Using of LOCAL calibration for predicting feed value of fresh forages from faeces samples

Donato Andueza, Fabienne Picard, Jean Marie Ballet, Michel Jestin, René Baumont

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D. Andueza*, F. Picard, J.M. Ballet, M. Jestin and R. Baumont
INRA, UR1213 Herbivores, Site de Theix, F-63122 St Genès-Champanelle, E-mail: donato.andueza@clermont.inra.fr

Introduction
The prediction of forages feed value is important to estimate the ruminant performances. Near infrared reflectance spectroscopy (NIRS) has been used to predict the *in vivo* digestibility (OMD) and voluntary intake (VI) of forages using both, forages and faeces samples. Prediction models are usually built using multiple linear regression (MLR), principal component regression (PCR) or partial least square (PLS) regression techniques. Because of the large variability of fresh forage population and source, LOCAL calibration could be well adapted for their application to the prediction of forages feed value. The aim of this communication is to evaluate the potential of NIRS to predict, the feed value of fresh forages using the LOCAL algorithm on faeces samples.

Materials and Methods
A total of 1220 faeces samples of different species; rye-grass (*Lolium perenne)*, italian rye-grass (*Lolium multiflorum)*, cocksfoot (*Dactylis glomerata)*, tall fescue (*Festuca arundinacea)*, timothy (*Phleum pratense)*, soft brome (*Bromus mollis)*, lucerne (*Medicago sativa)*, red clover *(Trifolium pratense)* rye-grass + white clover (*Trifolium repens*) and permanent grassland were used. Forages samples come from digestibility and intake measurements available at INRA Clermont-Ferrand/Theix which has been largely contributed to develop the tables of nutritive value of feeds (Andrieu *et al.*, 1989).
Samples were oven-dried at 80° C for 48 h to determine dry matter (DM) and then ground through a 0.8 mm screen. They were stored at environmental laboratory conditions.
The determination of OMD and VI were determined for each forage sample on 6 sheep wethers, according to Demarquilly *et al*., (1995). From a digestibility trial a faeces sample was constituted by weighting a subsample of faeces of each animal taken daily. In each digestibility trial, forages were offered *ad libitum* to measure OMD and VI at the same time. A refusal of 10 percent of the offered quantity was allowed. Forages were offered chopped at a length of 5-7 cm twice a day, at 0800 h and 1600 h. During the experimental period, animals had free access to water and vitamin-mineral blocks.
After samples homogenization, forages were placed in a 50 mm diameter ring cup and scanned in reflectance mode at 2 nm intervals from 400 to 2500 nm using a Foss NIRSystems model 6500 scanning VIS/NIR spectrometer (Foss NIRSystems, Silver Spring, MD, USA). Spectra and reference values were recorded with the NIRS3 software (Infrasoft International, South Atherton St. State College, PA 16801 USA). Each spectrum was time averaged from 32 scans. A reference scan (using the internal ceramic reference tile) was performed before and after each sample The reflectance (R) values were converted into absorbance (*A*) values using the formula A=log (1/R).
Calibrations were developed with WinISI III version 1.60 software (Infrasoft International, South Atherton St. State College, PA 16801 USA). The samples were randomly divided into calibration (n=1085) and validation (n=135) sets accordingly to the number of samples of each population samples. The LOCAL approach was used. Different models were obtained for each sample according to different options in order to find the optimised models (Shenk *et al*., 1997). The options included: number of samples used; 40-200 steps of 40, number of PLS factors used; 10-40 step 5 and number of PLS factors removed 1-10 step 1. The best setting of each determination was retained and it was then used to predict the validation set. All models were performed using NIR wavelengths (700-2500 nm) on first derivative transformation of the spectral data and a scatter correction pre-treatment; standard normal variate and detrend (SNVD) (Barnes *et al*., 1989). Validation performance for each model was assessed by the coefficient of determination of external validation (R^2V), by the standard error of prediction (SEP), by the bias and by the residual predictive deviation (RPD) which is defined as the ratio SEP to the SD of calibration set.

Results and Discussion

The samples used in this study (n=1220), all of them tested for *in vivo* OMD and VI according to the methodology described by Demarquilly *et al*., (1995) were considered as representative of the feed value of the most fresh forages found in temperate regions. The calibration and validation sets covered similar ranges for each component. Mean and standard deviation values were also similar for both sets.

Table 1: Descriptive statistics for the *in vivo* organic matter digestibility (OMD) g/g and voluntary intake (VI) g/kg $BW^{0.75}$ within calibration and validation sets.

	Calibration set (n=1085)					Validation set (n=135)			
	Min	**Max**	**Mean**	**SD**	**SEM**	**Min**	**Max**	**Mean**	**SD**
OMD	0.48	0.85	0.70	0.06	0.01	0.58	0.84	0.72	0.06
VI	22.5	115.2	68.1	11.8	5.35	38.7	101.1	70.6	10.9

SD: standard deviation; Min= Minimum value; Max = Maximun value; SEM = standard error of the method

Calibration statistics are shown in Table 2. For both determinations, OMD and VI, the best LOCAL model does not use a large number of factors for predicting the validation set. A total of 25 factors were selected with the first four not used for the prediction of the OMD and 15 factors for the prediction of VI.

Table 2: Validation statistics for prediction of organic matter digestibility (OMD) g/g and voluntary intake (VI) g/kg $BW^{0.75}$ using the LOCAL algorithm

	N	**Factors**	**SEP**	**Bias**	**R^2V**	**RPD**
OMD	130	25 (-4)	0.017	0.004	0.91	3.5
VI	130	15 (-6)	6.04	0.61	0.67	1.8

N= number of samples; Factors= Number of PLS factors, in brackets number of PLS factors excluded SEP=standard error of prediction; R^2V= coefficient of determination in validation set; RPD=residual predictive deviation

Statitstics associated to the OMD predictions show that LOCAL algorithm explains more than 90 percent of the variability. SEP and RPD values are better than those obtained by Andueza *et al*., (2010) using a similar database of forages but scanning forages samples. For VI the 67 percent of the variability was explained using the LOCAL approach. Although statistic values are better than those obtained by Andueza *et al*., (2010), the calibration model was not adequate for using in quantitative applications according to the criteria proposed by Williams and Sobering (1996).The high variability of the reference method can partially explain these results. Bias values were negligible for both determinations

We concluded that LOCAL approach is appropriate to predict the OMD values. More effort should be made to expand the variability or reduce the error for the VI determination.

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