RUMINAL FLUID, A MULTI-POOL SYSTEM?

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Story in Brief

Liquid mixing within the rumen of three mature steers consuming a hay-based diet was investigated by administering two water soluble markers (cobalt and chromium complexes of ethylenediamine-tetraacetic acid) simultaneously by direct ruminal infusion or by mixing into the drinking water, respectively. Sampling sites differed in marker concentrations, being lower in the reticulum than at other sites in the rumen. This suggests that drinking water does not fully mix with total rumen fluid and that several pools of ruminal fluid exist. The reticular liquid pool has a faster dilution rate than total ruminal fluid. Incomplete mixing and presence of subpools may explain why drinking water partly evades the rumen and suggests that small dense particles flushed with liquids from the rumen also may evade ruminal digestion as well.

(Key Words: Rumen, Kinetics, Fluid Digesta.)

Introduction

Greater understanding of the drinking behavior of cattle and the fate of consumed fluid within the rumen may lead to new strategies for delivering specific nutrients to the post-ruminal tract of cattle. An increased nutrient supply may improve performance or efficiency.

For many years, ruminal fluid volume and passage in cattle has been studied using water soluble markers (WSM) under the assumption that these WSM mix with and behave similarly to total rumen fluid. Estimates that 40 to 90% of drinking water evades the rumen questions this assumption and suggest that several liquid subpools may exist in the rumen which differ in size and turnover rate. The objective of this study was to investigate this theory.

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Materials and Methods

A completely randomized design with three replicate measurement periods was used with three mature steers (990 lb) limit-fed a hay-based diet (2.3% BW/day; as-fed basis). During four consecutive days of a 20-day period, all animals were dosed three times a day via ruminal cannula with the cobalt salt of ethylenediamine-tetraacetic acid cobalt (CoEDTA) every 8 h; chromium (CrEDTA) was present in the drinking water. Ruminal fluid samples were obtained at 10:00 a.m. of day 5 (26 h after the last ruminal CoEDTA dose) from the reticulum, the ventral anterior and posterior sacs and as a total mixed sample of fluid obtained by total evacuation of ruminal contents.

Least squares means for marker concentrations were compared with a general linear model including marker type, rumen sampling site, animal, period and respective interactions. The error term for period x marker x animal interaction was used to analyze marker differences. Site differences among markers were tested using the residual error term.

Results and Discussion

Least squares mean relative concentrations for each marker (marker concentration expressed as a fraction of the daily dose) and relative difference comparisons across markers (the difference between Co and Cr relative concentration within each sampling site) are shown in Table 1. For CrEDTA, which was given in drinking water, relative marker concentrations differed ($P<.01$) between the reticulum and the total mixed fluid pool sample. With CoEDTA, the marker dosed into the rumen, relative marker concentrations differed ($P<.05$) between the reticulum and the ventral posterior ruminal sac. Relative differences between fractional concentrations of both markers were similar among all rumen sites suggesting that both markers were equilibrating with the same total fluid pools.

The lower concentration of Cr, the marker given in drinking water, and Co, the marker dosed intraruminal, in the reticulum as compared to the total pool samples and the ventral posterior sac, respectively, indicates that the liquid pool of the reticulum has a greater dilution rate (indicated by its lower concentration). Dissimilarity of these two markers when administered by different routes (infused directly vs in the drinking water) is further evidence for the presence of a reticular subpool which has a faster turnover rate than the total ruminal liquid pool.

Table 1. Rumen fluid concentrations of two water soluble markers obtained from different sites of the rumen of cattle consuming a hay-based diet (least squares means; n=3).

Sampling site[b]	Water soluble marker, relative concentration[a]		Relative difference[c]
	CoEDTA dosed in rumen	CrEDTA in drinking water	
Total content	.0076[de]	.0051[f]	.0025
Reticulum	.0075[d]	.0045[g]	.0030
Ventral ruminal:			
Anterior	.0077[de]	.0048[fg]	.0029
Posterior	.0078[e]	.0048[fg]	.0030
SE	.00011	.00011	.00074

[a] Marker concentration as a fraction of daily dose.
[b] Total content is whole rumen fluid content obtained after evacuation. All others are samples obtained manually through a large rumen cannula, before evacuation.
[c] Relative difference is the difference between concentrations of the two markers for each rumen site sampled.
[d,e] Means in the same column with different superscripts differ ($P<.05$).
[f,g] Means in the same column with different superscripts differ ($P<.01$).