

Comparison of NIR chemometric models to recognize the type of feeding of Iberian pigs

J. García-Olmo^{a,b}, A. Garrido-Varo^a and E. De Pedro^a

^a *Department of Animal Production, Faculty of Agriculture and Forestry Engineering, University of Cordoba, Apdo 3048, 14080 Córdoba, Spain*

^b *NIR/MIR Unit. Central Service for Research Support. University of Cordoba. Apdo 3048, 14080 Córdoba, Spain*

Introduction

Nowadays, it has been sufficiently proven that the characteristics of the Iberian pig fat basically depend on the type of feeding that the pig has received at the end of its fattening period, and that the use of different diet types, (ie. acorns, acorns and feed concentrates, only concentrates) have a significant repercussion on the fatty acid composition of the adipose tissues of its carcass.^{1,2} Previous works has shown the possibility to discriminate Iberian pig carcasses with different type of feeding based on spectral NIR data.^{3,4} The discrimination models previously reported for clasification of Iberian pig carcasses were obtained from pigs reared under experimental feeding conditions, that is, with well-defined and tightly-controlled feeding regimes. In order to confirm the previous results and to be able to apply the models obtained for carcasses classification at the slaughterhouse, it is needed to develop discrimination models using samples from other batches of animals more representative of real farm conditions.

The NIRS literature highlights the variety of chemometric algorithms used to develop models for classification, authentication and discrimination purposes.^{5,6} Some of these chemometric algorithms are more sophisticated than others and some of them are implemented as part of routine NIRS software.

The objective of this work is to compare the performance of several chemometric algorithms for the classification of Iberian pig carcasses according to the feeding system of the animals.

Material and Methods

Samples

Subcutaneous fat samples were taken from 121 carcasses of Iberian pigs belonging to 5 batches of Iberian pigs reared under different feeding systems. Table 1 contains the number of animals and the type of feeding for each of the five batches. It is important to highlight that the quality and the price of the derived products from each batch of animals decrease from batch 1 to batch 5.

Fat samples were taken from the tail insertion area in the coxal region of the carcass. That is the same location used by the Iberian Pig Designation of Origin committees and laboratories when taking samples for the quality control of Iberian pig carcasses. Each subcutaneous adipose tissue sample containing all the fat accumulation, with the skin and lean parts removed, was processed to

extract from it a liquid fat sample.⁷ A total of 121 samples of liquid fat were therefore available to carry out the present work.

Table 1. Characteristics of the batches included on the data set.

Batch	N	Type of feeding
1	41	Only acorns during 6 months
2	36	Only acorns during 3 months
3	20	Only acorns during 1 months
4	11	Acorns plus medium levels of compound feedingstuffs during 6 months
5	13	Only compound feedingstuffs

NIR Analysis

Liquid fat samples were analysed by folded transmission in a Foss-NIRSystems 6500 monochromator equipped with a spinning module. It was used a ring cup with a pathlength of 0.1 mm (ref. IH-03459). A diffuse reflecting surface placed at the bottom of the cup reflects the radiation back through the sample to the reflectance detectors.⁸ Spectra were collected by repacking of two subsamples using the ISI NIRS 3 software ver. 3.11 (Infrasoft International, Port Matilda, PA, USA).^{8,9}

Data treatment

Classification models were developed by using NIR spectral data of 121 liquid fat samples of Iberian pigs.

Four multivariate pattern recognition methods, namely linear discriminant analysis (LDA), quadratic discriminant analysis (QDA), soft independent modelling of class analogy (SIMCA) and discriminant analysis based on PLS regression (PLS-DA), were considered in this study to classify Iberian pig carcasses according to the type of feeding.

LDA and QDA models were obtained by using SAS software ver. 6.12,¹⁰ SIMCA models were developed with Unscrambler ver. 5.5 multivariate program¹¹ and PLS-DA models were obtained by using WinISI software.¹² Cross validation method was selected to evaluate the different multivariate models developed. The statistic calculated to compare the performance of the different classification methods was the classification error or percentage of misclassified samples by the pattern recognition model.

Results and Discussion

Table 2 to 5 include a summary of the classification results developed by the different pattern recognition algorithms. These tables show the classification matrix obtained after the allocation of each sample into one of the considered batches by using the chemometric models generated. As can be seen, LDA (Table 2), SIMCA (Table 4) and PLS-DA models (Table 5) classify correctly all the samples (121 of 121) into its original batch (41 samples into batch 1, 36 into batch 2, 20 into batch 3, 11 into batch 4 and 13 samples into batch 5).

However, in the case of QDA models, four samples were misclassified: two samples of the batch 1 were classified as belonging to batch 2, one sample of batch 2 were assigned to batch 1 and one sample of the batch 4 were classified as belonging to the batch 1 (Table 3).

According to these results, the classification errors obtained on the LDA, SIMCA and PLS-DA models were 0,0 % while this statistic had a value of 3.3 % for the QDA model. The low classification errors obtained by the different pattern recognition models confirm the possibility to

discriminate Iberian pig carcasses from animals reared under different feeding regimes by using NIR spectral data.

Table 2. Classification results obtained by using LDA models.

		CLASSIFIED AS				
		Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
ORIGIN	Batch 1	41	-	-	-	-
	Batch 2	-	36	-	-	-
	Batch 3	-	-	20	-	-
	Batch 4	-	-	-	11	-
	Batch 5	-	-	-	-	13

Table 3. Classification results obtained by using QDA models.

		CLASSIFIED AS				
		Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
ORIGIN	Batch 1	39	2	-	-	-
	Batch 2	1	35	-	-	-
	Batch 3	-	-	20	-	-
	Batch 4	1	-	-	10	-
	Batch 5	-	-	-	-	13

Table 4. Classification results obtained by using SIMCA models.

		CLASSIFIED AS				
		Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
ORIGIN	Batch 1	41	-	-	-	-
	Batch 2	-	36	-	-	-
	Batch 3	-	-	20	-	-
	Batch 4	-	-	-	11	-
	Batch 5	-	-	-	-	13

Table 5. Classification results obtained by using PLS-DA models.

		CLASSIFIED AS				
		Batch 1	Batch 2	Batch 3	Batch 4	Batch 5
ORIGIN	Batch 1	41	-	-	-	-
	Batch 2	-	36	-	-	-
	Batch 3	-	-	20	-	-
	Batch 4	-	-	-	11	-
	Batch 5	-	-	-	-	13

Conclusions

The results show that rather different chemometric algorithms (SIMCA, LDA and PLS-DA) produce similar classification errors of Iberian pig carcasses according to the feeding regime.

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