Near infrared reflectance spectroscopic determination of water, protein and fat in pork liver

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Introduction

As a molecular spectroscopic method, near infrared (NIR) spectroscopy is used mostly to determine the main constituents, i.e. water, protein, carbohydrates and fat, of food products.[1] Liver composition (nutritional quality) and sensory quality are the parameters that have an important influence on consumer preference.[2] Wet chemical analysis of pork liver is time-consuming, polluting and costly. NIR spectroscopy does not have these disadvantages and has been shown to be suitable for meat analysis.[3–7] The aim of this study was to obtain an NIR spectroscopic calibration for the determination of water, protein and fat in fresh pork liver samples.

Materials and methods

Six hours' post mortem fresh slices of pork liver were obtained from the carcasses of the various experimental groups of pigs. The samples of pork liver were cut and homogenised with a rotating knife homogeniser Moulinette S (Moulinex SA, France) prior to NIR spectroscopic and chemical analysis. Each analysis was performed after the temperature of the sample had reached room temperature (20°C).

Water was determined by drying at 103°C for 12 h, after homogenising about 5 g pork liver with sand and ethanol and pre-drying on a water bath. The dried residue was further used for determination of fat by extraction with petroleum ether in a Soxhlet apparatus. Protein was determined by the Kjeldahl method (% N * 6.25). Determinations were in duplicate and the results were expressed as a percentage of the weight of fresh pork liver.

NIR measurements were made in an open sample cup facilitating the levelling of the surface with filling-knife using a Bran+Luebbe InfraAlyzer 500. Spectra of fresh pork liver samples, equilibrated at room temperature (20°C), were taken on the same day as the chemical analysis.

The NIR reflectance spectra (1100–2500 nm) were measured at 2 nm intervals. Each sample was measured in three replicates (turning the sample cup to three different positions before scanning) and the mean of the replicate spectra obtained (log 1/*R*) was used in the calibration and prediction. The process of calibration was performed with SESAME software (Bran+Luebbe GmbH) on a 486DX2/66 computer. The averaged spectra of the total set of samples (n = 76) were used for calibration. Multiple linear regression (MLR) equations of raw data (log 1/*R*) were evaluated on 21 separate samples of pork liver by simple linear regression analysis of predicted versus chemical values.

Table 1. Chemical composition (% of fresh matter) of the pork liver samples for the calibration and prediction sets.

	Calibration (n = 76)			Prediction (n = 21)		
Constituent	Mean	*SD*	Range	Mean	*SD*	Range
Water	71.20	0.99	69.04–74.26	70.87	1.18	69.32–73.54
Protein	20.99	0.98	18.88 –23.88	20.91	0.94	18.67–22.50
Fat	0.68	0.18	0.26–1.30	0.59	0.17	0.32–0.91

Results and discussion

In Table 1, the chemical composition of the pork liver samples is summarised. All three constituents of the pork liver samples studied showed a very narrow range. The calibration and prediction sets covered similar ranges for each constituent. The best equation for each constituent was chosen by the optimal combination of the statistics parameters from the equation development: high *R* (multiple correlation coefficient), low *SEC* (standard error of calibration) and high *F*-values in the calibration set. The accuracy of the equations in prediction was expressed as high *r* (simple correlation coefficient), low *SEP* (standard error of prediction) and low bias.

The calibrations used in practice for the pork liver samples were obtained using five terms for each constituent. The results of statistical characteristics of the calibrations are shown in Table 2.

Conclusions

Results of this investigation indicate that the main constituents of fresh pork liver can be determined accurately and rapidly by NIR spectroscopic measurements. In the laboratory of the Central Station of Fodder Evaluation the above calibrations for on-line prediction of the pork liver composition are currently in use. Considering laboratory precision, NIR prediction was good for water and fat and somewhat less so for protein. The use of these calibrations has produced significant savings in energy consumption, chemical analyses and costs.

Table 2. Statistical characteristics of the calibrations.

Constituent		Water	Protein	Fat
Wavelengths selected (nm)		1660, 1744, 1856, 1968, 2080	1156, 1184, 1198, 1604, 1772	1198, 1212, 1268, 1296, 1324
Calibration	*R*	0.917	0.897	0.907
	SEC (%)	0.39	0.57	0.08
Prediction	*r*	0.910	0.830	0.904
	SEP (%)	0.40	0.63	0.10
	Bias (%)	0.03	–0.03	0.01

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