Electronic Nose as a potential method for measuring flavour characteristics of Pork

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Keywords: Pork, diet, flavour, sensory quality, rapid method

Background: It is well known that both feed and sex affect the flavour characteristics of pork meat. In order to assure that meat has the pr quality characteristics, it is of interest to have a rapid method to assess the odour and flavour properties of pork meat. In this study an Electronic Nose (Gas Emission Analyser) was studied as a potential method to determine the sensory quality of pork meat.

Materials and Methods:.

The experiment was performed using samples from *M longissimus dorsi* from 17 porks (life weight 70.2 - 85 kg). The flavour characteristics of pork meat were varied by feeding animals with either traditional feed or by-products (recycled food materials), table 1. *M Longissimus Dorsi* was cut one day after slaughter and then frozen. The samples for the experiment were cut in frozen condition, each muscle in 2cm slices. The slices were then individually vacuum packaged in barrier bags and put back to the freezer at -20°C, for eight or fourteen months before analysis. At the time of analysis, samples were thawed at 4°C over night.

Table 1. Overview of samples

No	Feed and quality	Months in freezer	Slaught-ery	No	Feed and quality	Months in freezer	Slaught-ery
1	Concentrates, low	8	2	10	Extra input of vit.E	14	2
2	Concentrates, low	8	3	11	Extra input of vit.E	14	2
3	Concentrates, medium	8	4	12	Concentrates, normal	14	3
4	Concentrates, medium	8	2	13	Concentrates, normal	14	3
5	By-products, low	8	1	14	By-products, normal	14	3
6	By-products, normal	8	3	15	By-products, low	14	1
7	By-products, low	8	1	16	By-products, low	14	1
8	By-products, low	8	1	17	Concentrates, medium	14	3
9	By-products, low	8	1				

Sensory analysis

Sample preparation for sensory analysis: After thawing, the samples were prepared in a 80°C waterbath for 1 hour, still in the original vacu packed condition. Core temperature after heat treatment was 75°C; this was reduced to 60°C during sensory assessment. Four pork chops we taken from each animal for sensory analysis. Samples were served in sessions of 5-6 samples and complete randomised within each session. Descriptive sensory profiling was performed by a panel consisting of 7 trained assessors. Test attributes were evaluated for a cross section of pork chop sample (fat and muscle together). Humans olfactory organ is described in figure 1.

The attributes describing deviating smell and taste were evaluated as being different from reference sample. All attributes are described in table The samples were evaluated on a 15 cm non-structured scale going from low to high in intensity of the respective attribute. The results were recorded directly on a computerised system in the booths (CSA, Compusense, Canada). After assessments the results were transferred to numericals on a scale from 1 to 9 according to their intensity.

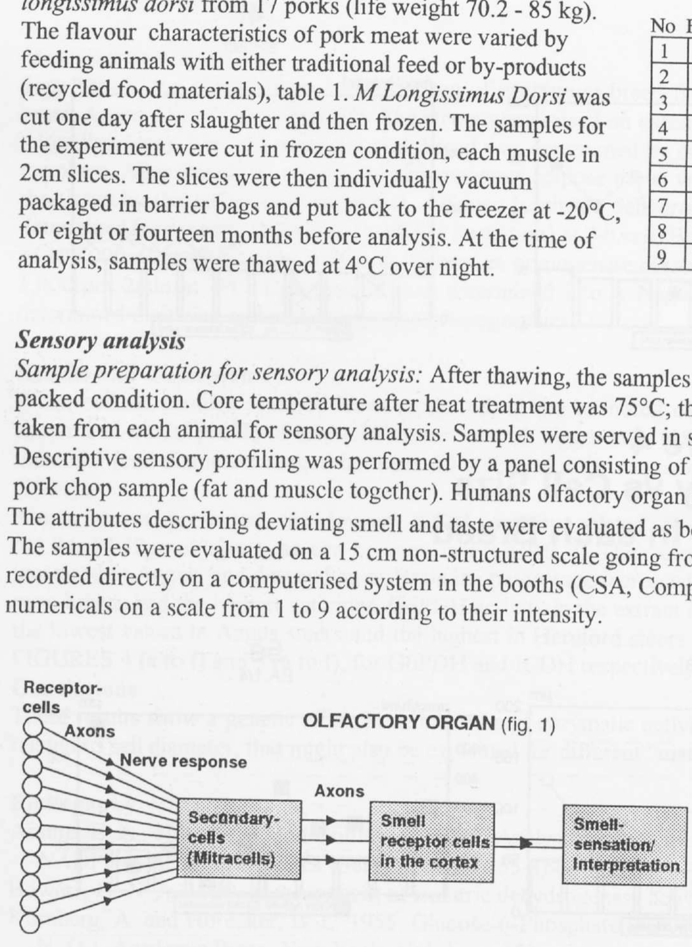
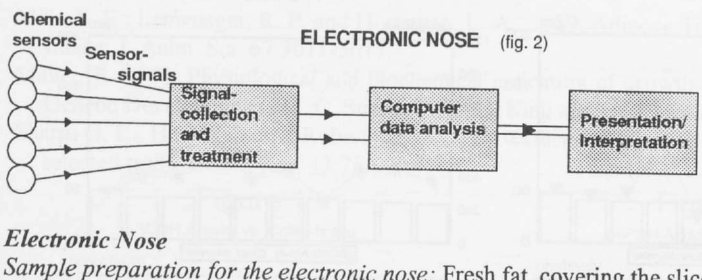


Table 2. Sensory attributes

1) Odour intensity	5) Rancid odour	9) Maturity flavour	13) Fatnes
2) Acidic odour	6) Off-odour	10) Meat flavour	14) Hard
3) Maturity odour	7) Flavour intensity	11) Rancid flavour	15) Tend
4) Odour of meat	8) Acidic flavour	12) Off-flavour	16) Juicin



The Electronic Nose, figure 2 (Nordic Sensor Technology, NSL, Lindköping, Sweden),consists of a gas sensor array using ten me oxide-semiconductor field effect transistors with gates of catalytic active metals (MOSFET sensors), and four commercially available chemical sensors based on tin dioxide (Taguchi sensors).

Electronic Nose

Sample preparation for the electronic nose: Fresh fat, covering the slices of meat, were cut off. For the electronic nose, we chose analysing the fat, as it is well known that a lot of the flavour and odour components are presented in the fat. The samples, 10 g of fat from each sample, were placed in 250 ml Erlenmeyer bottles, which were sealed-off by use of polyethylene foil, and placed in the refrigerator (4°C), until room conditioning (20°C) the last 30 minutes before analysing.

Measurement procedure:
Gas samples were pumped from the Erlenmeyer bottles by a membrane pump and injected to the sensor chamber. Each sample had a sampling period for 180 sec. (air baseline, 20 sec; sampling, 30 sec; air recovery 130 sec). The average number of replicates were 9 per sample. After analysing all parallels from one sample, an air sample was measured. This study is based on using normalized responses from the sensors.

Results and discussion

The PCA and PLS regression were validated by cross-validation; the UNSCRAMBLER program was used (CAMO A/S Trondheim, Norway). By using normalized responses and removing two outliers we found good correlation between the electronic nose and the sensory variables as described in table 3.

Table 3. Correlation between sensory variables and the electronic nose

Sensory variable	Variable no.	Correlation	Sensory variable	Variable no.	Correlation
Odour intensity	1	0.7	Flavour intensity	7	0.7
Acidic odour	2	0.6	Meat flavour	10	0.7
Rancid flavour	5	0.8	Rancid flavour	11	0.8
Off-flavour	6	0.6	Off-flavour	12	0.7

Classification by neural network crossvalidation
A crossvalidation technique and a backpropagation network (Kvaal et al, 1994) was used to monitor how well each sample could be classified according to the animal feed during growth. Each sample was taken out of the main sample population and used as test set with the other samples as calibration set. In this way one would get an indication how well each sample could be classified. The classes was the 5 different feeds (table 4). Principal component scores of the sensor responses is performing better than using the raw data as input to the network. Therefor the network inputs are the first five principal component scores of the sensor responses. There are 5 hidden nodes and 5 outputs. The number of principal components to be used is found by an optimation technique described in Kvaal et al, 1996. The neural network learning rule of delta-bar-delta was used. The training was stopped when the optimal model was achieved. Each output was constructed as a binary representation of food class. The prediction of a class is given by the winner output node (figure 3).

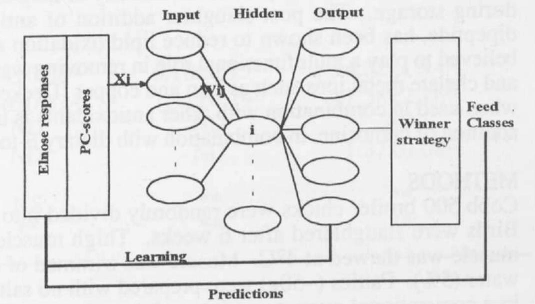


Figure 3. The neural network used as a classifier. The inputs are principal component scores of the responses from the electronic nose. The outputs are the different classes binarised. The winner predicted is the actual class.

The result of feed classification is shown in table 5. It shows that 88.2 % of the samples were correctly classified by this crossvalidation technique. It was possible to separate pork fed by by-products from pork fed by concentrates. The result also indicates that the electronic nose combined with a neural network classification technique will possibly tell what kind of food the animals got during growth.

Table 4. The feed classes to be translated

Feed class	Feed and quality
1	Concentrates, high
2	Concentrates, medium
3	Concentrates, low
4	By-products, medium
5	By-products, low
6	Extra input of vit.E

Table 5. The classification of animal feed during growth.

Object No	Class	Predicted Class	Ok
1	1	1	x
2	1	1	x
3	2	1	
4	3	3	x
5	5	5	x
6	5	5	x
7	3	3	x
8	4	3	-
9	2	2	x
10	1	1	x
11	3	3	x
12	3	3	x
13	1	1	x
14	1	1	x
15	4	4	x
16	4	4	x
17	3	3	x

Conclusions

The electronic nose, combined with partial least squares (PLS) and neural network modelling seems to be a powerful, rapid method to identify odour and flavour characteristics of pork meat.

Acknowledgements

The authors appreciates the valuable discussions from J.-E. Haugen and G. Vogt.

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