IMPACT OF OSMOTICALLY ACTIVE COMPOUNDS ON RUMEN DIGESTA KINETICS

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Story in Brief

With concentrate diets, high intakes of NaCl increased intake of water by 55% (5.81 ± .69 vs 8.98 ± .45 gallons/day), while reducing rumen volume 35% (12.68 ± 1.69 vs 8.19 ± 2.35 gallons). Consequently, a shifting of digesta downstream could be expected, flushing small dietary particles, like protein meals, to the small intestine and improving its utilization. Cattle consuming high roughage diets may be less susceptible to ruminal manipulation by means of osmotically active compounds.

(Key Words: Ruminants, Digesta Kinetics, Osmolality, Drinking Water.)

Introduction

Osmotically active compounds within the rumen have been used to alter ruminal fermentation through modification in the kinetics of the fluid fraction of the digesta. Traditionally, the rumen is viewed to thoroughly mix consumed feed and water with ruminal contents, assuming all drinking water arrives into the rumen. Our recent research supports the concept that a substantial proportion of drinking water evades or does not fully mix with rumen fluids (Garza et al., 1990). Therefore it seems possible to manipulate the extent of ruminal evasion and(or) residence time of drinking water within the rumen.

To test the possibility for altering the ruminal function and fate of drinking water, two experiments were conducted under contrasting dietary regimes, high concentrate or hay-based diets.

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Materials and Methods

Experiment 1.

Four adult ruminally cannulated steers (990 lb BW) housed in individual stalls were fed twice daily on 80% concentrate diet (2% of body weight; as fed basis). Three steers received 5% NaCl in their diets, while one animal remained on a .5% NaCl. Water was always available from an open trough.

Ruminal water evasion was estimated by comparing the intake of polyethylene glycol (PEG) in drinking water and its outflow from the rumen. Outflow was calculated from dilution rate of ruminally dosed CoEDTA, ruminal volume (evacuation) and PEG concentration in the rumen fluid. Osmolality of rumen fluid was measured also.

Two previous measurements of drinking water and rumen volumes obtained under similar management and feeding regimes as those adopted in the present trial for the only animal kept on the low NaCl diet were also included to compare treatment means difference against the high NaCl diet.

Experiment 2.

A 3 x 3 Latin square design was used with three mature steers (990 lb) with rumen cannulas. Steers were individually penned and fed a hay-based diet ad libitum, plus a protein supplement (2 lb/head/day). Treatments were: 1) Control (C, no extra supplement); 2) Salt (NaCl, 140 to 160 g/head/day); or 3) Dried molasses (Molasses, 2 lb/head/day). Water was always available from open troughs, provided with a scale indicator to facilitate recording of water intake. In each of the three 21-day periods employed, voluntary hay intake and ruminal evasion of drinking water was estimated in the last 4 days, in addition to a manual rumen evacuation on day 21. Jugular blood samples were obtained simultaneously with the evacuation.

Results and Discussion

Results for Experiments 1 and 2 are presented in Tables 1 and 2, respectively. In Experiment 1, the supply of NaCl (approximately 450 g/head/day) was intentionally kept at a level which would not depress intake. The net amount of drinking water estimated not to enter into the rumen (water evasion) was enhanced (59%) by a high level of NaCl in the diet. This effect was partially mediated by an increase in water consumption. Ruminal volume was cut by nearly one half (12.42 ± 1.69 vs 6.87 ± 2.01 gallons), largely

Table 1. Effect of NaCl on rumen function and liquid kinetics in steers consuming high concentrate diets in Experiment 1. (Mean ± SD).

	NaCl, % DM	
Measurement	0.5	5.0
Observations/treatment	3	3
Water intake, gallons/day	5.81 ± .69	8.98 ± .45
Water evasion[a], % intake	77 ± 9.2	79 ± 3.1
Ruminal volume:		
Total, gallons	12.68 ± 1.69	8.19 ± 2.35
Fluids, gallons	12.42 ± 1.29	6.87 ± 2.01
Solids, lb	13 ± 3.1	11 ± 3.1
Fluids/solids ratio	7 ± 1.5	5 ± 0.7
Total DM, %	12 ± 2.0	17 ± 2.0
Ruminal fluid dilution rate, %/h	3.9 ± 1.1	4.3 ± 1.2
Ruminal DM disappearance rate, %/h[b]	5.3 ± 1.3	8.3 ± 2.1
Rumen osmolality, mOsm/kg	300 ± 8.1	344 ± 8.5

[a] Water evasion = percentage of drinking water not mixing with rumen fluid.
[b] Ruminal DM disappearance rate = DM intake/DM in rumen.

due to a reduction in fluids. Total DM concentration in the rumen was increased. Ruminal osmolality failed to reach the values that would be expected if all of the added NaCl had reached the rumen (344 ± 8.5 observed vs 406 mOsm expected/kg).

With hay-based diets (Experiment 2), NaCl and molasses supplements increased water consumption over control ($P<.10$), though to a lesser extent than with concentrate diets. Neither rumen volume or fluid dilution rates, nor hay intake were influenced by treatment. Ruminal evasion of drinking water was similar among treatments, with the lowest numerical value noted for the molasses treatment (43.5% of intake) and highest for the control (48.2%). The NaCl treatment was intermediate (44.2%). Rumen fluid and plasma osmolality were similar and not influenced by treatment.

Table 2. Effect of osmotically active supplements on rumen function and liquid kinetics in steers consuming high roughage diets in Experiment 2 (Means).

	Supplements			
Measurement	Control	NaC1	Molasses	SE
Observations/treatment	3	3	3	
Daily intake:				
Hay, lb	23.1	23.5	21.1	.11
Water, gallons	8.88[a]	9.85[b]	9.72[b]	.47
Rumen content lb:				
Free liquid	104.7	111.1	104.9	2.7
Fresh solids	110.2	115.3	101.6	7.7
Total fluid	185.0	194.7	178.0	3.5
Total DM	29.9	31.7	28.8	1.5
Ruminal fluid dilution rate, %/h	5.7	5	5	.38
Water evasion, % of intake	48.2	44.2	43.5	1.95
Feces DM, %	20.2	19	18.8	1.06

a,b Means in the same row with different superscripts differ ($P<.10$).

Kinetics of ruminal fluid seems to be more susceptible to osmotically active substances in concentrate diets as compared to roughage diet. In both cases, the net ruminal evasion of drinking water appeared to be enhanced, increasing the potential for utilization of nutrients of feed origin that can be digested postruminally.

Literature Cited

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