Estimation of Fecal Output and Dry Matter Digestibility Using Various Chromic Oxide Marker Methods in the Horse

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Story in Brief

Eight Quarter Horse yearlings were used in a split plot designed experiment to estimate fecal output (FO) and dry matter digestibility (DMD) using different methods of chromic oxide administration. The two methods of chromic oxide application were: 1) mixed with the concentrate during pelleting (mixed diet), and 2) top-dressed on the concentrate prior to feeding (top-dressed diet). Total fecal output was measured to compare with calculated values. Diurnal grab samples were also taken at 6-h intervals for 24 h to measure variation in chromium (Cr) concentration over time. Dry matter intake did not differ between treatments. Calculated FO was higher in the mixed diet versus the top-dressed. Consequently, DMD was lower in the mixed diet versus the top-dressed. However, measured FO did not differ between treatments. Since calculated FO and DMD differed significantly between treatments, all subsequent data comparing calculated FO to measured FO will be reported within treatment. Within the mixed diet, calculated FO was higher than the measured FO. Similar results were found in the top-dressed diet, as calculated FO was higher than the measured. Concerning changes in Cr concentration over time, there was no significant diurnal variation in fecal Cr excretion within treatments. However, fecal Cr content was significantly higher in the top-dressed vs the mixed treatment at all times. It appears from these data that the use of Cr may result in an overestimation of fecal output.

Key Words: Fecal Kinetics, Chromic Oxide, Horses, Digestibility

Introduction

Chromic oxide was introduced as an external indicator by Edin (1918). Inert markers such as chromic oxide provide a means to estimate total fecal output, which is used to calculate digestibility when the collection of total fecal output cannot be done. Maynard et al. (1979) stated that an ideal marker for determining digestibility and fecal output should have the following properties: 1) totally indigestible, 2) pharmacologically inactive within the digestive tract, 3) pass through the tract at a uniform rate, 4) readily determined chemically, and 5) preferably a substance naturally present in the feed. There have been many problems associated with use of chromic oxide such as incomplete recovery and difficulty in determination of chromium concentration (Kotb and Luckey, 1972; McCarthy et al., 1974; Parr, 1977; Fenton and Fenton, 1979). Recovery rates have reported to range from 96.0% to 100.1% in horses (Haenlein et al., 1966). In mature swine, a recovery rate of 93.3% of the dietary chromium was reported (Saha and Gilbreath, 1991). Therefore, the objective of the present study was to test for differences in route of administration of chromic oxide and compare calculated fecal output values to total fecal collection for the determination of dry matter digestibility.

Materials and Methods

Eight Quarter Horse yearlings were used in a split-plot design experiment to estimate fecal output (FO) and dry matter digestibility (DMD) using different methods of chromic oxide (Cr_2O_3) administration. Horses were blocked by weight and sex and then randomly assigned to one of two treatment groups. The trial consisted of a 7-d adjustment period followed by a 72-h collection period. Horses were housed in 12' x 12' stalls and allowed free exercise (3 h /d) during the adjustment period and were hand walked (15 to 20 min) during the collection. Diets consisted of a pelleted concentrate of corn, soybean meal, and dehydrated alfalfa fed in a 60:40 ratio with native prairie grass hay (Table 1). Rations were formulated to meet current NRC (1989) requirements for yearling horses. The two methods of Cr_2O_3 application were 1) mixed with concentrate during pelleting (mixed diet) and 2) top-dressed on the concentrate prior to feeding (top-dressed diet). The Cr_2O_3 was mixed with corn sugar syrup and poured onto the pelleted ration prior feeding for the top-dressed treatment. Horses were weighed prior to initiating the trial and fed at 2.5% of the average body weight. Horses were fed at 7:00 am and 7:00 pm daily. Feed intake was calculated so that each group would receive 12 g of Cr_2O_3 (8 g of chromium) per day.

Table 1. Composition of diet, as fed

Ingredients, %	Mixed diet	Top-Dressed diet
Corn	16.9	17.0
Wheat	17.0	17.0
Alfalfa meal	15.0	15.0
Soybean meal	10.1	10.1
Limestone	.15	.15
Trace mineral salt	.30	.30
Dicalcium phosphate	.45	.45
Chromic oxide	.10	--
Prairie grass hay	40	40

Total fecal output was collected in three 24-h intervals. Horses were tied on rubber mats in box stalls during the collection period. At the end of 24 h, the composite was weighed and subsequent grab samples were taken and frozen for future chromium analysis. Diurnal fecal samples were also collected at 6:00 am, 12:00 pm, 6:00 pm, and 12:00 am to measure variation in fecal chromium concentration. Feed sample (8 samples total) were also taken (every fifth bag) to determine the variability in chromium concentration over a ton of feed.

Chromium analysis of feed and fecal samples was completed using inductively coupled plasma spectroscopy (ICAP 61, Spectro Analytical Instruments, Fitchburg, MA). Data were analyzed as a split plot design using general linear model procedure of SAS (SAS Inst. Inc., Cary, NC) with horse, treatment, and day as main effects. Least squares means were calculated and differences between treatments were detected using the p-diff procedure of SAS and significance was declared at $P<.05$.

Results and Discussion

Data for dry matter intake and the effect of chromic oxide application method on fecal output (FO) and dry matter digestibility (DMD) are reported in Table 2. Dry matter intake did not differ

significantly between treatments. Calculated FO was higher (P<.05) in the mixed diet (4190g/d) versus the top-dressed (3338g/d). As a result, DMD was lower (P<.05) in the mixed diet (56%) versus the top-dressed (64%). However, measured FO did not differ significantly between treatments. These data suggest an overestimation of FO and subsequent underestimation in DMD of calculated values compared to the measured values. This would indicate a low recovery of Cr_2O_3. In the present study recovery rates of fecal Cr were 60% and 81% for the mixed and the top-dressed respectively. In support of these findings, Knapka et al. (1967) and Jagger et al. (1992) reported low recovery rates of Cr when using Cr_2O_3 as an inert marker. In the present study, total FO for the measured values was collected every 2-h off a wooden floor. These measured values should, therefore, more accurately reflect total fecal output and dry matter digestibility. Research has indicated that Cr_2O_3 gave significantly lower recoveries, which has been attributed to the fineness of particle size of the marker leading to retention by the gastro-intestinal tract (Barnicote, 1945).

Table 2. Effect of chromic oxide application on dry matter intake, fecal output, and dry matter digestibility[a]

	Treatment		
	Mixed	Top-Dressed	S.E.M.
DM intake, g/d	9421	9442	24.15
Fecal output, g/d			
Measured	2530[d]	2693[d]	97.71
Calculated	4190[be]	3338[ce]	61.63
Dry matter digestibility, %			
Measured	73[d]	71[d]	2.3
Calculated	56[be]	64[ce]	.64

[a]Values are least squares means.

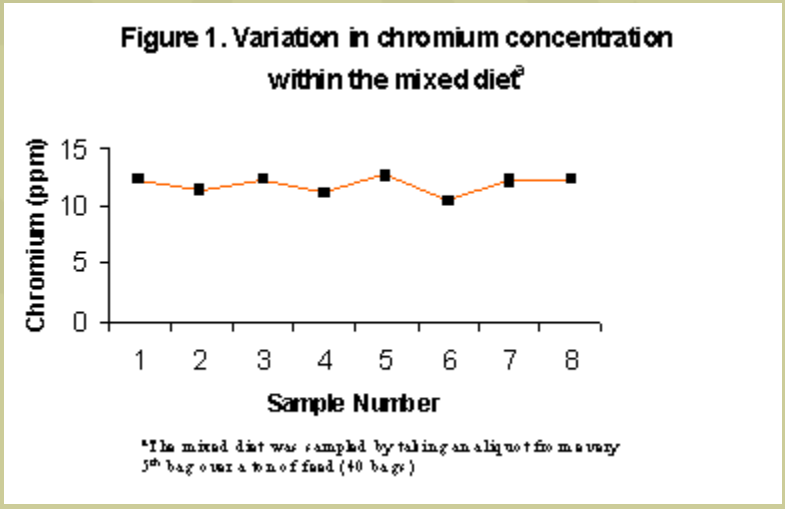
[b,c]Means within a row with different superscripts differ (P<.05).

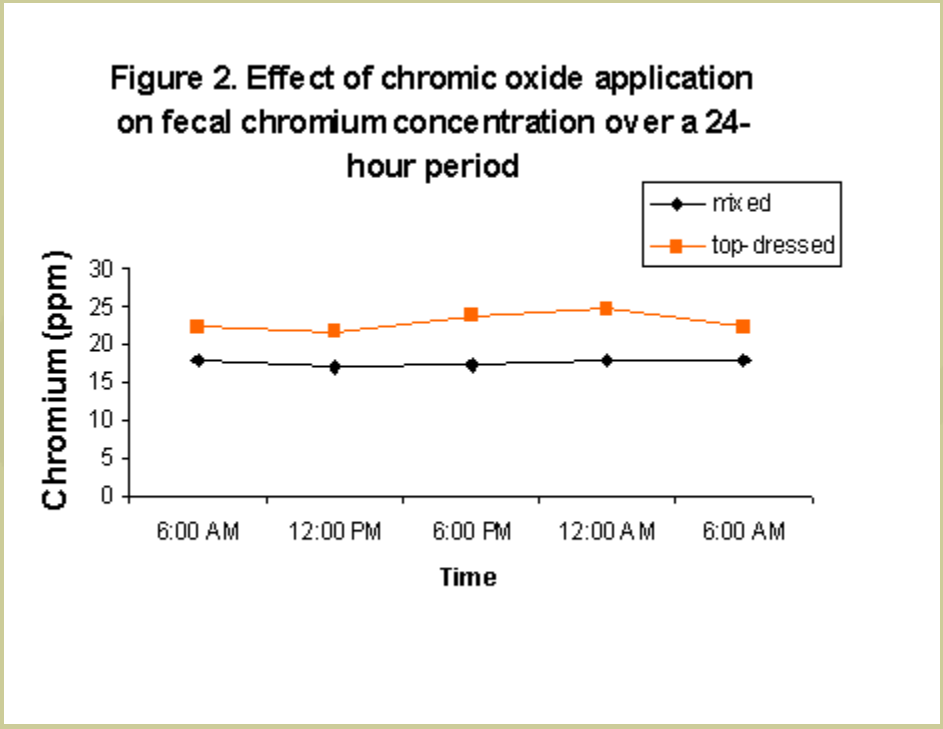
[d,e]Means within a column with different superscripts differ (P<.05).

Since there was a significant difference between application methods, FO and DMD are reported within each treatment. Within the mixed diet, calculated FO (4190g/d) was higher (P<.05) than the measured (2530g/d). Subsequently, calculated DMD (56%) was lower (P<.05) than the measured (73%). Concerning the top-dressed diet, calculated FO (3338g/d) was significantly higher than measured (2693g/d). As well, calculated DMD (64%) was significantly lower when compared to the measured (71%).

The variation of chromium concentration in the feed is illustrated in Figure 1. There was no significant difference in chromium concentration throughout the ton of feed between the eight samples. Additionally, changes in diurnal fecal chromium excretion can be seen in Figure 2. There was no significant diurnal variation in fecal chromium excretion within each treatment. The present study suggests that two doses of 6 g of Cr_2O_3 12 h apart were sufficient to keep diurnal variation to a minimum. Knapka et al. (1967) and Jagger et al. (1992) also found no significant variation in diurnal chromium excretion rates. Contrary to these findings, Haenlein et al. (1966) and Van Leeuwen et al. (1996) observed significant changes in diurnal chromium excretion in horses and pigs. The present study, however, does show that the top-dressed diet

was significantly higher in Cr then the mixed diet at all measured intervals. This further supports the previous data, which demonstrates a higher calculated FO in the mixed diet versus the top-dressed.





Conclusion

The results from this trial reveal a significant difference in fecal output for calculated values when compared to total measured. This resulted in an overestimation in the calculated fecal output and consequently an underestimation in dry matter digestibility. In addition, there was an observable effect in the application method. Therefore, this trial suggests that chromic oxide

may not be as reliable as a total fecal collection in the determination of total fecal output and subsequent dry matter digestibility.

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