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Utilizing faecal near infrared spectroscopy to improve nutritional management of grazing cattle in the tropics of northern Australia

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Introduction

Near infrared spectroscopy (NIRS) is used extensively for analysis of feedstuffs, including forages. NIRS can be used to analyse constituents of faeces such as N and fibre fractions. Despite digestion in the gastrointestinal tract much of the spectral information of forages can also be measured in faeces. Thus many attributes of forage diets of cattle can be measured from the NIR spectra of faeces (F.NIRS; Lyons and Stuth, 1992; Dixon and Coates, 2009).

Materials and methods

As for any NIRS application, calibration equations were developed to relate the NIR spectra of faeces to attributes of tropical forage diets. These calibration equations require that both the faeces and the diet be sampled, and that attributes of the diet be measured by conventional procedures. Cattle were fed hays or freshly harvested forages in pens, or cattle surgically prepared with oesophageal fistula grazed pastures, and representative samples of diets and faeces were obtained after at least 5 days to allow dietary adaptation. Calibration equations were developed using the chemometrics commonly used for NIRS analysis of forages (partial least squares models were developed from spectral data following derivative transformations). Calibrations were developed to predict the proportion of grasses to non-grasses (legumes, and other dicotyledonous plants) in the diet, concentration of total N in the diet, diet digestibility, voluntary intake of DM and metabolisable energy, and liveweight change of a ‘standard’ animal (Coates, 2004). The size and range of the spectral data sets developed with Australian tropical forages varied depending on the diet attribute, but represented at least 360 diets and 1200 animal measurements.

Results

The errors and reliability of the calibration equations for diet N concentration, diet digestibility or the proportion of grass to non-grass in the diet were generally comparable with those when NIRS or conventional laboratory procedures are used to analyse forages. F.NIRS calibrations for liveweight change have satisfactorily predicted the liveweight change of animals in field experiments in some circumstances (e.g. pasture systems where large data sets were available) but not in others, and not near the break of the season or where pasture availability was likely limiting voluntary intake. Furthermore current F.NIRS calibrations for voluntary intake or liveweight change can only be applied to the class of animal used to develop the calibration (a young growing healthy steer adapted to the environment), and not to cattle where a different physiological state (e.g. lactation, compensatory growth, greater maturity) affects voluntary intake and liveweight change (Dixon, 2008). A second approach has been to use F.NIRS predictions of the diet selected (DM digestibility, diet N) as inputs to a nutritional model (CSIRO, 2007) to estimate voluntary intake and animal performance.

Discussion

The great benefit of F.NIRS technology is that it allows frequent and economical estimates of the diet actually selected by grazing ruminants from faecal samples collected in the field. F.NIRS circumvents the difficulties associated with estimating and sampling the components of the pasture which are selected by the grazing animal, and allows quantitative nutrition to be applied routinely. A major constraint for F.NIRS technology is that development of robust and reliable calibrations requires many hundreds of diets encompassing the range of pasture systems and seasons of interest. Also NIR technology requires high capital cost instrumentation, and a high level of knowledge and skill to develop calibrations and to provide ongoing quality control of analysis. Effective utilization of F.NIRS analyses by the grazing industries requires agricultural extension professionals with extensive knowledge and experience in ruminant nutrition to appropriately apply the outputs for livestock management. F.NIRS technology has been applied in the extensive grazing cattle industry of northern Australia (Jackson, 2009) with analytical services provided by a commercial laboratory. Analytical results are accompanied by a brief report commenting on the nutritional consequences on cattle performance and what management steps might be considered to address sub-optimal performance. During the last decade some 20,000 samples from research trials, plus some 20,000 from commercial cattle properties have been analysed and results utilized.

Conclusions

F.NIRS has been developed to estimate the quality of the diet selected and the productivity of cattle grazing extensive rangelands in the tropics of northern Australia. F.NIRS can be used to estimate many attributes of the diet selected by grazing ruminants and provides opportunities to improve management for both production of grazing livestock and sustainability of the pasture resources.

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The effect of pasture utilization on the defoliation of grass species by steers grazing a tropical savanna woodland during the dry season

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Introduction

The relationship between grazing pressure and differences in the defoliation rate of grass species is not well understood for tropical savannas even though it is likely to have a substantial influence on the persistence of preferred species, pasture condition and sustainability of the grazing system. The objective of this study was to examine the relationship between grass species characteristics and their defoliation rate in a paddock under increasing levels of utilization.

Materials and Methods

Nine steers (318 $\pm$ 18 kg SD) grazed a Eucalyptus savanna woodland for 14 days near Charters Towers (QLD, Australia) during the late dry season of 2009. The pasture was fully mature as cattle did not have access to the experimental area (2.25 ha) since the beginning of the

Table 1 *Level of utilization (%) and plant description, STR: stem tensile resistance (N), SD: stem density (stems dm^{-2}), DMD: dry matter digestibility (%), LSR: leaf/stem ration, BD: bulk density (g m^{-3}), PH: plant height (cm); BA: plant basal area (cm^{2} m^{-2}), PP: proportion in pasture, D: day*

									Utilization		
	STR	SD	DMD	LSR	BD	PH	BA	PP	D 5	D 7	D 13
Aristida spp.	38	15	48	0,46	762	73	155	0.14	2	37	76
Bothriochloa ewartiana	182	22	47	0,28	2561	70	386	0.12	5	25	46
Bothriochloa pertusa	33	34	50	1,37	1964	40	777	0.08	49	73	81
Eragrostis lacunaria	8	254	50	0,75	6083	18	110	0.14	11	38	77
Eragrostis sororia	42	41	48	0,58	1810	66	169	0.16	12	44	70
Eriachne glauca	25	22	48	0,36	851	74	162	0.13	1	26	68
Heteropogon contortus	94	6	47	0,70	785	85	90	0.08	7	40	64
Leptochloa divaricatissima	47	5	49	0,65	489	96	232	0.08	1	34	62
Pasture utilization									10	38	70

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