COMPARISON OF EXTERNAL MARKERS FOR ESTIMATING FECAL OUTPUT OF CATTLE GRAZING WHEAT PASTURE

G.J. Vogel[1], J. Zorrilla-Rios[2], G.W. Horn[3], R.W. McNew[4] and K.B. Poling[5]

Story in Brief

Fecal output (FO) of steers grazing immature and mature wheat forage were obtained by total collection and marker dilution using three external markers: Cobalt EDTA solution, Chromium oxide powder and Ytterbium-labeled wheat forage. Percent recovery of markers varied from 86 to 97 percent for Cobalt (Co), after correction for an assumed 5 percent absorption, and from 99 to 106 percent for Chromium (Cr) and Ytterbium (Yb). Diurnal variation in fecal marker concentrations was much higher for Co, while Cr and Yb concentrations of fecal grab samples were much less variable. Fecal outputs estimated from Cr and Yb markers were in good agreement with FO obtained by total collection, while Co overestimated FO. Use of Cr resulted in estimated FO that were the least variable, while those obtained with Co exhibited the greatest amount of variability.

Key Words: Fecal Output, Markers, Grazing, Wheat Pasture, Steers.

Introduction

Estimates of forage intake of grazing ruminants are of primary importance in predicting animal performance and in planning supplementation programs. Daily forage intake can be calculated from measurements of fecal output and digestibility of the consumed forage by the following relationship:

Intake = Fecal Output/(1-Digestibility)

Several methods are available to determine fecal output. Among these, the direct measurement of total fecal excretion during the feeding cycle is considered the most reliable approach, though not entirely free of biases. Nevertheless, the amount of labor required and the relative stress imposed on the animals, among other considerations, are factors that limit collection of total feces. The accuracy and reliability of external markers to estimate fecal output needs verification under each managerial situation. The objective of this study was to investigate the usefulness of three external markers to estimate fecal output as compared with total collection of feces from steers grazing wheat pasture. Also, specific factors influencing the results, such as percentage marker recovery, postdosing fluctuations in fecal marker concentrations, and their interaction with the experimental conditions (stage of wheat forage maturity) were considered.

[1]Graduate Assistant [2]Research Associate [3]Professor
[4]Professor, Statistics [5]Animal Care Supervisor

Materials and Methods

Total daily fecal output (FO) of eight ruminally cannulated grazed a single paddock of wheat pasture (var. TAM-105) from March 7 to March 27 (immature stage) and April 22 to May 14 (mature stage), with forage dry matter availabilities of 1642 and 1565 lb/acre, respectively. Three external markers were investigated: Yb-labeled wheat forage (Yb-WF), cobalt EDTA solution (CoEDTA) and chromium (Cr_2O_3 powder administered in gelatin capsules). All markers were administered to steers by ruminal dosing twice daily (12 hours apart) for eight days prior to sampling. Fecal grab samples(GS) were obtained once for each animal at each of the following hours after the am dosing: 0, 3, 4, 6, 9 and 12. Total FO was measured with collection bags over a 4-day period with bags being replaced every 24 hours. Fecal marker concentrations were determined by atomic absorption spectrophotometry. Estimates of daily output from GS were calculated for each of the markers. The uncorrected FO from the GS samples was estimated by the following equation:

UFGS = marker dose/marker concentration in feces

With this approach it is assumed that the daily dosage of marker is completely recovered in feces of the same 24 hour period. Total fecal outputs and corresponding marker concentrations were used to calculate the percentage recovery of each marker (R). Estimated fecal outputs from GS were adjusted for recovery of markers by:

CFGS = dose of marker x R/marker concentration in feces

Extent of postdosing fluctuation in fecal marker concentrations was investigated by comparing GS to samples of total fecal collections (TFC).

Results and Discussion

Data obtained with Yb during the grazing of immature wheat forage were inconsistent and samples are being reanalyzed. Therefore, these results were not available at the time of preparation of this report.

Recovery of Markers From Total Fecal Collections

Recovery of markers from total fecal collections are listed in Table 1. Recovery of Co is presented as observed and after corrected for an assumed 5 percent absorption along the gastrointestinal tract. Regardless of the way it is expressed, cobalt recovery was lower ($P<.01$) than those for Cr and Yb. Stage of wheat forage maturity influenced recovery of markers (interaction $P<.05$).

Comparison of Marker Concentrations in Fecal Grab Samples (GS) and Samples of Total Fecal Collections (TFC)

The concentration of Cr in GS at 3 and 9 (immature stage) and 9 h (mature stage) postdosing were different ($P<.05$) from the concentrations in TFC (Figures 1 and 2). Significant differences were detected for Yb (mature stage) at 0, 3 and 4 h postdosing ($P<.02$).

Table 1. Recovery of markers from total fecal collections of steers grazing immature and mature wheat forage.

Stage of maturity	n	Percent recovery			SE
		Co[1]	Cr[1]	Yb[1]	
Immature	32	81.0(85.3)[ac2]	99.2[be]	NA[3]	2.26
Mature	32	91.9(96.7)[ad]	106.2[bf]	105.8[b]	2.17
SE		.028	.028	----	

[1]Co = CoEDTA, Cr = Cr_2O_3 powder, Yb = Yb-labeled wheat forage.
[2]Observed values (corrected values for an assumed 5 percent absorption of Co from the gastrointestinal tract).
[3]Not available.
[a,b]Means in a row with different superscripts are different (P<.01).
[c,d]Means in columns with different superscripts are different (P<.01).
[e,f]Means in columns with different superscripts are different (P<.04).

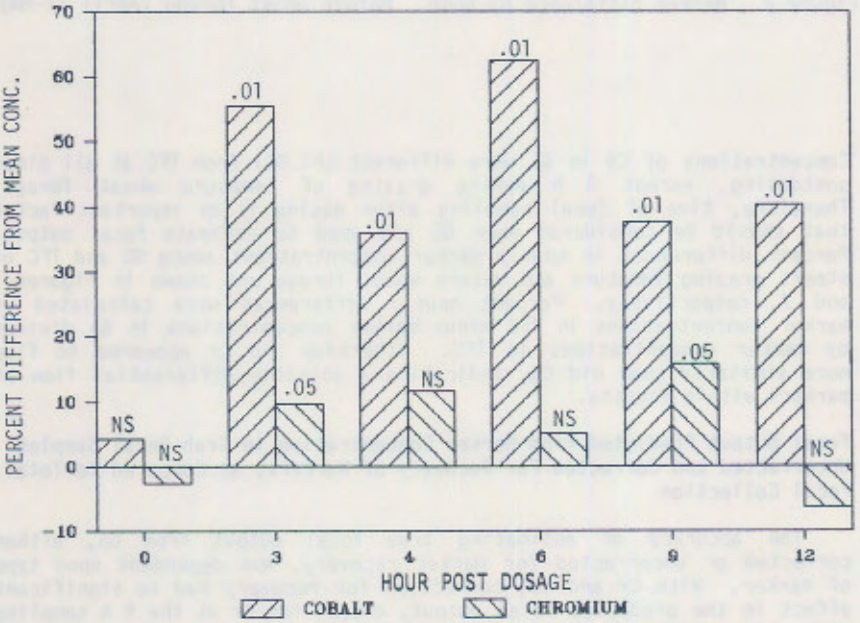

Figure 1. Marker difference by hour. Immature wheat forage (March 7-27).

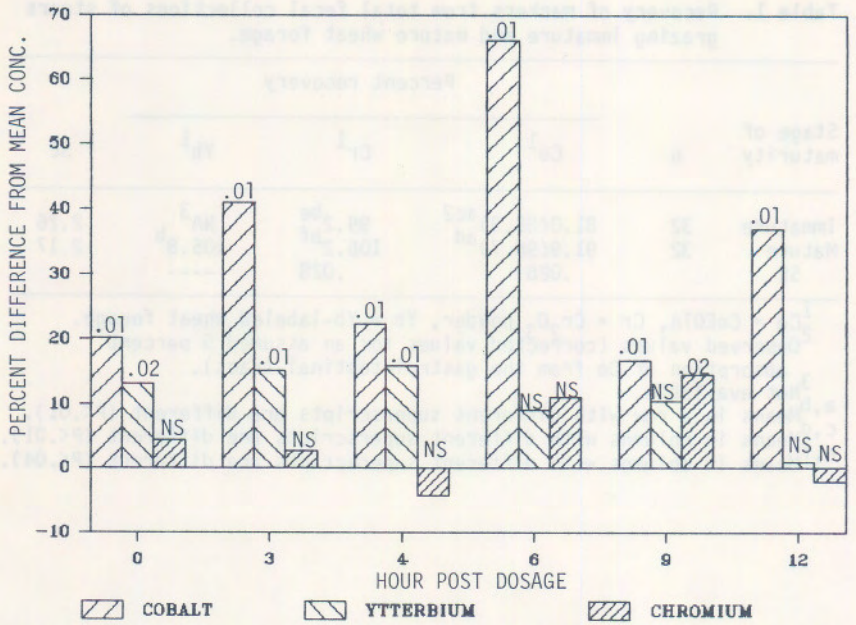

Figure 2. Marker difference by hour. Mature wheat forage (April 22-May 14).

Concentrations of Co in GS were different ($P<.01$) from TFC at all times postdosing, except 0 h during grazing of immature wheat forage. Therefore, time of fecal sampling after dosing is an important factor that should be considered when GS are used to estimate fecal output. Percent differences in hourly marker concentrations among GS and TFC of steers grazing immature and mature wheat forage are shown in Figures 1 and 2, respectively. Percent hourly differences were calculated as marker concentrations in TFC minus marker concentrations in GS divided by marker concentrations in TFC. Ytterbium and Cr appeared to flow more similarly than did Co, indicating a possible differential flow of markers within digesta.

Fecal Output Predicted From Marker Concentration in Grab Fecal Samples Uncorrected and Corrected For Recovery of Markers, as Compared to Total Fecal Collection

The accuracy of estimating true fecal output from GS, either corrected or uncorrected for marker recovery, was dependent upon type of marker. With Cr and Yb, correction for recovery had no significant effect in the predicted fecal output, except for Cr at the 9 h sampling with mature wheat forage. Cobalt estimates during the immature stage, were different among corrected and uncorrected values at all hours of sampling, except hour 4. No difference was observed for Co estimates with mature forage. The close 100 percent recovery of Yb and Cr in

Table 2. Fecal output prediction from grab fecal samples using three different markers vs total collection of feces as influenced by stage of maturity of wheat forage and adjustment for recovery of marker (kg/hd/day) (LS means, n = 8).

		Stage of maturity[1]			
		Immature		Mature	
Hour	Marker[2]	Uncorrected	Corrected	Uncorrected	Corrected
0	Co	2.73^{bc}	2.35^{d}	3.42^{b}	3.31^{b}
	Cr	2.07	2.05	2.46	2.64
	Yb	NA[3]	NA	2.63	2.78^{b}
	True	2.06^{a}		2.38^{a}	
3	Co	6.69^{bc}	5.77^{bd}	5.08^{b}	4.81^{b}
	Cr	2.32	2.30	2.33	2.47
	Yb	NA	NA	2.67	2.82
	True	2.06^{a}		2.38^{a}	
4	Co	5.36^{b}	4.62^{b}	3.60^{b}	3.48^{b}
	Cr	2.21	2.20	2.18	2.31
	Yb	NA	NA	2.69	2.85
	True	2.06^{a}		2.38^{a}	
6	Co	8.44^{b}	7.27^{b}	8.23^{b}	7.96^{b}
	Cr	2.28	2.26	2.65	2.81
	Yb	NA	NA	2.53	2.67
	True	2.06^{a}		2.35^{a}	
9	Co	4.37^{bc}	3.77^{bd}	3.39^{b}	3.28^{b}
	Cr	2.50^{b}	2.48^{b}	2.68	2.84^{b}
	Yb	NA	NA	2.54	2.69
	True	2.06^{a}		2.31^{a}	
12	Co	4.88^{a}	4.20^{b}	4.82^{b}	4.66^{b}
	Cr	1.97	1.96	2.25	2.38
	Yb	NA	NA	2.31	2.44
	True	2.06^{a}		2.38^{a}	
24 h Mean					
	Co	5.44^{bc}	4.69^{bd}	4.70^{b}	4.55^{b}
	Cr	2.21	2.20	2.42	2.56
	Yb	NA	NA	2.56	2.71
	True	2.06^{a}		2.38^{a}	

[1] Immature = March 7-27; Mature = April 22-May 14.
[2] Co = CoEDTA solution; Cr = Cr_2O_3 powder; Yb = Yb-labeled wheat forage.
[3] NA = not available.
Means are different from true values = a,b (P<.05).
Corrected vs uncorrected means are different: c,d (P<.05).

feces caused correction for recovery to have no effect on the predictions of fecal output. Comparisons of true fecal output obtained by total collection and fecal output estimated from GS are presented as uncorrected and corrected values (Table 2). An indication of variability within each method of measurement of FO was considered. This was derived from the uncorrected total sum of squares obtained in the analysis (General Linear Model) of the differences among fecal output estimated by the dilution marker technique as compared with total fecal collections. Fecal output estimated with Cr had the smallest variation followed by Yb while those obtained with Co exhibiting the greatest variation.

In conclusion, these data confirm sources of variation and their implications with regard to obtaining estimates of fecal output of cattle grazing wheat pasture. The need to validate both choice of marker and its time of sampling after dosing is also demonstrated. Failure to do this may result in biased estimates of FO. Chromium oxide powder and Yb-WF gave comparable estimates of FO, while Co-EDTA gave highly variable estimates of FO.