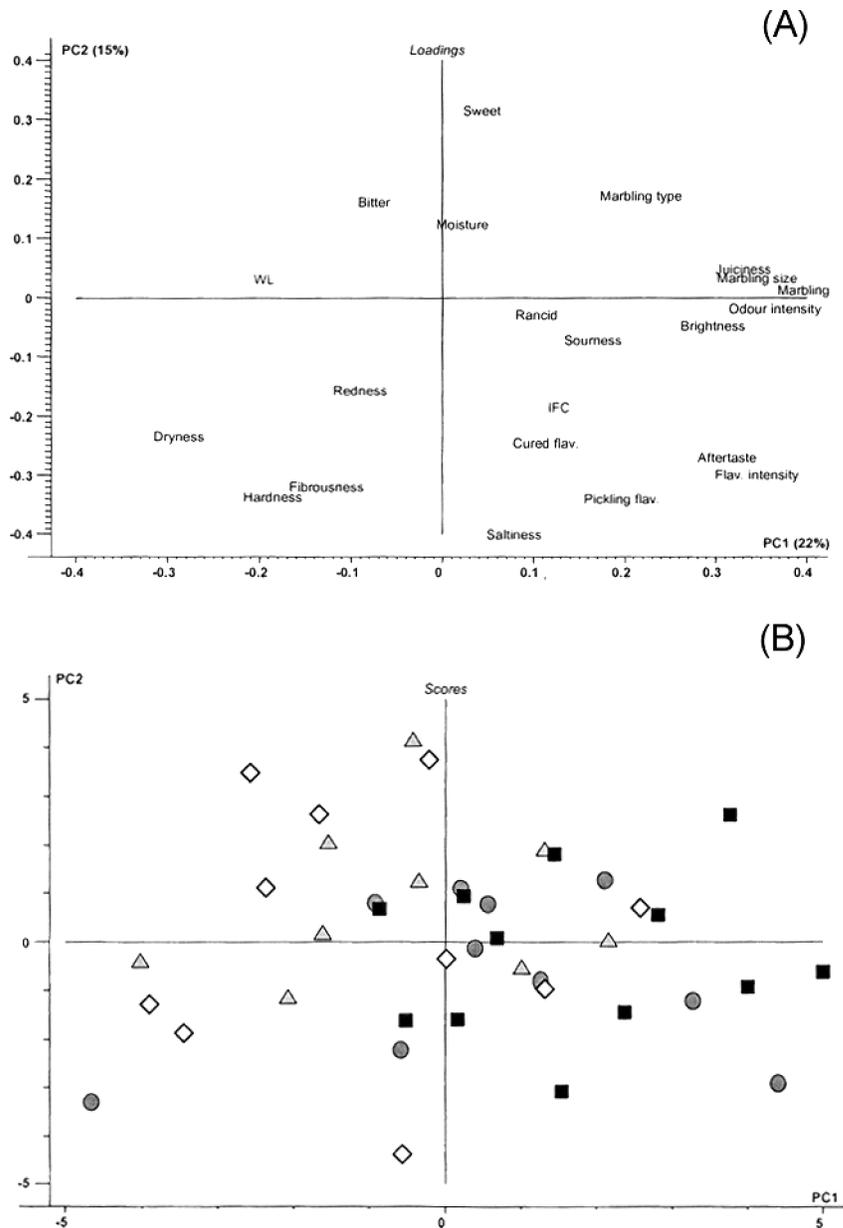


Figure 1. Loading (A) and score (B) plots of the first two principal components of the Principal Component Analysis carried out with all sensory and physico-chemical data: (■) Lampiño; (●) Entrepelado; (▲) Retinto; (◇) Torbiscal.

Moreover, marbling seemed to decrease scores for those textural traits with negative implications. Thus, loins from the Iberian pigs with higher marbling degree, as are those from the Lampiño and Entrepelado lines, had better sensory characteristics (Figure 1). Cured loins from Lampiño and Entrepelado animals were located in the positive area of the PC1, in which juiciness, marbling and odour intensity showed the highest loadings, whereas those from the Retinto and Torbiscal pigs were in the negative quarter.

Weight losses obtained negative loadings in the PC1, showing a negative relationship with marbling, in agreement with the mentioned effect of fat content on dehydration. Loins with higher weight losses resulted

more dry, hard and fibrous, as can be deduced by the loadings of these variables in the negative part of the PC1. However, moisture content did not seem to influence these textural traits.

Finally, PC2 seemed to be mainly determined by taste and flavour traits. From the loadings of the variables involved in PC2, it seemed that those loins with a more intense pickling flavour resulted saltier and with a more intense cured flavour, whereas they were less bitter and sweet. Although it was only slightly evidenced in the PCA, juiciness was positively and significantly correlated with pickling flavour ($R=0.349$; $P<0.05$). This would be due to the salivary secretion stimulation caused by some volatile components coming from

marinated spices, mainly paprika and garlic, which favoured the lubrication of the product during chewing and enhanced juiciness sensation (Atal and Kapur, 1982).

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REFERENCES

- Aguirrezabal M.M., Mateo J., Dominguez M.C. and Zumalacarregui J.M. (2000). The effect of paprika, garlic and salt on rancidity in dry sausages. *Meat Science* **54**: 77–81.
- Andres A.I., Cava R., Mayoral A.I., Tejada J.F., Morcuende D. and Ruiz J. (2001). Oxidative stability and fatty acid composition of pig muscles as affected by rearing system, crossbreeding and metabolic type of muscle fibre. *Meat Science* **59**: 39–47.
- Ansorena D., Gimeno O., Astiasaran I. and Bello J. (2001). Analysis of volatile compounds by GC-MS of a dry fermented sausage: chorizo de Pamplona. *Food Research International* **34**: 67–75.
- Antequera T., Lopez-Bote C., Cordoba J.J., Garcia C., Asensio M.A., Ventanas J., Garcia-Regueiro J.A. and Diaz I. (1992). Lipid oxidative changes in the processing of Iberian pig hams. *Food Chemistry* **45**: 105–110.
- Arnau J., Guerrero L. and Sarraga C. (1997). Effects of temperature during the last month of ageing and of salting time on dry-cured ham aged for six-months. *Journal of the Science of Food and Agriculture* **74**: 193–198.
- Association of Official Analytical Chemist (AOAC, 1984). *Official methods of analysis*. 3rd edn, Washington, DC: AOAC.
- Atal C.K. and Kapur B.M. (1982) *Cultivation and Utilisation of Medicinal Plants*, Jammu-Tawi: Regional Research Laboratory. pp. 115–118.
- Benito J., Vazquez C., Menaya C., Ferrera J.L., Garcia-Casco J.M., Silio L., Rodrigañez J. and Rodriguez, M.C. (1998). Evaluacion de los parametros productivos en distintas lineas de cerdo Iberico. In: *Proceedings IV International Symposium of Mediterranean Pig*. Evora, Portugal 1998.
- Bligh E.G. and Dyer E.J. (1959). A rapid method of total lipid extraction and purification. *Canadian Journal of Biochemistry and Physiology* **37**: 911.
- Brewer M.S., Zhu L.G. and McKeith F.K. (2001). Marbling effects on quality characteristics of pork loin chops: consumer purchase intent, visual and sensory characteristics. *Meat Science* **59**: 153–163.
- Candek-Potokar M., Zlender B., Lefaucheur L. and Bonneau M. (1998). Effects of age and/or weight at slaughter on *longissimus dorsi* muscle: biochemical traits and sensory quality in pigs. *Meat Science* **48**: 287–300.
- Carrapiso A.I., Ventanas J. and Garcia C. (2002). Characterization of the most odor-active compounds of Iberian ham headspace. *Journal of Agricultural and Food Chemistry* **50** (7): 1996–2000.
- Cordoba J.J., Antequera T., Ventanas J, Lopez-Bote C., Garcia C. and Asensio M.A. (1994). Hydrolysis and loss of extractability of proteins during ripening of Iberian ham. *Meat Science* **37**: 217–227.
- Dobao M.T., Poza M.L., Rodrigañez J. and Silio L. (1985). Diferencias en la composicion de canal de tres estirpes de cerdo Iberico. *Anales del INIA. Serie Ganadera* **22**: 99–112.
- Edwards R.A., Ordoñez J.A., Dainty R.H., Hierro E.M. and De la Hoz L. (1999). Characterization of the headspace volatile compounds of selected Spanish dry fermented sausages. *Food Chemistry* **64**: 461–465.
- Fernandez X., Monin G., Talmant A., Mourot J. and Lebret B. (1999). Influence of intramuscular fat content on the quality of pig meat – 1: Composition of the lipid fraction and sensory characteristics of *M. longissimus lumborum*. *Meat Science* **53**: 59–65.
- Garcia C., Ventanas J., Antequera T., Ruiz J., Cava R. and Alvarez P. (1996). Measuring sensorial quality of Iberian ham by Rasch model. *Journal of Food Quality* **19**: 397–412.
- Garcia-Casco J. (1993). *Aspectos genéticos de la mejora de caracteres de crecimiento de cerdos Ibéricos*. Ph. Thesis, Universidad Complutense de Madrid.
- Gou P. (1998). Dinámica del secado del jamón curado. In: *Eurocarne, II International Symposium of Cured Ham*, pp. 90–106.
- Gou P., Guerrero L., Gelabert J. and Arnau J. (1996). Potassium chloride, potassium lactate and glycine as sodium chloride substitutes in fermented sausages and in dry-cured pork loin. *Meat Science* **42**: 37–48.
- Grill H.J. and Flynn F.W. (1987). Behavioural analysis of oral stimulating effects of amino acid and glutamate compounds on the rat. In: Kawamura Y. and Kare M.R. (eds), *Umami: A basic taste*. New York: Marcel Dekker.
- Hernandez P., Navarro J.L. and Tolodr  F. (1998). Lipid composition and lipolytic activities in porcine skeletal muscles with different oxidative pattern. *Meat Science* **49**: 1–10.
- Jurado A., Carrapiso A.I., Timon M.L. and Garcia C. (2003). Efecto de las l neas de cerdo Ib rico en las caracter sticas sensoriales del jam n madurado. In: *2nd World Congress of Ham Science, Technology and Marketing*. Caceres, Spain, 2003.
- Petron M.J. (2002). *Estudio de la fracci n lip dica intramuscular en diferentes tipos de jam n Ib rico*. Ph. Thesis, Universidad de Extremadura.

- Rodriguez C., Bejar F., Rodrigañez J. and Silio L. (1993). Componentes de varianza, heterosis y depresion consanguinea en el tamaño de camada de cerdos Ibéricos. *Investigación Agraria Producción y Sanidad Animales* **8**: 45–53.
- Ruiz J., Cava R., Antequera T., Martin L., Ventanas J. and Lopez-Bote C. (1998a). Prediction of feeding background of Iberian pigs using the fatty acid profile of subcutaneous muscle and hepatic fat. *Meat Science* **49**: 155–163.
- Ruiz J., Ventanas J., Cava R., Timon M.L. and Garcia C. (1998b). Sensory characteristics of Iberian ham: influence of processing time and slice location. *Food Research International* **31**: 53–58.
- Ruiz J., Ventanas J. Cava R., Andres A.I. and Garcia C. (2000). Texture and appearance of dry cured hams affected by fat content and fatty acid composition. *Food Research International* **33**: 91–95.
- Ruiz J., Garcia C., Muriel E., Andres A.I. and Ventanas J. (2002a). Influence of sensory characteristics on the acceptability of dry-cured ham. *Meat Science* **61**: 347–354.
- Ruiz J., Muriel E. and Ventanas J. (2002b). The flavour of Iberian ham. In: Toldrá F. (ed.), *Research advances in the quality of meat and meat products*, Trivandrum, India: Research Signpost, pp. 289–309.
- Samir M., Mahlau M. and Furitsch P. (1996). Comportamiento del consumidor español frente a la demanda de productos carnicos (I). *Eurocarne* **43**: 35–44.
- Tejeda J.F., Garcia C., Muriel E. and Antequera T. (2002) Muscle lipid composition of Iberian pig meat as related to genetic line. In: *48th International Congress of Meat Science and Technology*. Vol. II, August 2002, Rome, Italy, pp. 734.