“Global” and “local” predictions of dairy diet nutritional quality using near infrared reflectance spectroscopy

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ABSTRACT

The objective of the study was to evaluate performance of classic (global) and innovative (local) calibration techniques to monitor cattle diet, based on fecal near infrared reflectance spectroscopy (NIRS). A 3-yr on-farm survey (2005-2008) was carried out in Vietnam and La Reunion Island to collect animal, feed intake, and feces excretion data. Feed and feces were scanned by a Foss NIRsystem 5000 monochromator (Foss, Hillerod, Denmark) to estimate diet characteristics and nutrient digestibility. A data set including 1,322 diet-fecal pairs was built and used to perform global and local calibrations. Global equations gave satisfactory accuracy [coefficient of determination (R^2) >0.8, 10% ≤ relative standard error of prediction (RSEP) ≤20%], whereas local equations gave good accuracy (R^2 >0.8, RSEP <10%) or excellent accuracy (R^2 >0.9, RSEP <10%) for the prediction of diet intake, quality, and digestibility. When validating the equations using the external individual data, both techniques were robust, with similar RSEP (8%) and R^2 (0.82) values. The predictive performance of global and local equations was improved (RSEP = 5% and R^2 = 0.90) when averaged animal data from farm, visit, and similar milk production were used. In particular, local equations reduced RSEP by 43% and increased R^2 by 15%, on average, compared with those obtained from individual data. The low RSEP (4%), high R^2 (0.96), and good ratio performance deviation (RPD = 5) illustrated the excellent accuracy and robustness of the local equations. Findings suggest the ability of fecal NIRS to successfully and more accurately predict diet properties (intake, quality, and digestibility) with local calibration techniques compared with classic global techniques, especially on an averaged data set. Local calibration techniques represent an alternative promising method and potentially a decision support tool to decide whether diets meet dairy cattle requirements or need to be modified.

Key words: dairy diet , near infrared reflectance spectroscopy , quality , prediction

INTRODUCTION

Dairy performance relies on short- and medium-term management of daily amounts and quality of forages

and feeds given to lactating herds. Underfeeding or overfeeding will affect animal performance, health, and environmental effects of dairy production (NRC, 2001). One kilogram difference of a concentrate such as maize at about 2.0 Mcal of NE_L/kg of DM would supply enough additional energy for over 2.5 kg of milk at 4% FCM. This is particularly important in early lactation, when a loss of 2 L of milk could result in ≥500 L being lost over the whole lactation. Monitoring the effective feed intake of animals has received much attention for many years. Fast and accurate methods are still needed to determine to what extent actual nutrient supplies match the overall requirements of dairy cattle and to help farmers with their feeding strategies.

Near infrared reflectance spectroscopy (**NIRS**) offers many advantages over standard methods of dietary evaluation. Near infrared reflectance spectroscopy of rumen fluid or feces can be used as a decision support tool to improve feeding management decisions (Lyons et al., 1993). An NIRS analysis of rangeland herbivore diet has been conducted with diets collected via esophageal fistula (Holechek et al., 1982) or feces (Lyons and Stuth, 1992; Lyons et al., 1995). More recently, fecal NIRS was applied to predict diet intake and diet quality of domestic animals (Awuma, 2003; Boval et al., 2004; Coleman, 2005; Landau et al., 2006; Fanchone et al., 2007, Decruyenaere et al., 2008) and wild animals (Kidane, 2005; Landau et al., 2006). However, the databases in each study were limited with regard to diet diversity and quantity of samples, and thus only permitted the development of fecal NIRS equations with global calibration from whole databases.

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