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EVALUATION OF CONTROLLED RELEASE CHROMIC OXIDE BOLUSES AND ALKALINE PEROXIDE LIGNIN AS MARKER METHODS TO DETERMINE FORAGE INTAKE OF GRAZING RUMINANTS

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Summary

Twenty Hampshire ram lambs used in a digestibility trial were administered controlled release chromic oxide intraruminal boluses to evaluate chromic oxide and alkaline peroxide lignin in combination as potential markers for determining intake of ruminants grazing dormant winter range. Lambs were fed ad libitum mature prairie grass hay and provided .1 lb crude protein from one of four supplements. The ability to predict fecal output using chromic oxide boluses and diet digestibility using alkaline peroxide lignin were not affected by supplemental treatments. Chromic oxide concentration in the feces was not affected by the time of sampling. The amount of chromium oxide excreted averaged 224 mg/day and was not affected by treatment. The amount of lignin consumed that was recovered in the feces was 97.8 $\pm$ 11.6%. Predicted fecal output was closely related to actual values (R^2 = .83, c.v. = 8.4%). Predicted digestibility and dry matter intake were similar to actual values (P = .77 and .90, respectively). Controlled release chromic oxide boluses and alkaline peroxide lignin procedures may be used to predict dry matter intake of ruminants grazing mature forages.

(Key Words: Chromium, Alkaline Peroxide Lignin, Markers, Grazing, Mature Forages.)

Introduction

Forage consumption by grazing animals is difficult to estimate. Understanding factors affecting forage intake is important, however, when conducting research on the nutritional management of grazing animals. Forage intake can be calculated by the equation Dry matter intake = Fecal output/(1 - forage digestibility) if accurate measurements of daily fecal output and digestibility of the forage grazed can be made. Diet digestibility and fecal output have often been determined through the use of internal (indigestible fractions of the forage) and external (indigestible foreign compounds introduced into the diet or animal) markers. New technology has led to a controlled release chromic oxide bolus that allows accurate estimates of fecal output in grazing animals to be made with less labor than previous methods. An indigestible fraction of the diet such as lignin could be used to determine digestibilty of the grazed forage. Recent methods of analysis have incorporated an alkaline peroxide predigestion into the typical lignin procedure which may improve estimates of diet digestibility. The objective of this study was to evaluate controlled release chromic oxide boluses and alkaline peroxide lignin procedures for use in estimating forage intake in grazing ruminants.

Materials and Methods

Hampshire ram lambs (mean weight 116.5 lb $\pm$ 7.3) fed mature prairie grass hay ad libitum were assigned to one of four protein supplemental treatments (see page 31, Tables 1 and 2). Hay was weighed and fed twice daily with feed refusals incorporated into the next day's feed. Five days prior to fecal collections, lambs were orally administered a chromic oxide bolus[3] designed to release 204 mg/day of chromium oxide (chromium sesquioxide) at a constant rate. Fecal samples were collected over two 3-day collection periods, subsampled, pooled within collection period and oven dried at 60 °C for later laboratory analyses. After the final collection period, four fecal grab samples were taken at 6-hour intervals from two lambs on each of the four treatments to determine if fecal chromic oxide concentration was affected by time of sampling. Fecal samples were analyzed for chromic oxide using a microdigestion-oxidation procedure and flame atomic absorption

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spectrophotometry. Alkaline peroxide lignin levels (APL) of hay and fecal samples were determined using an alkaline peroxide predigestion followed by standard lignin analysis. Equations used to ultimately derive dry matter intake are expressed in Table 1.

Data were analyzed by least squares procedures using General Linear Model (GLM) of the Statistical Analysis System (SAS). Least squares means were separated by the Predicted Difference option (Pdiff). Data from both collection periods were pooled for actual vs predicted models. Actual vs predicted values were also compared using MEANS procedure with the paired t-test option (T PRT).

TABLE 1. EQUATIONS USED IN THE PROCESS OF ESTIMATING DRY MATTER INTAKE

Cr_2O_3 excretion rate, mg/day = (mg Cr2O3/g fecal dry matter) x (g fecal dry matter/day)
Predicted fecal dry matter output, g/day = (mean Cr_2O_3 excretion rate[a])/(mg Cr_2O_3/g fecal dry matter)
Percent lignin recovery = (% fecal APL x g fecal dry matter/day)/(% dietary APL x g dry matter intake/day)
Predicted digestibility = (% fecal APL)/(% dietary APL)
Predicted dry matter intake = (predicted fecal dry matter/day)/(1 - predicted digestibility)

[a] Average excretion rate for 20 lambs = 224 mg Cr_2O_3.

Results and Discussion

Mean excretion rate of the 20 chromic oxide boluses based on total fecal collections was 224 $\pm$ 24.5 mg Cr_2O_3 per day. Manufacturer validation tests indicated that 201 mg Cr_2O_3 per day disappeared in similar boluses in the rumen each day. Excretion values in this study ranged from 171 to 267 mg Cr_2O_3 per day. Predicted fecal output estimates were closely associated (R^2 = .83; C.V. = 8.4%) with actual fecal output determinations for individual lambs. Supplemental treatments had no effect on chromic oxide release rates or prediction of fecal output (Table 2). Time of sampling did not affect fecal chromic oxide concentrations (P = .98; Table 3).

Average fecal recovery of alkaline peroxide lignin (APL) for the 20 lambs was 97.8 $\pm$ 11.6%. Recovery values for APL ranged from 82.4 to 129.3%. Pooled data from the two collection periods resulted in poor predictions of apparent digestibility (R^2 = .009; C.V. = 18.3%) for individual lambs. This can be partially explained by the small range in actual apparent digestibility values found in this trial (mean digestibility = 45.6 $\pm$ 2.7%; range = 41.2 to 50.2%) compared to the error associated with determining digestibility using marker procedures. Predicted vs actual digestibility values were not different (P = .77), however, when analyzed using a paired T-test. Supplemental treatments had no effect on fecal recovery of APL or prediction of apparent digestibility (Table 2).

The relationship between predicted and actual dry matter intake (R^2 = .540; C.V. = 17.0%) was influenced by the error associated with determining digestibility. However, predicted vs actual dry matter intake values were similar (P = .90) using paired comparisons. The ability to predict dry matter intake was not influenced by supplemental treatments (Table 2).

TABLE 2. EFFECT OF SUPPLEMENTAL TREATMENTS ON PREDICTIVE VALUE OF MARKER PROCEDURES

Item	Supplements			
	Soybean meal	Urea + methionine	Urea + sulfur	Urea
Recovery of alkaline peroxide lignin, %[a]	96.4	102.1	92.4	98.1
Chromic oxide release rate, mg/day	225	218	216	236
Predicted minus actual				
Fecal dry matter, g	11.9	15.6	30.7	-25.6
Apparent digestibility, %	-2.6	.9	-4.3	-1.3
Dry matter intake, g	11.7	94.3	2.7	-47.9

TABLE 3. EFFECT OF SAMPLING TIME ON FECAL CHROMIC OXIDE CONCENTRATIONS

Sampling time, hr	Cr_2O_3,mg/g[a]
0	39.6 ± 2.4
6	39.1 ± 2.3
12	39.6 ± 2.7
18	38.5 ± 2.4

[a] Mean ± standard errors.

These preliminary results indicate that controlled release chromic oxide boluses can be used to predict fecal dry matter output for individual lambs. The relationship between predicted and actual digestibility as determined by alkaline peroxide lignin procedures is more variable and inflates the error associated with predicting dry matter intake. While effective estimates of dry matter intake for a group of lambs can be made using these procedures, limitations remain for predicting an individual's consumption. Present research will involve assessment of these same techniques with mature cows in drylot and under range conditions.