Determination of crude fat in animal feces—monitoring with near infrared spectroscopy in zootechnical experiments

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Introduction

Near infrared (NIR) reflectance spectroscopy is highly sensitive analytical method that has been used to predict variation in chemical composition of biological samples.[1] Estimates of animal intake and potential weight gain can be made from the content of nutrients of feeds, such as fiber and crude protein, and from *in vitro* and *in vivo* digestibility data, all predicted by NIR spectroscopy.[2–4] The purpose of this work was to obtain NIR calibration equations for the determination of the crude fat contents in animal feces samples. An additional objective of this research was to determine if a general NIR equation, containing samples representing fatteners and sow feces, could be used to predict the crude fat contents of a specific group of feces samples, to the same degree as an equation developed from that specific group.

Materials and methods

The independent feeding experiments have been conducted with 120 fatteners and 90 sows. These pigs have received feed mixtures with different levels of crude fat—fatteners (2.6–6.8%) and sows (2.1–2.9%). The samples of collected feces (considered to represent the undigested forage feed during the five day collection period) were dried in a drying oven at 60°C for 72 hours. The samples were ground using a laboratory centrifugal mill ZM1 (Retsch GmbH, Haan, Germany) with 1.0 mm sieve and analyzed for crude fat content by the classical Soxhlet's method—six hours extraction with petroleum ether.

Sets of 82 samples (for fatteners) and 58 samples (for sows) of feces with determined content of crude fat (% in dry matter) were selected for calibration with an InfraAlyzer 500 (Bran+Luebbe GmbH, Norderstedt, Germany). Selection was modified to ensure coverage of the full range of observed content of crude fat.

Near infrared reflectance measurements were carried out in the wavelength range of 1100–2500 nm in steps of 2 nm. Because of the heterogeneous nature of the material, each sample was measured in three replicates and the mean of the replicate spectra obtained (log 1/Reflectance) was used in the calibration. The process of calibration was performed by using an IDAS (InfraAlyzer Data Analysis Software, Bran+Luebbe GmbH, Norderstedt, Germany) on an interfaced PC 486DX2/66 computer. Calibration development was performed using the all-possible-combinations wavelength search routine from three to five wavelengths. The multiple linear regression (MLR) method was used to find the best multiple–regression equations of raw data (log1/*R*) fit. Evaluation of the obtained calibrations was performed on 38 (for fatteners) and 32

Table 1. Statistical data of the Soxhlet method for determined crude fat contents of the feces samples (% in dry matter).

	Calibration					Prediction				
Set	*n*	Mean	Min.	Max.	Std. dev.	*n*	Mean	Min.	Max.	Std. Dev.
Fatteners (I)	82	6.14	3.46	14.78	2.61	38	5.84	3.11	12.97	2.89
Sows (II)	58	2.08	1.36	3.04	0.44	32	1.97	1.40	2.93	0.39
General (I) + (II)	140	4.11	1.36	14.78	2.89					

(for sows) remaining samples of the feces by simple linear regression analysis of predicted versus observed crude fat data.

Results and discussion

Table 1 shows maximum and minimum values of the crude fat content resulting from the analysis of the feces samples used for calibration and prediction.

Successful NIR equations were developed from individual research experiments, fatterners (I) and sows (II), that accurately predicted the crude fat content in animal feces (Table 2). Table 2 shows the statistics and wavelengths chosen by the MLR method.

When the general (I + II) NIR equation (Table 2) was used to predict the crude fat content of samples from the prediction groups, fatterners (I) and sows (II), *SEP* values changed from 0.60 to 0.67% and from 0.21 to 0.25%, respectively. General (I + II) NIRS equations predicted the crude fat content of specific groups of samples with the same degree of accuracy as did NIR equations developed from specific sample groups.

Table 2. Statistics for calibration and prediction and wavelengths chosen by MLR method.

	Calibration		Prediction		Wavelength (nm)
Set	*R*	*SEC* (%)	*r*	*SEP* (%)	
Fatteners (I)	0.988	0.51	0.926	0.60	1576, 1702, 1744, 1758
Sows (II)	0.945	0.16	0.914	0.21	1996, 2038, 2234, 2262, 2332
General (I) + (II)	0.981	0.43	For fatteners prediction set		1716, 1744, 2150, 2262
			0.919	0.67	
			For sows prediction set		
			0.907	0.25	

Conclusions

The NIR equations generated in this experiment have given accurate predictions of the crude fat content in the animal feces. These results, compared with the reference method, indicate that NIR spectroscopy has a useful role in the measurement of crude fat content in zootechnical experiments. Whether the equations generated by this experiment are valid for other studies is unknown.

Acknowledgments

H.W.C.M. would like to thank the ICNIRS and Bran+Luebbe (Norderstedt) for financial assistance to attend NIR–95 in Canada.

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