FATE OF DRINKING WATER IN RUMINANTS: SIMULTANEOUS COMPARISON OF TWO METHODS TO ESTIMATE RUMINAL EVASION

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Story in Brief

Two methods to estimate ruminal evasion of drinking water in cattle were tested simultaneously. Estimates of evasion were 30.5 18 and 45.3 9% of intake for the inflow/outflow method and the marker ratio method, respectively. Estimates were comparable to previous estimates from other experiments. Based on relative precision and the need to base input/output data on a single estimate of ruminal volume and outflow, the marker ratio method seems preferable to estimate evasion.

(Key Words: Drinking Water, Ruminants.)

Introduction

In our studies of the fate of drinking water in cattle, we have used several approaches to measure ruminal evasion. Xylose, a sugar presumably excreted following absorption, and water soluble markers (WSM) have been employed. Failure to quantitatively recover intravenously injected xylose in urine forced us to focus our attention on WSM.

In previous experiments, two approaches were used to study behavior of WSM within the rumen. These were the measurement of ruminal outflow of the WSM offered in the drinking water as a proportion of its inflow (intake), and the ruminal concentration ratio of two WSM, one being offered in the drinking water and the other being infused directly into the rumen. These were compared and differences were observed (Garza et al., 1990). Nevertheless, simultaneous use of both approaches had not been conducted. Direct comparison avoids confounding of method with experiments, diets and animals. This report describes results from a simultaneous comparison of these two approaches.

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Materials and Methods

A completely randomized design with three replicate measurement periods was used with three mature cattle (990 lb BW) fitted with large ruminal cannulas, housed individually and given ad lib access to a high roughage diet (2.3% BW as-fed basis) with fresh feed added twice each day. Water was continuously available from open troughs and individual voluntary consumption was recorded at 2 to 4-h intervals from 8 a.m. till midnight. The two mathematical models applied were:

Marker ratio method:

$$\text{Ruminal evasion} = \frac{\text{[WSM 1] in rumen/daily oral dose of WSM 1}}{\text{[WSM 2] in rumen/daily ruminal dose of WSM 2}}$$

Ruminal input-output method:

Ruminal evasion = Daily consumption of water x [WSM 1 in water] - (Ruminal fluid outflow x [WSM 2 in rumen fluid]

where

WSM 1 is CrEDTA offered in the drinking water and WSM 2 is CoEDTA infused into the rumen.

During the last 5 days of each 15-day period, CrEDTA was added to the drinking water (daily dose range 650-970 mg/head). CoEDTA was infused into the rumen (daily dose range 350-420 mg/head) at 8-h intervals on the first four days of the 5-day period. During the third, fourth and fifth day, ruminal fluid samples were obtained at approximately 4-h intervals. Terminating CoEDTA dosing into the rumen allowed us to estimate ruminal fluid dilution rate. At the end of each period, total ruminal contents were evacuated and volumes of total digesta were separated into free liquid and total solids by filtration through a screen with .25 x .25 inch pores.

Least squares means for ruminal evasion estimates were compared with a model including method, animal, period, period x animal, and animal x method interaction as sources of variation. The animal x method interaction was used as the error term to test differences between methods. In addition, coefficients of variation and determination were obtained for each evasion estimate approach.

Results and Discussion

Mean estimates for drinking water evasion for each method together with coefficients of variation (CV) and determination for each model are shown in Table 1. Although no difference was observed between methods of estimation of ruminal evasion, numerical values differed by 15 percentage units. Because we have no absolute measurement of evasion, relative validity of the two methods cannot be determined. Based on the relative repeatability of these methods, the marker ratio model had a lower CV and accounted for a greater proportion of the total variation.

The ruminal inflow-outflow balance method relies on the assumption that ruminal volume and fractional outflow rate are constant and outflow is based on a single estimate of dilution rate and ruminal volume. With infrequent feeding and water intake, these assumptions may be invalid. Hence, the marker ratio approach seems more suitable for dynamic systems and more appropriate for estimating ruminal evasion of drinking water in cattle. However, dosing times relative to water intake and site of ruminal dosing and sampling may add to the error and complicates physiological interpretation of evasion, if evasion is simply a phenomenon of incomplete ruminal mixing.

Table 1. Comparison of two methods to estimate ruminal evasion.

Item	Method	
	Marker ratio	Input - Output
Water evasion, % of drinking	45.3 ± 9.1[a]	30.5 ± 18.0
Coefficient of:		
Determination	.874	.841
Variation	10.6	47.2

[a] Least squares mean ± standard deviation.

Literature Cited

Garza, J. et al. 1990. Ruminal water evasion and steady state. Okla. Agr. Exp. Sta. Res. Rep. MP-129:114.