The ability of near infrared reflectance spectroscopy (NIRS) to assess quality and level of tropical grass intake by creole sheep

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The ability of Near Infrared reflectance spectroscopy (NIRS) to assess quality and level of topical grass intake by creole sheep.

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Abstract

Near infrared spectroscopy is increasingly use as an alternative to classical analytical method to evaluate quality and functional properties animal feeds and human food. This method provides a rapid, clean and green, and accurate measure of chemical composition of diet. At the same time, attempts to evaluate these parameters in grazing systems are laborious, time consuming, costly and introduce bias in parameter estimation. The aim of this study is to evaluate the potential of faecal and forage NIRS to assess functional properties of diet ingested by Creole sheep. Derived standard errors of cross validation (SECV) and coefficient of determination using faecal spectra were 2.18% and 0.70 for organic matter digestibility, 9.27g/kg$P^{0.75}$ and 0.28 for organic matter intake and 6.76 g/kg$P^{0.75}$ and 0.27 for digestible organic matter intake. Association of faecal and herbage spectra lead to increase of prediction accuracy of 17.4, 7.4 and 7.2 % for organic matter digestibility, organic matter intake and digestible organic matter intake respectively. These results clearly indicate that near infrared reflectance spectroscopy represent a new tool to study and monitor breeding systems.

Introduction

Amongst parameters contributing to ruminant production from forage, intake is the more important (Minson, 1990) but also the most variable and the most difficult to measure accurately. In pen fed experiments, measure of intake is laborious, costly, and time consuming. In grazing systems, voluntary intake can only be estimated by indirect methods requiring estimation of both total faecal excretion and digestibility. If several indirect methods allow estimations of digestibility (in vitro digestibility (Tilley and Terry, 1963, in sacco degradability (Demarquilly and Chenost, 1969), or method based on faecal index (Boval, 2003), they can introduce bias in intake estimation. At the same time, near infrared spectroscopy (NIRS) is increasingly used in agro industry to evaluate nutritional quality of animal and human foods. The aim of this study is to determine the potential NIRS to predict quality and quantity of diet ingested by martnik ewes.

Materiel & Method

The experiment was carried out at the experimental station of the National Agronomic Research Institute (INRA) in Guadeloupe. Twelve martnik ewes weighing 44 (± 10 kg) were employed in this study. Each ewe was individually housed in metabolism cage to be fed fresh forage harvested from plot of Digitaria decumbens (Pangola). Grass was cut daily early in the morning and chopped (5 cm length) before being offered. Animals received amount of forage 1.1 times greater than their voluntary intake. Fresh weight of forage offered, forage refusals and faeces excreted were measured. Sub-samples at approximately 300 and 200 g fresh weight were collected for dry matter (DM) determination for forage and faeces respectively. Forage and faeces sub-samples were pooled within week and ewe before further processing and analysis. Organic matter intake (OMI), organic matter digestibility (OMD) and resultant digestible organic matter intake (DOMI) were calculated for each ewe per each week. Absorbance spectra (log 1/R) of samples were recorded using a Foss NIRSystem 6500 monochromator. Samples were scanned at 2 nm intervals over the wavelength range 700-1100 and 1100-2500. Spectrums were subsequently reduced over the NIR region. Spectral data were processed using ISI software (Infrasoft international; Shenk, 1992). Calibration of dietary composition, OMI and OMD were developed using Modified Partial Least Square procedure (MPLS) as this technique has been proven to be superior in earlier research (Shenk and Westerhaus, 1993; Park et al., 1997, 1998).

Results & Discussion

Calibrations statistics for OMD obtained in our study (Table 1) using faecal NIRS compare favourably with those reported by Boval et al (2004) with steers fed with Digitaria decumbens or Dichatium sp (SEC-V = 2.0; R^2 = 0.69). Coates (1998) develop faecal NIRS equation for predicting DM digestibility (DMD) using data from 54 in vivo trials covering a wide range of pasture grass and legume hay and the author obtains a SEC of 2.5% and R^2 of 89.0 (n = 187). Faecal NIRS equation for predicting OMD developed by Lyons and Stuth (1992) and Leite and Stuth (1995) used *in vitro* estimates of digestibility determined on oesophageal fistula sample as reference values. The resultants SEC value of 1.66 and 2.01%, respectively were comparable with the 1.88 % from this study despite the fact that we used *in vivo* digestibility as reference value. Indeed, *in vivo* digestibility introduces an "animal factor" into the calibration process which is not taking into account in *in vitro* digestibility.

Variable	*n*	SEC	SEC-V	R^2_{CV}
OMD (%)	82	1.88	2.18	70.7
OMI ($g/kg^{0.75}$)	82	6.03	9.27	27.3
DOMI ($g/kg^{0.75}$)	82	6.13	6.76	28.5

There was deterioration in cross validation statistics for intake (Table 1) as reported by Boval et al (2004). This is consistent with previous reports based on forage NIRS predictions of OMI where SECs (and R^2) for OMI of 9.6 (72.0), 7.3 (71.0) and 3.4 (90.0) $g/kgBW^{0.75}$ were reported for cattle consuming arid and semi-arid forages (Ward et al., 1982), temperate grasses and legumes (Redshaw at al., 1986), and silage (Park et al., 1987), respectively. Comparatively with OMD, *in vivo* OMI is subject to further "animal factors" such as rumen size or physiological stage. Moreover it is also affected by "forage factors" (forage digestibility, dietary chemical content …).

Since digestible organic matter intake is the resultant of digestibility and intake processes, it would allow intermediate statistics. Nevertheless, with SEC-V of 6.76 and R^2 of 27.31 % (Table 1) and taking into account the standard deviation of the reference value (SD = 7.69), calibration of DOMI in as poor as intake calibration. To how knowledge, no published reports of faecal NIRS calibration for predicting DOMI were found with which to make a real comparison.

Association of faecal and herbage spectra lead to increase of prediction accuracy (SECV = 1.80 and R^2 =0.79, SECV = 8.58 and R^2 = 0.46 and SECV = 6.27 and R^2 = 0.51) for OMD, MOI and DOMI respectively. Requirement of software (Dardene, unpublished data) to associate faecal and forage spectrum makes this technique difficult to implement in breeding systems. Moreover, in grazing systems sampling of diet ingested are laborious and supply variable results.

Conclusion

These results clearly indicate the potential of near infrared spectroscopy to assess intake and digestibility of ruminants. Although precision obtained in intake prediction are lowest than digestibility prediction, it remain acceptable compared with those usually used in grazing system. Association of faecal and forage spectrums offers a new tool of research of diet quality in grazing system.

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