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in

Audiot A. (ed.), Casabianca F. (ed.), Monin G. (ed.).
5. International Symposium on the Mediterranean Pig

Zaragoza : CIHEAM

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 76

2007

pages 225-227

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=800589>

To cite this article / Pour citer cet article

De Pedro E., Núñez N., García J., Aparicio D., Campos M.I., Pérez M.D., Fernández V.M., Garrido A.
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Implementing near infrared spectroscopy in the Iberian pork industry

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SUMMARY – The objective of this paper is to summarise the research and development strategy carried out, in close cooperation with the Iberian pork industry, for implementing Near Infrared Spectroscopy as an integral part of its quality control programs and/or traceability systems. NIRS data obtained from the adipose tissue of 224 animals, using a fiber optic probe, were used to develop calibration equations to predict the four main fatty acids (C16:0, C18:0, C18:1 and C18:2) in Iberian pig adipose tissue samples. According to the precision and accuracy obtained with these equations a methodology has been implemented, at an industry-wide level, for the payment of farmers, according to the three Iberian pork commercial categories ("bellota", "recebo" and "cebo").

Keywords: Iberian pork, fatty acids, NIRS, optic fiber.

RESUME – "Mise en place de la Spectroscopie dans le Proche Infrarouge dans l'industrie du porc Ibérique". Ce travail a pour objectif de résumer la recherche et la stratégie de développement réalisées en étroite collaboration avec l'industrie de la viande de porc ibérique, pour incorporer la Spectroscopie dans le Proche Infrarouge comme partie intégrante des programmes d'assurance qualité et(ou) des systèmes de traçabilité. Les données obtenues du tissu adipeux de 224 animaux, en utilisant une sonde à fibre optique, ont été utilisées pour développer des équations de calibration pour la prédiction des quatre acides gras principaux (C16:0, C18:0, C18:1 et C18:2) dans des échantillons de tissu adipeux de porc ibérique. D'après la précision et l'exactitude obtenues avec ces équations, la méthodologie a été mise en œuvre, au niveau industriel, pour le paiement aux producteurs selon les trois catégories commerciales de porc ibérique ("gland", "recebo" et "cebo").

Mots-clés : Porc Ibérique, acides gras, spectroscopie PIR, fibre optique.

Introduction

The Iberian pork industry has established quality control programmes to determine the type of food given to Iberian pigs, especially during the final growing period. These programmes include on-farm inspection and analysis of the fatty acids composition in subcutaneous fat.

Over the last years, the Official standard established by the National Government has included the percentage of the palmitic (C16:0), stearic (C18:0), oleic (C18:1) and linoleic (C18:2) acids in the liquid subcutaneous fat, determined by gas chromatography (GC), to classify Iberian pigs into the three commercial categories ("bellota", "recebo" and "cebo"). The high cost and time-consuming nature of farm recording and analysis of liquid subcutaneous fat by gas chromatography restricts the extension of these quality control programs to all of the animals produced. As a consequence, only a representative sample of a group of animals is analysed, sampling oscillates between 20% and 50% of the pigs in every group. Thus, the Iberian pork industry needs fast, accurate and low-cost methods for the quality control of the animals and their expensive luxury products.

Years of research conducted at the University of Cordoba (De Pedro *et al.*, 1992; Hervás *et al.*, 1994; De Pedro *et al.*, 1995; De Pedro *et al.*, 2001; García-Olmo, 2002; Garrido *et al.*, 2004) have clearly confirmed the potential of different NIRS analysis modes for the classification of carcasses into commercial categories according to the feeding regime. However, the successful implementation of NIRS in the Iberian pork industry is still pending joining research-industry efforts. Moreover, in order to facilitate the implementation of NIRS technology to quality control processes in the Iberian pork industries, it is important to develop and validate calibration models using different instruments, cups/cuvettes and fibre optic probes.

The objective of this paper is to summarise one methodology that has been developed, in close cooperation with the Iberian pork industry, for implementing NIRS as an integral part of its quality control programs and/or traceability systems.

Materials and methods

A total of 224 samples of subcutaneous fat from Iberian pigs belonging to SCA "Corsevilla" were used to implement Near Infrared Technology in the Iberian pork industry. NIR spectra from 400 to 2500 nm were obtained using a remote reflectance fibre optic probe to a Foss-NIRSystems 6500 monochromator. Spectra were collected by using WinISI software ver. 1.5 (Infrasoft International, Port Matilda, PA, USA).

Liquid fat samples were obtained after adipose tissue samples were fused by microwaves (De Pedro *et al.*, 1996). Each liquid fat sample was analysed by gas chromatography to determine the fatty acids content.

WinISI software ver. 1.50 (ISI, 2000) was used for the chemometric analysis of NIR data along with the methodology for the development and validation of NIR calibrations described by Mark and Workman (1991) and Shenk and Westerhaus (1995 and 1996). Statistics used to select the best NIR calibration equations were the standard error of cross validation (SECV) and coefficient of determination of cross validation (r^2).

Results

NIR calibration equations were obtained for the prediction of C16:0, C18:0, C18:1 and C18:2 in Iberian pig adipose tissue. Calibration equations were developed using NIR spectral data and the fatty acids composition of adipose tissue samples belonging to animals reared in the Iberian pork industry. The precision and accuracy of the equations were evaluated by the coefficient of determination (r^2) and standard errors of cross validation (SECV). Both statistics showed high precision and accuracy for the fatty acids studied, with R^2 values of 0.87, 0.78, 0.86 and 0.91, and SECV (%) values of 0.38, 0.36, 0.59 and 0.23, for C16:0, C18:0, C18:1 and C18:2, respectively.

According to the precision and accuracy obtained with these equations a methodology has been implemented, at an industry-wide level, for pay farmers according to the three Iberian pork commercial categories ("bellota", "recebo" and "cebo").

The methodology (Fig. 1) consists of sampling the adipose tissue of a carcass, which is then analysed at room temperature using a NIRS instrument attached with a fiber optic probe. Once the sample spectrum is obtained, NIR calibration equations are used to predict instantaneously the fatty acid content of the sample.

This methodology, based on NIRS equations, is already used to predict fatty acids composition, which is used to pay farmers according to the three commercial categories ("Bellota", "Recebo" and "Cebo").

Further R & D and implementation activities

Further R & D activities, in cooperation with the Iberian pork industry and Official Inspection bodies, is needed to develop quality assurance programs where NIRS plays a pivotal role controlling animals at a farm and industry-wide level. Portable NIRS instruments provided with different type of cuvettes and fibre optic probes should be evaluated.

Acknowledgments

This reserach has been funded by the Spanish Project INIA CAL 02-25 "Aseguramiento de la calidad y autenticación de canales de cerdo ibérico y productos derivados mediante espectroscopia NIR".

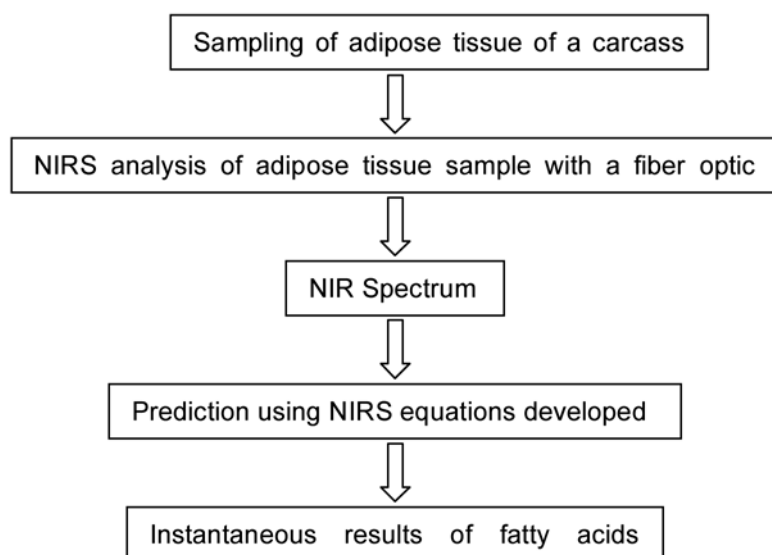


Fig. 1. Methodology to predict, using NIRS, the fatty acid content of Iberian pig carcasses at the slaughter house.

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