DISCRIMINATION OF BEEF *VS.* PORK MEAT AND SAMPLE PREPARATIONS BY AN ELECTRONIC NOSE (EN): PRELIMINARY STATIC AND DYNAMIC RESULTS

S. Barbera*[1], P. Cornale[1], G. Sala[2] and G. Masoero[2]

1. Dipartimento di Scienze Zootecniche, Università di Torino, via L. da Vinci 44, 10095 Grugliasco (TO), Italy salvatore.barbera@unito.it 2. C.R.A. - Istituto Sperimentale per la Zootecnia, via Pianezza 115, 10151 Torino, Italy

Keywords: electronic nose, beef, pork, partial least squares analysis, prediction

Introduction

Meat flavour is an aspect intrinsic to quality parameters. Electronic Nose (EN) devices are a promising family of instruments which operate rapidly and at low costs, both in qualitative mode, comparing patterns, and in quantitative mode by fitting specific volatile compounds. Several studies have shown the possibilities in the application of EN to meat products. Spanish researchers (Gonzales-Martin *et al.*, 2000; Otero *et al.*, 2003) attempted to classify special Iberian cured ham into very different commercial categories. Other researchers from Spain (Santos *et al.*, 2004) discriminated feeding regimen effects in pig meat and optimised some ripening time parameters and they also concluded that different types of Iberian ham can be discriminated and identified successfully by EN. The EN properties of raw meat materials were investigated by Hansen *et al.* (2005); they concluded that sensory quality of porcine meat loaf, based on measuring the volatiles in either the raw materials or the meat loaf produced from those raw material may be modelled in a predictive-causative multivariate analysis. The present work aims to preliminarily ascertain EN reliability in the investigation of the positive aspects of meat aromatic traits, induced by animals and technologies. Thus EN multichannel evaluation of samples of bovine and porcine meat, whole or minced, will be carried out when the examination occurs in static or dynamic modes. For the static mode, the raw and the cooked samples were utilised respectively, while in the dynamic mode gas flux from a furnace at 165°C was examined in continuous monitoring or in samples of air bags captured at 5 and 15 min.

Materials and Methods

Eight beef and 8 pork *Longissimus dorsi* muscle portions refrigerated at 4°C were used as the meat source. From each muscle a 1cm thick circular sample (steak, 5.5cm Ø) was obtained according to the MCS method proposed by Barbera (2006). A 1cm thick, hamburger sample (minced) weighing 30g was produced using minced meat of the same muscle. Cooking was performed at 165°C for 15 min in an electric forced-air convection oven. By forcing air into the oven, after passing through an active charcoal filter, regular cooking odour out flow was guaranteed to pass in the PEN 2 (AIRSENSE Analeptics GmbH, Hagenower, Germany) 10 metal oxide sensors (MOS) to carry out dynamic allotherm measurements. This instrument was utilised in the non-stop monitoring of volatile compounds of meat produced for 15 min cooking. The trial started performing a zero point trim to standardise the sensors conditions (oxidation-reduction). The continuous measurement included 120 second white reference (air in the bin), and 180 of raw sample aroma whiffing. Then the cooking trend was performed. The EN was connected to a spill duct of oven, thus in a same way a 120 second white reference of 165°C air of the oven and then 900 seconds of cooking sample aroma were carried out. After 1020 seconds, the cooked sample was taken into another smaller bin, where the trend of concentrate aroma after cooking was tested. At 420 and 720 seconds (5 and 10 minute of cooking) a Nalophan bag was connected with the inner oven and filled up with "cooking air". The bags were inflated under vacuum. The aim of this procedure was to try to understand if is possible to collect the aroma for subsequent or later analysis. The static isotherm, 100 sec long, EN analyses of bags were carried on within 6-15 hours directly by the EN aspirating for 90 sec at 400 ml/min flow. Two other static isotherm measurements of raw (70 sec) and cooked samples (150 sec) were, as previously reported, carried out under a glass bell (50 ml vol.) at 400 ml/min flow rate allowing input of pure filtered air. In all, 32 steak and minced samples were used. Chemometrics were performed by Modified Partial Least Squares method (ISI, 1994) using a cross-validation system to assess the optimal number of latent variables to be included in the equations. The design variables: Species (beef/pork) and preparation (steak/minced) were fitted to numbers (1/2). Binary discrimination between groups allowed one passage for elimination of few outliers (t>2; H>10) (Fearn, 1997). The points from sensors were adjacently vectored, then mathematically pre-treated as Standard Normal Deviate with Detrend and finally 1st derived and smoothed.

Results and Discussion

In the Table 1 the whole experiment is represented in term of R^2 values. In spite of the high values recovered in the calibration mode, the cross-validation process and the elimination of few outliers (on average 6% of the observations) resulted in some more reliable and robust causative models, thus special attention must be paid to the R^2_{cv} Coefficient. The Dynamic examination during the cooking process will account 81% of the variance observed in the cumulative MOS sensors due to the preparation of sample, because release of odour from the more homogeneous and aired minced samples was more linearly dependent on the raising of temperature during cooking (Cornale *et al.*, 2006) while only 23% occurred when species comparisons was attended. Better results for discrimination of beef vs pork meat by EN, than for the post-identification of sample preparation, emerged when EN examinations were carried out in Static mode. This was realised first in the pre-cooking raw muscle examination, R^2_{cv} 0.75 *vs.* 0.39 respectively; secondly the result was replicated when the examination was carried out immediately after the end of cooking on the warm meat (0.58 *vs.* 0.15). The examination of Nalophan bags did show significant differences between the two sampling points at 5 and 10 min (R^2_{cv} = 0.27) but when the data were pooled, the between species account of variability (0.48) was higher than those between preparations (0.37). The time delay between capture and examination of pure meat aroma may be not so critical for meat as it was for tobacco smoke, as investigated by van Harreveld (2003) who, in the frame of EN13725 "Air Quality-Determination of Odour Concentration by Dynamic Olfactometry" enhanced great decay of signals in bags after 12-30 hrs.

The discrimination of single specimens from beef or from pork pursued in this experiment represents only a preliminary challenge for the rapid analysis of studied factors in animal production experiment involving meat intrinsic quality. In this sense some R^2, in validation mode, of medium value (0.5-0.6) do not appear as accurate for individual prediction but it may be adequate for a preliminary and rapid evaluation of average effects. Partial Least Squares is a linear method and may not be so accurate as the non-linear one utilised by other researchers (Santos *et al.*, 2004) in the Iberian ham classification; however Neural Network Analysis becomes efficient in validation mode only with adequate and wide datasets. Finally, EN efficiency in the candidate meat products appears more suitable without sample heating: the freeze-drying process, which works with cold muscles, can capture volatile compounds and could be of major interest, but remains unexplored.

Table 1: Results of calibration and cross-validation chemometrics of the transformed olfactograms on the Species origin and on the sample Preparation.

Electronic Nose Analysis	Static Sample						Dynamic Sample	
	Raw		Cooked		Bags		Cooking	
Time measurement, sec	180		150		100		750	
R^2Coefficient	*RSQ*	R^2_{cv}	*RSQ*	R^2_{cv}	*RSQ*	R^2_{cv}	RSQ	R^2_{cv}
Species: Beef_1 vs Pork_2	*0.87*	0.75	*0.97*	0.58	*0.96*	0.48	*0.55*	0.23
Preparation: Steak_1 vs. Minced_2	*0.54*	0.39	*0.41*	0.15	*0.41*	0.37	*0.94*	0.81

Conclusions

The electronic nose was confirmed to be very useful in order to investigate global aroma characteristics in raw meat, and to a lesser extent in cooked meat or sampling gas in Nalophan bags. Dynamic monitoring of the cooking process in a wide oven appears not to be so reliable because it may interfere with sample preparation for cooking meat whole or ground.

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