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Evaluation of Iberian pig carcasses based on NIR spectra of pork loins

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SUMMARY – The objective of this paper is to develop multivariate models based on NIR spectral data from Iberian pork loins to determine the quality of the carcass. The official methods to evaluate carcass quality have different limitations. Thus, it is necessary to find new methods to classify carcasses according to their feeding regime. Near Infrared Spectroscopy (NIRS) allows quick analysis to be obtained with low cost per sample, high accuracy, and easy handling. Loin samples were taken from Iberian pigs. The feeding regime was: exclusively grass and acorn for 104 days (B1) and 83 days (B2), grass and acorns, supplemented with a commercial compound feed during the last 13 days (R) and only commercial compound feed (C). Lineal discriminant analysis was used to obtain a multivariate model based on NIR spectra. The model results show that all the samples from group C were correctly classified.

Keywords: Iberian pork, NIRS, carcass classification, multivariate model.

RESUME – *"Evaluation des carcasses de porc Ibérique basée sur les spectres NIR des longes de porcs". Ce travail a pour objectif de développer des modèles basés sur des données spectrales NIR de longe de porc Ibérique pour déterminer la qualité des carcasses. Les méthodes officielles pour évaluer la qualité des carcasses ont certaines limitations. C'est pourquoi il est nécessaire de chercher de nouvelles méthodes de classification des carcasses en correspondance avec leur régime alimentaire. La Spectroscopie dans le Proche Infrarouge (NIRS) permet de réaliser des analyses rapides avec un bas prix par échantillon, avec précision et manipulation facile. Les échantillons ont été pris de la longe de porc Ibérique. Le régime alimentaire a été: pâturage et gland exclusivement 104 jours (B1), 83 jours (B2), pâturage et gland complété avec aliment composé commercial les 13 derniers jours (R) et seulement aliment composé spécial (C). Avec une analyse discriminante linéaire, il a été obtenu un modèle multivarié basé sur les spectres NIR. Les résultats du modèle montrent que tous les échantillons du groupe C ont été correctement classés.*

Mots-clés : *Porc Ibérique, NIRS, carcasses, modèle multivarié.*

Introduction

The final fattening stage of Iberian pigs can be achieved in three possible ways: just using the natural resources from the "dehesa"; supplementing these resources with commercial compound feeds; and just using commercial compound feeds. Animals fattened in this way are classified using the following commercial categories, "Bellota" "Recebo" and "Cebo", respectively.

Since pigs are monogastric, and therefore the lipids in food are deposited in their tissues without being modified, the fat taken from animals fattened in each of the three aforementioned ways will differ in its composition. Furthermore, since lipids are largely responsible for the flavour properties in meat, the qualities of each of these categories will be different; "Bellota" products are the highest quality, which implies higher market prices.

The difficulty in carrying out strict controls of the food ingested by animals in the countryside led to the differentiation of different carcasses based on the main fatty acid values (palmitic, stearic, oleic and linoleic), determined by gas chromatography, of an average sample of subcutaneous adipose tissue, taken from a random selection of animals.

The higher prices that products in the "Bellota" category command has led to the appearance of commercial feed that, when given to the animals, gives a similar fatty acid deposit composition to that of animals fattened with acorns. However, this similarity in fatty acids does not produce the same sensorial quality as in "bellota" quality products.

Our increasing concern regarding quality, traceability and food safety means that the quality control systems of these products need to be modernised and automated, both at the level of the farms, industry and related services.

As an alternative to traditional analysis methods, new analytical technologies are emerging, including Near Infrared Spectroscopy (NIRS). In the Animal Production Department of ETSIAM (Faculty of Agriculture and Forestry Engineering), in Cordoba, several R&D projects have been carried out, related to the study of factors that affect production, quality of carcasses and products derived from Iberian pigs, using such technology.

NIRS technology, based on near infrared absorbance, offers the possibility of fast analysis, with low cost per sample, and also has other highly important features to respond to current requirements, both at an industry and consumer level, such as: accuracy, versatility (multiproduct and multiconstituent), easy handling, and of course, it is a non-polluting technique (Garrido *et al*., 1996).

This technology can perform both quantitative and qualitative analyses. Currently we have great expectations regarding the application of qualitative analysis, thanks to the advances in instrumentation, computer development and improvements in the treatment of spectral data. This analysis enables large amounts of samples to be classified in a short period of time by generating classification models, using spectral information.

Hence, the objective of this paper is to develop a qualitative model based on spectral characteristics in near infrared of Iberian pork loins for the classification of carcasses according to the animal's feeding regime.

Material and methods

Experimental material

Four batches of 40 Iberian pigs were used, whose feeding regime in the final fattening stage is shown in Table 1.

Table 1. Feeding regime of the Iberian pigs during the final fattening stage

Batch	Duration of fattening stage	Feeding regime
B1	104	Only grass and acorns
B2	83	Only grass and acorns
R	72	7 days acorns + 2 kg commercial feed 16 days only acorns 35 days acorns + 2 kg commercial feed 14 days commercial feed ad limitum
C	115	Special commercial feed that simulates acorn quality

Once the animals had been slaughtered, the loins were separated from the carcass, and a sample was taken (80 g) from the anterior end of each of them, so that only the *Longissimus dorsi* muscle was included, without any external or intermuscular fat.

They were then packaged and refrigerated, and transported to the Department of Animal Production Laboratory, where the spectra of each sample were obtained.

Analysis equipment

The equipment used to obtain the spectra was a Foss NIRSystems 6500 SY-I scanning monochromator equipped with a spinning cup working in reflectance mode in the spectral range 400-2500 nm, at intervals of 2 nm. This equipment has standard circular capsules to analyse solid products (reflectance readings), with a quartz glass window of 3.75 cm diameter.

The software used for obtaining and chemometric analysis of the spectral data was WINISI II version 1.04 (Infrasoft International). The instrumentation and NIRS software used are the property of the Central Research Support Service (SCAI) of the University of Cordoba.

Preparation of the sample and spectra collection

The samples were minced until a homogeneous paste was achieved. Then the capsules were filled, avoiding the formation of air pores or the presence of connective tissue fibres in contact with the glass (Martínez *et al.*, 1998), and then the spectra of each subsample were obtained.

Qualitative analysis

In order to develop the discriminant model, we used WINDISCRIM software, which classifies the samples according to how close they are to the model. The models are determined by analysing the main components in which the original variables are the absorbency values for each wave length of the spectra. In this paper, we have followed recommendations of Downey (2000), which set the limit for a sample's belonging to a determined category at 1.5.

Batch quality criteria

According to the information collected from the countryside (average weight gain of the animals and type of food consumed), the batches would be classified into *Bellota* (batches B1 and B2) *Recebo* (batch R) and *Cebo* (batch C).

To classify the batches according to the Official Sales Contract (OSC) of Iberian pigs in force when the tests were carried out (BOE, 2000) a sample of fat from each carcass at the slaughterhouse was taken from the dorsal area, in the animal rump.

The content of palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1) and linoleic acid (C18:2) was determined using NIR spectroscopy, applying the methodology and prediction equations developed by García Olmo (2002).

Results and discussion

Table 2 shows the average fat composition of each batch, and the corresponding quality depending on the levels established in the Official Sales Contract (OSC) (BOE, 2002) for the average subcutaneous fat composition.

Table 2. Average composition and standard deviation of the subcutaneous fat of the experimental batches and their classification according to the OSC criteria

Batch	Fatty acid (%)				Classification
	Palmitic	Stearic	Oleic	Linoleic	
	x ± sd	x ± sd	x ± sd	x ± sd	
B1	19.6 ± 1.0	9.1 ± 0.9	55.4 ± 1.7	9.3 ± 0.8	Bellota
B2	20.2 ± 0,8	9.8 ± 0.6	54.4 ± 1.3	9.3 ± 0.5	Recebo
R	22.1 ± 0.9	11.1 ± 0.8	50.5 ± 1.4	9.5 ± 0.6	Cebo
C	22.2 ± 1.0	11.0 ± 0.9	50.5 ± 1.3	9.1 ± 0.7	Cebo

As we can see in Table 2, only in the case of batches B1 and C would the classification based on the field information agree with that based on the OSC analytical criteria. In the case of batch B2, this would be classified in the RECEBO category, since it exceeded (9.8) by three decimals the limit percentage of stearic acid established in the OSC (9.5), which is extremely strict.

In the case of batch R, which, according to the field information should be in the RECEBO category because of its use of acorn foraging and then commercial feed consumption, the analytical results clearly show a fatty acids profile characteristic of animals in the CEBO class. This is probably the consequence of low acorn consumption and significant contributions of commercial feed.

It is important to highlight that the classification of the batches was carried out based on the average composition. Given the variability between the groups (as the standard deviations in Table 2 show) not all the animals would fit the profile of the category into which the batch has been classified. The high cost and time necessary to perform a gas chromatography analytical determination of the samples on an individual basis, makes this option unviable.

With the spectral information of the loin samples, a linear discriminant analysis model was obtained. The results are shown in Table 3.

Table 3. Classification matrix of the model developed with the NIR spectral information of the Iberian pork loins using linear discriminant analysis

Batch reference	Number of samples classified in the batch			
	B1	B2	R	C
B1	37	0	3	0
B2	1	38	1	0
R	0	3	37	0
C	0	0	0	40

As we can see in Table 3, no samples from batches B1, B2 and R were classified in category C. Furthermore, all the samples from batch C were correctly classified in their groups. The erroneous classification of some samples from batches B1, B2 and R into different batch categories could be due to variation in the animals with regards their feeding behaviour. This feeding behaviour would cause animals to have a higher or lower consumption of acorns, grass or commercial feed, which would be reflected in different fat characteristics and a certain similarity with specimens from other batches. However, this would not imply an erroneous classification but rather recognition of the greater or poorer quality of these specimens.

However, if we accept erroneously classified samples as an error in the model, the accuracy achieved by this methodology is high (95%), bearing in mind that it has been applied to individual samples and not to the batch as a whole.

Therefore, NIRS technology can be applied to the recognition of the individual quality of Iberian pork loins. Furthermore, this technique is more accurate, fast and economic than fat composition analysis using gas chromatography.

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References

BOE (2000). Orden de 19 de octubre de 2000 por la que se homologa el contrato-tipo de compraventa de cerdos Ibéricos cebados con destino a sacrificio y elaboración, que regirá hasta el 31 de agosto de 2001. Boletín Oficial del Estado de 258 de 27 de octubre de 2000.

Downey, G. (2000). Discrimination et authentification des aliments et des ingrédients alimentaires par spectroscopie dans l'infrarouge proche et moyen. In: *La spectroscopie infrarouge et ses applications analytiques*. Bertrand, D. and Dufour, E. (eds). Editions TEC & DOC, Paris, France, pp. 397-422.

García-Olmo, J. (2002). *Clasificación y autentificación de canales de cerdo Ibérico mediante espectroscopía en el infrarrojo cercano (NIRS)*. PhD Thesis, University of Córdoba, Spain.

Garrido, A., Gómez, A., Guerrero, J.E. and Fernández, V. (1996). NIRS: Una tecnología de apoyo para un servicio integral en Alimentación Animal. In: *Avances en Alimentación y Nutrición Animal*, De Blas, C., Mateos, G.G. and Rebollar, P.G. (eds). FEDNA, Madrid, Spain, pp. 275-300.

Martínez, M.L., Garrido, A., De Pedro, E.J. and Sánchez, L. (1998). Effect of sample heterogeneity on MIR meat analysis: the use of the RMS statistic. *Journal of Near Infrared Spectroscopy*, 6: 313-320.