Use of NIRS for the prediction of the chemical composition of sainfoin Onobrychis viciifolia Scop.

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Introduction

Sainfoin is a forage legume adapted to cool climates, thriving well on basic and dry soils. It is much appreciated by farmers due to its high palatability, high nutritional value and non bloating properties. Sainfoin herbage contains variable amounts of condensed tannins that are implied in its nutritional characteristics and confer anthelmintic properties. Thus, their precise quantification, along with others parameters of chemical composition becomes crucial. The use of NIR technology for this characterisation is particularly relevant, especially since huge numbers of sainfoin samples are being generated by the efforts under way to select accessions from different European conditions. The aim of this work is to evaluate the suitability of NIRS for predicting the chemical composition and the content of condensed tannins of a collection of sainfoin samples

Materials and Methods

A total of 186 sainfoin samples obtained from several trials were used. Samples were oven-dried at 80° C for 48 h to determine dry matter (DM), ground through a 0.8 mm screen and then stored at environmental laboratory conditions. Approximately 5 g of ground sample were placed in a 50 mm diameter ring cup and scanned in reflectance mode at 2 nm intervals from 400 to 2498 nm using a Foss NIRSystems model 6500 scanning visible/NIR spectrometer (Foss NIRSystems, Silver Spring, MD, USA) controlled by ISIscan software version 2.21 (Infrasoft International, Port Matilda, PA, USA). Each spectrum was time averaged from 32 scans.

Forage samples were analyzed for ash and crude protein (CP) according to AOAC (1990), for neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) according to the method described by Van Soest et al., (1991). Analyses of condensed tannins were performed according to Porter et al., (1986).

Calibrations were developed using WinISI II version 1.60 (Infrasoft International, Port Matilda, PA, USA). The modified partial least squares (MPLS) regression method was used to obtain NIR equations for all the studied parameters. Spectra were subjected to standard normal variate and detrending (Barnes et al, 1989) as scatter correction, and transformed through a mathematical first order derivatisation (1,4,4,1) where the first digit is the number of the derivative, the second is the gap over which the derivative is calculated, the third is the number of data points in the first smoothing, and the fourth is the number of data points in the second smoothing. Critical values for removing outliers were T=2.5, and two passes of elimination were allowed. The obtained models were evaluated by the coefficient of determination in calibration (R^2C) and cross-validation (R^2CV), the standard error of calibration and cross-validation (SEC and SECV) respectively and the residual predictive deviation (RPD) that was defined as the ratio between the SD and the SECV (Williams and Sobering, 1996).

Results and Discussion

The descriptive statistics for ash, CP, the partitioning of structural carbohydrates by the detergent systems and CT were shown in Table 1. A wide variability was observed in all studied parameters.

Table 1: Descriptive statistics for ash crude protein (CP) neutral detergent fibre (NDF) acid detergent fibre (ADF) acid detergent lignin (ADL) and condensed tannins (CT) in sainfoin samples (g/kg dry matter (DM))

	Nº	Min	Max	Mean	SD
Ash	145	65.2	159.5	108.2	17.35
CP	164	135.5	307.5	206.11	36.89
NDF	171	138.4	522.0	347.3	98.95
ADF	173	160.6	375.0	255.3	49.09
ADL	170	58.1	124.5	83.3	13.05
CT	136	0.65	4.32	2.05	0.712

Nº= number of samples; SD: standard deviation; Min= Minimum value; Max = Maximum value; SD = standard deviation

Table 2 summarizes the statistical values for the calibration equations obtained for the different determinations. R2C, R2CV and RPD values obtained for CP, NDF and ADF indicate that the prediction models have a very good precision, whereas prediction models obtained for ash and ADL are not capable of predicting these parameters adequately. Statistical results obtained for CT were also considered satisfactory, although RPD values did not reach 3, the obtained value was considered acceptable for screening purposes as well. Similar coefficients of determination values were found by Smith and Kelman (1997) for the prediction of CT concentrations in *Lotus uliginosus* Schkuhr.

Table 2. NIR calibration and cross-validation statistics for ash, crude protein (CP), neutral detergent fibre (NDF) acid detergent fibre (ADF) acid detergent lignin (ADL) and condensed tannins (CT) of sainfoin samples (g/kg DM)

	Nº	SEC	R^2C	SECV	R^2CV	RPD
Ash	145	10.37	0.64	11.29	0.58	1.54
CP	164	8.58	0.95	9.37	0.94	3.94
NDF	171	20.8	0.96	23.3	0.95	4.25
ADF	173	12.4	0.94	13.8	0.92	3.56
ADL	170	7.08	0.71	7.62	0.66	1.71
CT	136	0.27	0.86	0.32	0.80	2.23

Nº= number of samples; SEC= standard error of calibration; R^2C= coefficient of determination in calibration; SECV= standard error of cross-validation; R^2CV = coefficient of determination in cross-validation; RPD=residual predictive deviation;

We conclude that NIR equations developed for determination of CP, NDF, ADF and CT were adequate for the chemical characterization of sainfoin accessions. The use of NIR technology may increase dramatically the time and cost efficiency of sainfoin germplasm screening, thus facilitating the current pre-breeding programs under way.

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