QUANTITATIVE ORIGIN OF RUMINAL LIQUID WITH VARIOUS DIETS AND FEED INTAKES

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Story in Brief

Heifers fed hay diets drank more water (25.6 liters/day) than heifers fed concentrate (21.5 liters/day). As level of feed intake was increased, daily water consumption increased linearly. The amount of drinking water which entered the rumen was higher for the roughage than the concentrate diet (9 liters/day vs 4 liters/day). Percent of ruminal water from drinking water was greater for the hay diet (7.5%) than for the concentrate diet (5.3%). It was estimated from this study that 92 to 96% of ruminal fluid originates from saliva and water flux through the rumen wall, and not from drinking water. Type of diet and level of intake did not alter ruminal osmolality, but it influenced serum osmolality. Of drinking water consumed, 60 to 80% bypassed the rumen. Thus, drinking water may be an ideal vehicle to permit compounds (electrolytes, amino acids, vitamins, glucose) to evade ruminal fermentation.

(Key Words: Water Intake, Ruminal Water Origin, Beef Cattle.)

Introduction

Fluid in the rumen may originate from feed, drinking water, saliva and diffusion through the rumen wall. Feeding forages will increase the amount of time spent masticating and ruminating, both of which increase saliva production. Saliva is an important source of water in the rumen for buffering and for flushing fluid through the rumen.

Saliva and solutes such as volatile fatty acids (VFA) and salts in the rumen create osmotic gradients that can affect water absorption from the rumen into the blood. If the rumen contents are highly concentrated (salts, and VFA) water from blood diffuses into the rumen. Such fluxes of water are difficult to quantify because of the constant turnover of material. Digesta (liquids and solids) rate of passage techniques have evolved, but how water

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moves in and out of the rumen still is not clearly defined. When lactating cows were given water after several hours of water deprivation in one previous study (Woodford et al., 1984) up to 18% of the consumed water bypassed the rumen. The objective of this study was to assess quantitatively the origin of ruminal water by using an external liquid marker.

Materials and Methods

Two diets composed of either concentrate or hay (60% alfalfa, 40% prairie) were fed to 1320 lb heifers in two 3x3 Latin squares. Feeding methods are described in a companion paper by Garza and Owens (1989). Starting three days before ruminal evacuation polyethylene glycol (PEG) was added at a rate of 10 g per gallon of drinking water for each animal. The polyethylene glycol concentrations in drinking water and ruminal samples were determined by a turbidimetric method. Ruminal liquid and serum osmolalities were determined by the freezing point depressing procedure. Total PEG intake (g/day) was calculated by multiplying PEG concentration in the drinking water times daily water intake. Amount of PEG leaving the rumen (g/day) (PEG outflow) was calculated by multiplying PEG concentration in ruminal liquid times rumen volume times the liquid dilution rate. Liquid dilution rate was calculated from cobalt dosage and cobalt concentration in ruminal fluid 21 h later when the rumen was evacuated.

Results and Discussion

Results are presented in Table 1. As discussed previously, water intake, rumen volume, particle-associated liquid and liquid outflow were greater with the hay than with the concentrate diet. Also, as DM intake increased, water intake and ruminal dilution rate increased in a stepwise fashion. However, ruminal liquid volume did not increase as feed (and water) intake increased.

Amount of consumed water which entered the rumen with the roughage diet was more than double ($P<.01$) that with the concentrate. Yet based on PEG concentrations only 4.5 to 8.4% of ruminal liquid was obtained from consumed water. The remaining 90% presumably was derived from saliva and diffusion from blood. Some diffusion from blood would be expected when ruminal fluid osmolality is greater than blood serum osmolality. But in this study, differences in osmotic pressure between blood serum and ruminal fluids were quite small (Figure 1), so net influx of ruminal liquid from blood presumably would be minor.

Based on PEG analysis the percentage of drinking water which did not mix with rumen contents and thereby evade the rumen was greater ($P<.05$)

Table 1. Origin of ruminal liquid in beef heifers fed hay and concentrate diets.

	Diets										
	Hay			Concentrate				Hay		Conc	
Intake of DM, % wt/day	1.0	1.4	1.8	1.0	1.4	1.8	Diet	L	Q	L	Q
Water intake, l/day	19.6	26.3	30.5	15.0	20.5	29.0	.10	.001	NS	.001	.001
Rumen outflow, l/day	106.1	143.0	147.3	68.3	77.3	79.3	.001	.001	NS	NS	NS
Rumen outflow, %/h	6.1	8.1	8.8	6.4	6.6	7.4	NS	.001	NS	.06	NS
Rumen volume, l	70.5	74.0	69.5	44.6	49.1	45.7	.001	NS	NS	NS	NS
Free liquid, l	45.3	40.6	36.3	34.2	36.8	32.0	NS	.008	NS	NS	NS
Bound liquid, l	25.0	32.7	32.9	10.3	12.0	13.4	.001	.003	.02	NS	NS
Rumen water from drinking water.											
Drinking water entering the rumen, l/day	9.0	9.3	11.4	3.0	4.0	5.0	.002	NS	NS	NS	NS
% from drinking	8.4	6.3	8.0	4.5	5.0	6.3	.08	NS	NS	NS	NS
Bypass of drinking water, l/day	10.6	16.5	22.0	13.2	17.0	24.1	NS	.001	NS	.001	NS
% of consumed	54.1	64.6	66.6	81.4	79.7	82.2	.002	NS	NS	NS	NS

L = Linear effect of level (treatment).
Q = Quadratic effect of level (treatment).
NS = No significance.

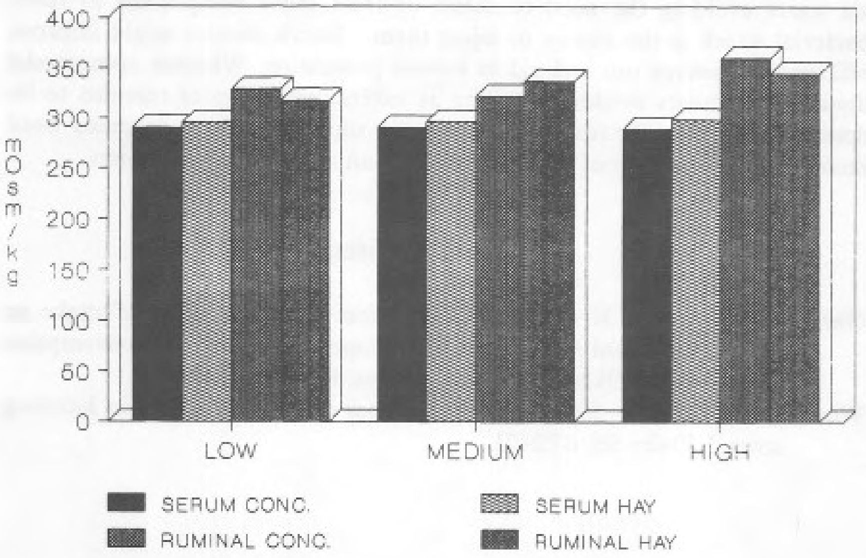

Figure 1. Ruminal liquid and serum osmolality changes in heifers fed concentrate vs. hay diets.

with the concentrate than the roughage diet (81.0 vs 60.4%), values much higher than following water deprivation (Woodford et al., 1984). This water presumably was flushed through the rumen due to the proximity of entry and exit points. Such a high level of water evasion has a number of nutritional and health implications.

First, if all drinking water entered the rumen, it would cause drastic shifts in volume, osmotic pressure and, in some cases, temperature. Such changes would be detrimental to the microbial population and disrupt the fermentation process. Thus, extensive bypass will prevent disturbance of ruminal function.

Secondly, high bypass means that the amount of drinking water consumed will not alter turnover or dilution of ruminal contents. Hence, feeding salt or compounds to increase water intake might not be expected to increase ruminal turnover and thereby improve efficiency of microbial growth in the rumen.

Third, high bypass of drinking water can provide a vehicle to increase flow of selected nutrients to the intestines for digestion and absorption. For shipping stressed cattle, electrolytes, amino acids and B vitamins in water should escape fermentation and potentially could improve health status. Soluble protein, amino acids, vitamins or electrolytes might be supplemented via water avoiding the need to select or treat these compounds to resist bacterial attack in the rumen or inject them. Starch slurries might improve efficiency of energy use and aid in ketosis prevention. Whether commercial liquid supplements evade the rumen as extensively as water remains to be determined. Overall, results indicate that supplementation schemes need reconsideration in light of this new information about ruminal evasion.

Literature Cited

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