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Influence of water treatment on digestion dynamics of steers consuming high- and low-forage diets

Abstract

The influence of drinking water treatment (Oxion Inc., Hugoton, KS) on digestion and metabolism was evaluated in steers fed low- and high-forage diets. Water treatment did not influence digestibility of any nutrient measured nor did it influence the profile of ruminal metabolites. Water treatment did increase water consumption two- to threefold and also increased ruminal fractional water outflow (%/h) for steers fed the high forage, but not the high concentrate, diet. Increased water consumption could be a beneficial response, but it is not known if water consumption increases with management programs different than those used in the present study.

Keywords

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INFLUENCE OF WATER TREATMENT ON DIGESTION DYNAMICS OF STEERS CONSUMING HIGH- AND LOW-FORAGE DIETS

D. L. Harmon and A. D. Flood

Summary

The influence of drinking water treatment (Oxion Inc., Hugoton, KS) on digestion and metabolism was evaluated in steers fed low- and high-forage diets. Water treatment did not influence digestibility of any nutrient measured nor did it influence the profile of ruminal metabolites. Water treatment did increase water consumption two- to threefold and also increased ruminal fractional water outflow (%/h) for steers fed the high forage, but not the high concentrate, diet. Increased water consumption could be a beneficial response, but it is not known if water consumption increases with management programs different than those used in the present study.

(Key Words: Steer, Water, Digestibility, Intake, Rumen.)

Introduction

A relatively new system is being marketed in Kansas for treatment of livestock drinking water. This system involves a process whereby air is passed through an electrical field and then bubbled through drinking water. This process of water treatment has been utilized for feedlot cattle and improvements in animal performance have been reported. This study was undertaken to examine the effects of water treatment on ruminal metabolism and diet digestibility in steers fed low- and high-forage diets.

Experimental Procedures

Six ruminally cannulated Holstein steers, (450 lb) were utilized in a Latin square design experiment. The treatment structure was a 2 × 3 factorial with factors being diet: 80% forage:20% grain or 80% grain:20% forage, and water treatment: control (no treatment) and low (one-half voltage) or high Oxion treatment. The forage used was good quality alfalfa hay (18% CP), and the grain mixture was composed of 44.8% cracked corn, 44.8% rolled sorghum grain, .9% dical, .23% NaCl, and .1% Vitamin A and D. Additional monocalcium phosphate and salt were added to the low forage diet to meet nutrient requirements. Animals were tethered in tie-stalls and fed in two portions daily at 0800 and 1700 h. Feed was offered at 2.5% of body weight (as fed basis) to ensure equal and complete feed consumption. Water was available free choice from individual 2-gallon tanks equipped with floats and a metered supply line to enable determination of daily water consumption.

Each period was composed of 3 weeks, 1 week for switching of diets to prevent digestive disturbance, 1 week of adaptation, and 1 week of sampling. The sampling period consisted of a 7-day total fecal collection for estimating digestibility. Three days prior to the end of each experimental period, steers were dosed intraruminally prior to the morning feeding with 200 ml of Cr:EDTA to estimate ruminal water kinetics. Samples of ruminal fluid for Cr, volatile fatty acids, and pH analyses were collected at 3, 6, 9, 12, 18, and 22 h postdosing.

Results and Discussions

Dry matter intakes were equalized, and the only differences seen in other nutrients were the result of differing chemical composition of the diets (Table 1). Similarly, the majority of differences seen in digestibility were inherent in the differing diet compositions. Neutral detergent fiber digestibility was higher for animals receiving the low-Oxion treatment. This would suggest stimulation of fiber-digesting microorganisms.

Treated water had a higher pH ($P < .01$), a higher oxidation-reduction potential ($P < .05$), and a higher percent oxygen saturation ($P < .01$). The pH was higher simply because of the bubbling of air through the water. The oxidation-reduction potential is an indicator of oxidizing or reducing power and was high because of the higher oxygen content. These changes could possibly be induced through bubbling air alone through the water. Also, there was a diet effect on the water parameters. Oxygen saturation was higher on the 80% concentrate diet. Because dietary treatments were independent of water treatments, that may represent a chance occurrence. The most notable influence of water treatment was the effect on water intake (Table 2). Water intake increased nearly 2.5 to 3 times ($P < .01$) and was not different for the low-Oxion or high-Oxion treatment. The increased water intake did not influence ruminal volume or ruminal liquid outflow, which were lower ($P < .05$ and $P < .01$, respectively) for steers fed the 80% concentrate. However, there was a diet by water treatment interaction ($P < .05$) for ruminal fractional outflow. It increased from 5.5 to 9.5%/h on the forage diet but was unaffected on the high concentrate diet. This may relate to the greater viscosity of ruminal fluid in steers fed the high concentrate resulting in poorer marker equilibration and (or) poorer drinking water equilibration.

Ruminal pH, oxidation-reduction potential, and volatile fatty acids (Table 2) were all affected ($P < .05$) by diet, but none was influenced by water treatment. Only butyrate for steers consuming the high concentrate diet tended ($P < .10$) to be influenced by water treatment. Water treatment resulted in no measurable changes in fermentation or digestibility. The large increase in water intake seen may be a beneficial response, but additional research is needed under more typical management schemes.

Table 1. Influence of Water Treatment on Intake and Digestibility in Steers Fed High- or Low-Forage Diets

Item (Diet: / Water:)	80% Forage: Low Oxion	80% Forage: High Oxion	80% Forage: Control	80% Concentrate: Low Oxion	80% Concentrate: High Oxion	80% Concentrate: Control	SE	Probability[a]: Diet	Probability[a]: Water	Probability[a]: Dt. × Wtr.
Intake, kg/d										
Dry matter	6.5	6.7	6.6	6.7	6.7	6.7	.35			
Organic matter	5.9	6.1	6.0	6.4	6.4	6.5	.31	**		
Neutral detergent fiber	2.54	2.62	2.63	1.24	1.22	1.25	.17	**		
Acid detergent fiber	1.74	1.79	1.79	.63	.62	.64	.12	**		
Crude protein	1.08	1.11	1.12	.79	.78	.79	.06	**		
Starch	.86	.94	.81	3.45	3.44	3.45	.13	**		
Digestibility, %										
Dry matter	65.4	68.2	65.3	72.8	72.9	71.0	1.6	**		
Organic matter	67.4	70.3	67.6	74.0	74.0	72.3	1.6	**		
Neutral detergent fiber[b]	49.6	54.5	51.0	54.3	59.8	53.5	2.4	**		
Acid detergent fiber	49.4	53.3	51.7	51.4	53.4	48.9	2.1			
Nitrogen	69.8	71.5	69.3	63.4	63.7	59.9	1.7	**		
Starch	86.9	89.7	86.7	84.3	82.6	83.7	1.9	*		

[a]** ($P < .01$), * ($P < .05$).
[b]Low vs High Oxion ($P < .05$).

Table 2. Influence of Water Treatment on Water and Ruminal Parameters for Steers Fed High- or Low-Forage Diets

Item	Diet: Water	80% Forage Control	80% Forage Low Oxion	80% Forage High Oxion	80% Concentrate Control	80% Concentrate Low Oxion	80% Concentrate High Oxion	SE	Probability[a] Diet	Probability[a] Water	Probability[a] Dt.* Wtr.
Water pH		6.26	7.34	7.46	6.36	7.46	7.55	.10		**	
Water redox, mV		-35.2	40.4	71.7	-11.2	57.5	87.1	38.8		*	
Water oxygen saturation, %		.69	3.98	5.58	0.84	6.10	5.86	0.50	*	**	
Water intake, liters/d		10.4	25.4	28.8	8.7	22.8	24.6	4.2		**	
Ruminal volume, liters		40.1	36.3	34.8	21.4	32.2	24.3	5.3	*		
Ruminal outflow, liter/h		2.0	2.3	2.4	1.1	1.8	1.2	.3	**		
Ruminal fractional outflow, %/h		5.5	6.6	9.5	5.2	5.8	5.1	.8			*
Ruminal pH		6.33	6.37	6.44	6.10	6.12	6.12	.06	**		
Redox, mV		-172	-178	-183	-158	-156	-153	3.9	**		
Ammonia, mM		15.8	13.9	16.3	11.0	8.9	11.6	2.4			
VFA, mol/100 mol											
Acetate		69.4	68.7	69.8	60.6	60.2	59.9	1.3	**		
Propionate		18.7	19.2	18.5	24.6	26.0	27.1	1.4	**		
Isobutyrate		1.01	1.05	1.05	.89	.83	.85	.04	**		
Butyrate[b]		8.3	8.3	8.0	10.5	8.8	8.9	.57	*		
Isovalerate		1.6	1.7	1.6	2.6	2.5	2.4	.20	**		
Valerate		1.0	1.0	1.0	.0	.8	.8	.04	**		
Total VFA, mM		112.6	106.9	105.8	91.5	88.1	97.7	5.1	**		
Acetate/Propionate		3.8	3.6	3.8	2.5	2.3	2.4	.20	**		

[a]**(P < .01) *(P < .05).
[b]Control vs. Low and High on 80% concentrate diet (P < .10).