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Classification of Iberian pigs as to their nutrition through the ChemSensor technique

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Abstract. We have developed a classification method to discriminate the quality of Iberian pigs with different feeding patterns (*bellota*, *recebo*, *extensive* and *intensive* feeding) in view of the large price differences encountered in the market depending on availability of acorns diet or other type of food. We used the *ChemSensor* Technique which combines a gas chromatograph with a mass detector as well as a liquid autosampler and a headspace system. Our starting material consisted of 207 samples of back side bacon extracted from pigs previously fattened with different feeding systems and subsequently fatty acid and volatile compound analysis were performed. Up to 75% of the samples were analyzed in a first step obtaining a prediction model that applies to the remaining 25% of samples. A proper software adds mass abundances in the range of m/z scanned (41-550) for further analysis by a chemometric software (Pirouette, by Infometrix Inc.). The classification method used was established with SIMCA (Soft Independent Modelling Class Analogy). Our results indicate a satisfactory classification up to 96% and a prediction of ca. 90% in bellota-type pigs and in intensive type and somewhat lower in recebo and extensive types.

Keywords. ChemSensor – Rating Iberian pigs – Mass Spectrometry – Traceability.

Classification des porcs Ibériques selon leur nutrition grâce à la technique du ChemSensor

Résumé. *Nous avons développé une méthode de classification pour distinguer la qualité du porc Ibérique élevé selon différents modes d'alimentation (*bellota*,* recebo*,* extensif *et* intensif*) en raison de grandes différences de prix sur le marché en fonction du régime alimentaire ou d'un autre type d'alimentation. Nous avons utilisé la technique ChemSensor qui combine un chromatographe en phase gazeuse avec un détecteur de masse ainsi qu'un échantillonneur automatique liquide et un système d'espace-de-tête. Notre matériau de départ se composait de 207 échantillons de lard arrière extraits de porcs engraissés avec différents systèmes d'alimentation et ensuite les analyses des acides gras et des composés volatils ont été effectuées. Dans un premier temps jusqu'à 75% des échantillons ont été analysés, obtenant ainsi un modèle de prévision appliqué aux 25% restants des échantillons. Un software ajoute l'abondance de masse dans la gamme des m / z numérisés (41-550) pour une analyse plus approfondie par un software de chimiométrie (Pirouette, par Infometrix Inc.). La méthode de classification utilisée était SIMCA (Soft Independent Modelling Class Analogy). Nos résultats indiquent une classification satisfaisante jusqu'à 96% et une prévision de presque 90% chez les porcs de type Bellota et de type intensif et un peu plus faible pour les types Recebo et les modes extensifs.*

Mots-clés. *ChemSensor – Evaluation du porc Ibérique – Spectrométrie de masse – Traçabilité.*

I – Introduction

The extensive production systems are appreciated because of the valuable preservation of natural environments as well as the well spread reputation of the meat products obtained. Spain is characterized by having a perfect ecosystem for such production, the *dehesa*, with over a million and a half hectares of cork and oak trees that supply the necessary food for the Iberian pigs. Acorns constitute a unique raw material for the Iberian pork industry, providing high valued products, like ham, paleta and pork loin. However, there is a high differential cost between this grazing system and the intensive, massive systems used by the bulk of farmers, which affects not only the cost of the animals themselves but the price of manufactured products.

The Spanish government has established quality standards classifying pigs as *bellota*, *recebo*, *extensive* and *intensive* types, depending on the final fattening phase.

There have been developed several analytical methods to assess this type of classification, one of them is presented here as part of a research proyect supported by the Instituto Nacional de Investigaciones Agrarias y Agroalimentarias (INIA) using the Agilent ChemSensor technique.

II – Materials and methods

Analysis were performed using a 4440B ChemSensor (*Agilent Technologies*), which combines a gas chromatography-mass spectrometer (GC / MS) with a chemometric software developed by *Infometrix Inc*. The former consists of a 6890 GC with a DB.23 column (*Agilent*), a liquid autosampler for 100 samples (HP 7683) and a 5973N MS mass spectrometer with a 5973 quadrupole detector operating in electron impact mode and scanning of masses in the m / z 41 and 550 range.

The starting material was backfat taken from Iberian pigs proceeding from some farms and livestock farms in Extremadura, Andalusia and Salamanca. The animals were fattened according to the *bellota*, *recebo*, *extensive cebo* and *intensive cebo* diet patterns. The total number of tested samples was 207, mostly pure Iberian breed, with 160 kg average weight. All the samples were originally obtained from the subcutaneous rump fat according to the standards (*ASICI specification*). After fat extraction using microwave and methyl transesterification with KOH in methanol, fatty acid methyl esters were recovered and submitted to the ChemSensor 4440B analyzer obtaining an array of ion mass fragmentation in the range m / z 41 and 550.

The whole number of samples (207 in total) was split as follows. In a first step the procedure involved an initial determination of the classification and predictive mathematical model based on known samples (156 samples, 75% of total) and in a second step it took place the prediction test, using a random set of samples (51 samples, accounts for *ca*. 25%).

III – Results and discussion

The chemometric analysis was applied using chemometric software SIMCA (*Soft Independent Modelling Analogy Class*) of *Infometrix Inc*. The first set of samples (156) was classified according to this model into four groups (see Table 1) with distances between groups shown in Table 2. We applied the above mathematical modelisation on the 25% remaining samples, obtaining the prediction results shown in Table 3.

Table 1. Classification results

	Classified				
Samples	***Bellota***	***Recebo***	***Cebo ext.***	***Cebo int.***	**% success**
Bellota	53	0	0	0	100
Recebo	0	53	1	0	98.15
Cebo ext.	2	1	24	0	88.89
Cebo int.	0	0	0	22	100
Total	55	54	25	22	97.44

Table 2. SIMCA model relative distances

	Distance to			
	Bellota	***Recebo***	***Cebo ext.***	***Cebo int.***
Bellota	0	0.9673	0.6596	3.1937
Recebo	0.9673	0	0.8810	3.6142
Cebo ext.	0.6596	0.8810	0	3.3592
Cebo int.	3.1937	3.6142	3.3592	0

Table 3. SIMCA model predictions

Actual samples	**Prediction**				
	Bellota	***Recebo***	***Cebo extensive***	***Cebo intensive***	**% success**
Bellota	16	0	2	0	88.8
Recebo	1	13	1	1	81.2
Cebo ext.	2	5	2	0	22.2
Cebo int.	1	0	0	7	87.5

IV – Conclusions

The use of ChemSensor for classification purposes proves to be highly reliable in all types of samples, grouped in four classes (*bellota, recebo, cebo extensivo, cebo intensivo*) with an average selectivity greater than 97%.

With the classification model generated with *ChemSensor* some certain predictions have reached 90% reliability. That is the case of *bellota* and *cebo intensivo* types.

Predictions carried out for *recebo*-type animals provided a reliable 81% whereas the *cebo extensivo*-type forecast is only 22%. This one is explained on the basis of the small number of samples used: a single failure over a small set gives necessarily a low percentage.

Compared to other technologies ChemSensor shows a clear advantage in terms of reliability, because it is based on gas chromatography and mass determination, and thus provides up to 500 variables per sample which are easily treated with *Pirouette* chemometrics software. This guarantees a reproducible analysis.

In addition, this technique does not use sensors, which are subjected to a limited lasting or aging. Chemsensor is not affected by environmental humidity and temperature conditions, so results gain accuracy and reproducibility.

The analysis time of each sample is very short, and may use the fatty acids of the sample or volatile compounds directly.

As used for the classification of dead animals is also perfectly suited for the analysis of the derived products such as a ham or loin. This technique is also a valuable tool in traceability tasks in industry.

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