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COMPARATIVE STUDY OF COMMERCIAL COLD-CUTS USED NIRS AND SENSORY ANALYSIS

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ABSTRACT

In the everyday diet cold-cut meat products are important food products, thus a comparative study of those with consumer perception and instrumental techniques were undertaken. Five different „Párizsi" (Lyoner) samples were compared with full aroma profile analysis and near infrared spectroscopy. Moreover, the OptiProbe fiber optic and the conventionally used Sample Transport Module (STM, Foss Tecator, Sweden) were as well compared on the meat products, from the aspect of applicability. The results provided 76.3% and 49.1% successful classification results during the calibration and cross-validation. The brand of the different samples could be only less accurately determined with the sensory analysis. The basis of this bias was the exchange of two samples falling very close to each other in the sensorial characteristics (samples 2 and 3). The classification based on NIR spectra was more powerful. The OptiProbe unit applied the wavelength range of 650–1850 nm successfully. The principal component analysis (94%) and the discriminant analysis (cross-validation = 98%) provided reliable results only with the STM unit. In contrast, the NIR spectrum results gained with the OptiProbe unit was markedly weaker (PLSDA cross validation = 71%).

Keywords: meat products / cold cut / NIR / sensory analysis

1 INTRODUCTION

Healthy nutrition is a spreading trend throughout the world with high stress burden. Due to the improvement of the nutritional science and the health-sound behaviour of consumers food products and in particular heat-treated meat products are sensorial and chemically characterized (Pénzes, 2008). Sensory properties of products are of primary importance from the aspect of consumer perception of cold-cuts (Delahunty *et al.*, 1998). Properly chosen sensory studies can answer important questions during the evolvement of a defined product, help to elucidate production faults, to monitor the quality and may help to compare production lots or differently developed products as well (Sidel and Stone, 1993). Besides this, quick analytical methods for the description of chemical composition are needed as well. Such a method is near infrared spectroscopy, used more and more widely in the food industry (Wang and Paliwal, 2007). This methodology requires minimal sample preparation and gives multitude information (chemical and physical properties) from a single spectrum, and is useful for quantitative (chemical composition) and qualitative (e.g. differentiation among types or sorts) analysis. Quantitative analysis requires reference results (determined e.g. with conventional chemical analysis), and after calibration, which describes the relationship between measured and spectral data, further estimations are possible, also for samples not analyzed with the reference method (Bázár and Romvári, 2009). Rich literature is available on both quantitative and qualitative approaches for meat products (Wang and Paliwal, 2007). Bázár (2011) evaluated NIR technique from both aspects, based on the investigation of pork and meat products. It was found that NIR spectroscopy is applicable for the classification of pork according to genotype, meanwhile the chemical composition is also predictable. This study aimed to classify commercial cold-cut sorts (Lyoner sam-

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ples of different quality and price), based on sensory tests and NIR spectroscopy.

2 MATERIALS AND METHODS

2.1 MATERIALS

In local groceries commercial Lyoner samples were purchased: 5 sorts (1–5), 4 individual, parallel samples. Samples of different price and quality were chosen. Package declared compositional information on chemical composition and ingredients was available. Prices are given in Table 1.

Table 1: *Prices of different Lyoners*

Sample code	Price HUF/kg
1	1188 (ca. 4 Euro/kg)
2	941 (ca. 3 Euro/kg)
3	941
4	710 (ca. 2.5 Euro/kg)
5	1878 (ca. 6 Euro /kg)

2.2 SENSORY ANALYSIS

Full profile analysis was performed according to the Hungarian Standard (MSZ ISO 6564:2001), involving 13 university students and teachers. All panellists analyzed all samples using a questionnaire, on which quality traits were differentiated (free marking possibility) on a 10 cm long, unstructured scale. Questionnaires were evaluated with SPSS 10.0. for Windows and PanelCheck V.1.3.2. Statistical softwares using Principal Component Analysis (PCA) on different types of consensus (averages across assessors and replicates).

2.3 NIR MEASUREMENT

The NIR reflectance spectra of the samples were recorded with FOSS NIRSystems 6500 spectrometer equipped with regular Sample Transport Module (STM) and OptiProbe fiber optic module. Each single sample was scanned five times with the OptiProbe, when the head of the probe was laid on the surface of the freshly cut samples. When STM was used, samples were put into small ring cups. WinISI II v1.5 spectral analytical software was applied for operation of the spectrometer and data analyses. The quantitative analysis of the collected data was done with Partial Least Squares (PLS) regression based on Global method. Principal Component Analysis (PCA) and PLS based discriminant analysis (PLSDA) were used for qualitative measurements. Second derivative spectra were taken for quantitative, while first derivatives were used for qualitative processes.

3 RESULTS AND DISCUSSION

3.1 SENSORY ANALYSIS

Among the sensory traits of the Lyoner samples, significant differences were found. One of the problematic points during statistical evaluation is the subjectivity of panellists. A basic point is the filtering of the evaluators giving inconsistent responses. According to the results of PanelCheck V.1.3.2. two panellist were excluded and thus no significant panellist-effect was found in the model for any of the traits analyzed. In contrast, the effect of prod-

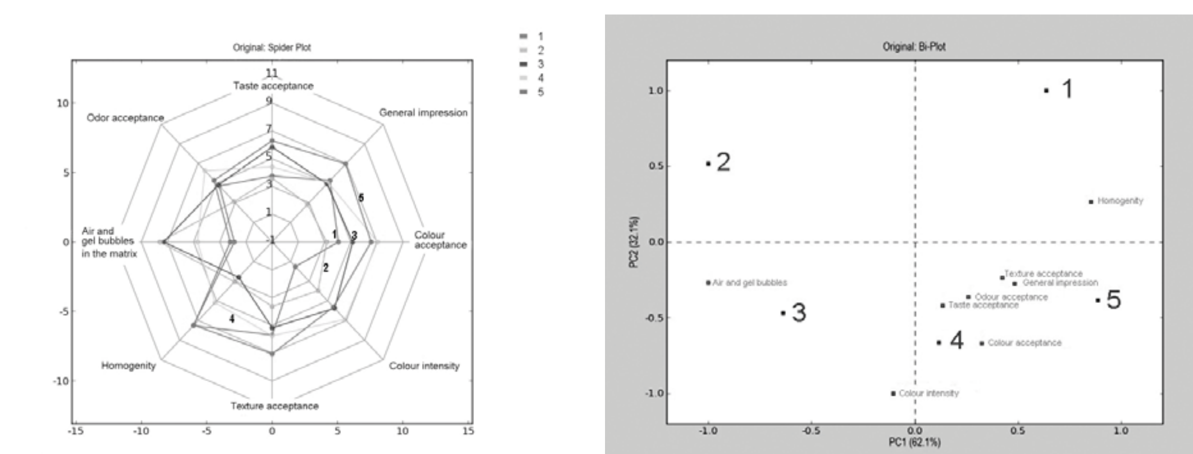

Figure 1: *Profile and bi-plot depiction of the results gained from the panel evaluation of the pork Lyoner sample groups (n = 5)*

Table 2: *Successfully classified Lyoner samples (%) in the groups during calibration and cross-validation*

	Group	1	2	3	4	5
Calibration	1	81,8	0	0	0	18,2
	2	9,1	63,6	9,1	18,2	0
	3	0	9,1	81,8	0	9,1
	4	0	9,1	9,1	81,8	0
	5	18,2	0	0	9,1	72,7
Cross-validation	1	72,7	9,1	9,1	0	9,1
	2	9,1	36,4	36,4	9,1	9,1
	3	9,1	36,4	36,4	9,1	9,1
	4	9,1	9,1	18,2	45,5	18,2
	5	18,2	0	9,1	18,2	54,5

uct sort was significant for the following characteristics: air bubble in the matrix, gel bubble in the matrix, homogeneity, colour intensity, taste, odour and texture acceptance ($P < 0.001$), and general impression ($P < 0.05$). Makała *et al.* (2006) published a similar experiment about Mortadella from Poland and Italy. They examined the texture, the taste, the odour and the difference was attributed to manufacturing and type and the level of the employed functional additives. In our experiment there was no significant difference in the following traits: character of taste, spiciness, character of odour and texture elasticity. In the frame of the further analysis only those traits were involved which were significantly affected by the product sort. The sensorial evaluation was based on the cumulative score given by the panellists, the so-called consensus value. A profile-graph (Fig. 1) was used to depict the mean scores for the traits sub-divided to product sorts. The intensity of a given trait means higher mean scores. Figure 1 indicates large inter-sample differences in most of the traits analyzed. Figure 1 is a bi-plot depiction of the studied groups. The figure is based on the principal component analysis of the mean scores for the different characteristics. It is clearly visible that the 5 sample groups were reliably differentiated by the panellists. Based on the quality characteristics and the relative distance of the samples different samples are sensitively differentiated. Samples 4 and 5 are preferred by most of the panellists based on the majority of the quality traits. By samples 2 and 3 evaluators described air sacs and gel bubbles, while these samples were described with low or poor homogeneity. Based on the panel test results of the different sample-groups, discriminant analysis was applied to discriminate them. In addition, discrimination equation was tested for applicability in classifying Lyoner sorts based merely on the sensory traits. The discriminant analysis, as based on the panel test is shown in Table 2, providing results on the calibration and cross-validation of the 5 sample groups as analyzed by 11 panellists. 76.3% of the samples were successfully classified and the cross-validation gave a 49.1% result. Latter data refers to relatively low classification reliability when grouping the unknown samples merely based on their sensorial test results. The misclassification was mostly attributed to Lyoner samples 2 and 3, falling relatively close to each other in their sensorial characteristics.

3.2 NIRS MEASUREMENT

The diffuse reflectance NIR spectra recorded with two different modes (STM and OptiProbe) were analyzed. Figure 2 shows the considerable noise appeared in the region above 1900 nm of the spectra recorded with OptiProbe. The noise is amplified during derivation mostly when gap and smooth values are low. Thus, fourth derivatives were investigated to detect regions loaded with remarkable noise. These areas can be seen in Fig. 3. Spectra recorded with STM and small ring cup also contain detectable noise, but the level of that is much lower than that of spectra recorded with OptiProbe. The difference appears in the order of magnitude of noise spectra,

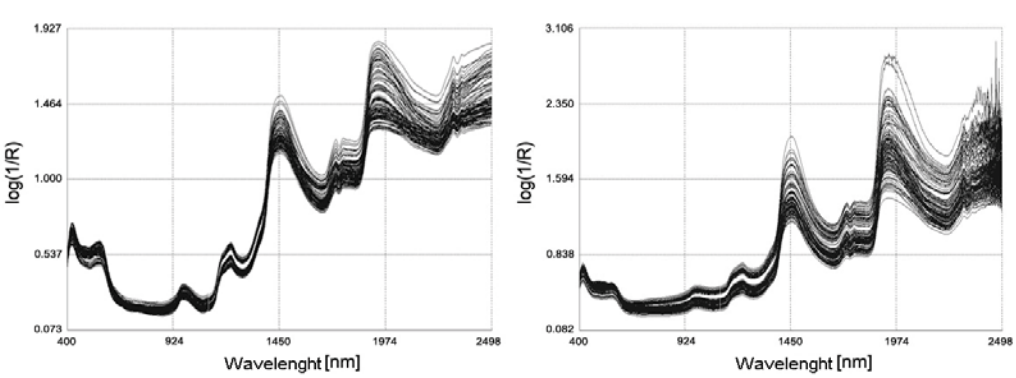

Figure 2: *The diffuse reflectance NIR spectra of the Lyoner samples investigated with (a) STM and (b) OptiProbe*

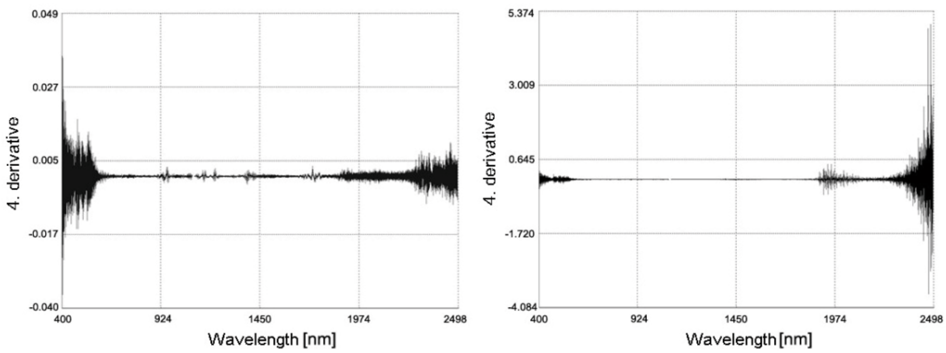

Figure 3: *The fourth derivatives of diffuse reflectance NIR spectra of the Lyoner samples investigated with (a) STM and (b) OptiProbe*

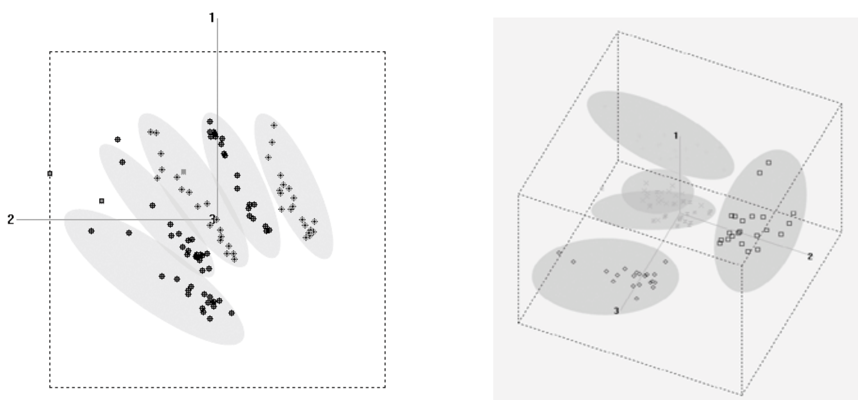

Figure 4: *Classification results of (a) PCA and (b) PLSDA based on NIR data of Lyoners recorded with NIR-sample transport module*

i.e. OptiProbe noise spectra have 100 times higher values compared with STM. In case of spectra obtained with using OptiProbe, the wavelength region of 650–1850 nm is applicable for further analyses. Accordingly, only this region was used in the further data analyses of spectra recorded with fiber optic probe.

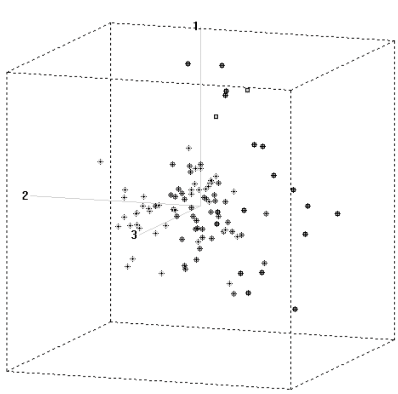

Figure 5: *Classification results of PCA based on NIR data of Lyoners recorded with OptiProbe*

Chemometric classification methods were used during the qualitative data analyses in order to describe differences between the groups. The result of PCA is shown in Fig. 4, where NIR spectra recorded with STM applied. The groups of the five Lyoner samples appear separately in the plane of the 1st and 2nd principal component (PC). These two PCs describe 94% of the total variance. The identical groups follow each other in the following row (clockwise): 5, 4, 3, 2, 1. Discriminant analysis (PLSDA) based on STM dataset was also successful. A discriminant equation was generated which gave 98% hit-rate during cross-validation. Incorrect classification was registered in case of group 5 where two samples were identified as members of group 4. Products of these two groups originated from one producer, however, represented a different price/quality level. The result is shown in graph of Fig. 4.

Results obtained with spectra, recorded with OptiProbe analyzer (650–1850 nm) were less successful. Figure 5 shows the result of PCA. The identical groups can be recognized but they are not separated within the 3D space described by the first three PCs. Based on these data, PLSDA gave also inadequate result. The ratio of correctly classified samples was 71% during cross-validation. 65% of products of group 1 were identified incorrectly. Gracía-Rey *et al.* (2005) published better results about dry-cured ham using fiber optic probe. They used K nearest neighbours' method to classify colour and texture parameters. Percentages of total correctly classified were 88.5% (texture) and 79.7% (colour).

4 CONCLUSION

Based on the human panel test results it was found that cold-cut sorts of lower quality and price provide compromised homogeneity. In connection with this, panellist found air sacs and gel bubbles in these samples. The preference was markedly higher by samples of higher price-niveau, mostly attributed to the "overall impression" and "preference" characteristics. As compared to the discriminant factor analysis based on the sensory panel test the NIR based classification was more successful. Latter method can be adapted to industrial processes even in an on-line manner, and provides a low-cost analytical possibility by high sample numbers. In addition, it may as well be useful for the estimation of chemical composition (moisture, fat etc. content).

5 ACKNOWLEDGEMENT

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