Animal Feed Science and Technology 194 (2014) 44–57

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

Can faecal markers detect a short term reduction in forage intake by cattle?

Marcelo A. Benvenutti[a,e,*], David B. Coates[e], Jérôme Bindelle[b], Dennis P. Poppi[c], Iain J. Gordon[d]

[a] The University of Melbourne, Australia
[b] University of Liège, Belgium
[c] The University of Queensland, Australia
[d] James Hutton Institute, UK
[e] Sustainable Ecosystems, CSIRO, Australia

ARTICLE INFO

Article history:
Received 23 May 2013
Received in revised form 4 May 2014
Accepted 6 May 2014

Keywords:
Markers
Intake
Tropical pastures
Chromium
Alkanes
Polyethylene glycol

ABSTRACT

Detection of a reduction in forage intake is particularly relevant in grazing animals due to its negative effect on animal performance. Estimations of intake reduction using faecal markers can be inaccurate due to the time delay between a change in forage intake and the subsequent change in faecal output. This delay may vary depending on forage quality and marker type. A pen study was conducted for 29 days to test the efficacy of liquid (PEG = polyethylene glycol) and solid (alkanes and $CrCl_3$ = chromium chloride) phase faecal markers to detect a reduction in intake by steers of diets that varied in forage quality. Ten Brahman cross steers (296 ± 16 kg) were allocated equally to diets of leafy, high quality buffel grass (*Cenchrus ciliaris*) hay and stemmy, low quality buffel grass hay. Hay was offered *ad libitum* from day 1 to 7, at 90% of voluntary intake from day 8 to 14 and then reduced by 8% each day from day 15 to 24. On day 5 each steer was dosed with two slow release alkane capsules; also, steers received a single daily dose of PEG and $CrCl_3$ at 09:00 on days 5–24. Actual and marker derived estimates of forage intake over days 10–22 were assessed by repeated-measures analysis of variance. Overall marker recovery rates were satisfactory (0.92–1.03) and there was a significant ($P<0.001$) progressive decrease in daily recovery rate over time for all markers and diets. Actual and marker-determined forage intake declined over the course of the experiment for both leafy and stemmy hay diets ($P<0.001$) for all three markers. There was a lag of 3–5 days to detect a significant reduction in estimated intake by steers using markers. The lag period was similar for both liquid and solid phase markers. Results of this experiment indicated that decreases in forage intake by cattle could be detected using indigestible faecal markers, albeit in association with (i) progressively larger reductions in actual forage intake, and (ii) a time lag of 3–5 days between the decrease in actual intake and its statistical detection using faecal markers.

Abbreviations: ADF, acid detergent fibre; C32, n-dotriacontane; C36, n-hexatriacontane; CHR, chromium; CP, crude protein; DMD, dry matter digestibility; F.NIRS, faecal NIRS; FO, daily faecal output; MRT, mean retention time; NDF, neutral detergent fibre; NIRS, near infrared reflectance spectroscopy; PEG, polyethylene glycol.

* Corresponding author at: cnr Tin Alley and Royal Parade, Parkville, VIC 3010, Australia. Tel.: +61 3 90353051.
E-mail addresses: marcelo.benvenutti@unimelb.edu.au, Marcelo.Benvenutti@hotmail.com (M.A. Benvenutti).

http://dx.doi.org/10.1016/j.anifeedsci.2014.05.002
0377-8401/

1. Introduction

Pasture utilization can have a substantial impact on the productivity of grazing animals *via* its effect on forage intake and/or diet quality (Ash et al., 1995). There are a number of ways to measure an intake response to pasture utilization including set stocking at different utilization rates (Jamieson and Hodgson, 1979) or in experiments where progressive defoliation at high grazing pressure leads to decreasing intake over the course of the experiment (Chacon and Stobbs, 1976). All approaches require a reliable method to estimate intake. In grazing ruminants faecal markers work well in steady state conditions (Penning, 2004); however, under non-steady state conditions, estimation of faecal output using markers can be inaccurate (Penning, 2004) due to the time delay between a change in forage intake and the consequent change in faecal output.

The time lag is expected to be longer with low quality diets compared with high quality diets due to their slower passage rate (Poppi et al., 1981a,b). Consequently, changing intake should be monitored more readily and accurately using faecal markers in high quality forage than in low quality forage diets due to differences in the passage rate of ingesta.

Faecal markers move through the digestive tract either in solution (liquid phase) or attached to particulate matter (solid phase). Although the transit time of both types of markers is similar (Grovum and Williams, 1973; Seo et al., 2009) the fractional passage rate of liquid phase markers is faster than that of solid phase markers (deVega and Poppi, 1997). This will influence the rate of change in marker concentration in the faeces as intake declines and be more apparent in high quality forages which have lower retention time in the rumen. Furthermore, as observed by Dias et al. (2011), animals fed at restricted intake levels have longer particulate matter retention time in the reticulorumen while the liquid phase retention time seems little affected by changes in total feed intake. Therefore, it can be hypothesized that a change in intake can be detected sooner by liquid phase markers than by solid phase markers and additionally that liquid phase markers would more readily and accurately detect intake changes in non-steady state conditions.

The objective of the experiment was to test the efficacy of a liquid and two solid phase faecal markers to detect a reduction in forage intake in non-steady state conditions for high and low quality forage diets.

2. Materials and methods

The experiment was conducted in the pen feeding facility at James Cook University, Townsville in north Queensland. The experiment was approved by the relevant Animal Ethics Committees of The University of Queensland (Approval Number: SAS/JCU/107/09) and James Cook University (Approval Number: A/1360).

2.1. Animals, diets and experimental design

Ten Brahman cross steers, mean initial liveweight of 296 ± SD = 16 kg, were allocated at random to individual 2 m × 3 m covered pens with concrete flooring. Five of the ten steers were randomly assigned to receive a diet of leafy buffel grass (*Cenchrus ciliaris*) hay and five a diet of stemmy buffel grass hay. The experiment consisted of 5 replicates (steers) × 2 diet treatments in a completely randomized design with repeated measures. The hay was milled through a chaff cutter prior to feeding to minimize diet selection and spillage. Daily allowances of chaffed hay were fed in two equal portions at 08:00 and 16:00, which represents the natural diurnal feeding pattern of grazing cattle. Feed subsamples were taken every Monday, Wednesday and Friday for DM (dry matter) determination (drying in a forced draft oven at 60 °C for 2 days) and later processing and analysis. Refusals were collected daily so that *ad libitum* hay intake could be determined as the difference between the DM offered and refused.

The experiment ran for 29 days with each day regarded as the 24 h period from 8am to 8am. Daily allowances of hay were offered according to the following schedule.

Days 1–7:	*ad libitum* (approximately 10% refusal rate)
Days 8–14:	90% of average hay consumption for days 5–7
Days 15–24:	hay allowance was reduced progressively each day by a set amount calculated as 8% of the daily allowance for days 8–14.
Days 25–29:	90% of average eaten from day 5 to 7. This period was necessary to measure overall recovery rate of markers.

2.2. Markers

Three faecal marker types were used – polyethylene glycol (PEG) was used as a liquid phase marker and alkanes and chromium chloride as solid phase markers. Chromium chloride is a rare earth marker that attaches to particles in the feed. Rare earth markers have different binding properties and may move from one particle to another. Unlike chromium oxide they do not exist as a separate complex within digesta.

On day 5 each steer was dosed with two slow release alkane capsules (Captec Ltd, Auckland, New Zealand). Each capsule contained 4 g n-dotriacontane (C32) and 4 g n-hexatriacontane (C36) and was designed to release 200 mg of C32 and C36 each day for approximately 20 days. Since accurate calculation of daily faecal output depends on actual marker dose rate, marker release rate was checked by measuring the recovery of C32 during days 10–14. During this period intake of hay was held constant at 90% of the measured *ad libitum* intake and faecal excretion of alkanes was assumed to be the same as daily intake of alkanes. Alkanes C32 and C36 gave similar results and, therefore, only the results from C32 are presented. At 09:00