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Impact of Withholding Feed on Weight and Composition of Ruminal Contents

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Authors:

S.M. Janloo, H.G. Dolezal, C. Strasia, W. Clarkson, F.N. Owens and A. La Manna

Story in Brief

To determine how weight and composition of ruminal contents change during fasting, ruminally cannulated heifers (410 kg) were used in three experiments. In the first trial, ruminal contents of 10 heifers were fully evacuated at 0, 12, 24, and 36 h after the last meal of an 84% concentrate diet based on rolled corn. Mass of ruminal contents decreased steadily for 24 h but less rapidly thereafter. At 24 h, weight of ruminal contents had decreased by 20% while weight of organic matter had decreased by 44%. In Trial 2, six heifers were fed the diet above, either without or with monensin. Again, weight of ruminal contents had decreased by 19% by 24 h while ruminal organic matter had decreased by 68%. For Trial 3, six heifers were transported to Goodwell, OK and fed feedlot diets (92% concentrate) based on either high moisture corn or steam flaked corn. Weight of ruminal contents, though considerably lower with processed grain than with the rolled corn diets in earlier trials, had decreased by only 7% at 24 h although organic matter had decreased by 50%. Live weight losses at 24 h for the three trials averaged 2.0, .4 and .7%. With 24 h of feed withdrawal, ruminal pH increased to values above 6.5; reduced acidity should permit fiber digestion to resume. The decrease in organic matter content of the rumen indicates that the "pollution potential" of ruminal contents for packing plants could be reduced by 50 to 60% by withholding feed for 24 h prior to harvest.

(Key Words: Feed Withdrawal, COD, Rumen Contents.)

Introduction

At every packing plant, each feedlot steer yields about 50 lb of partially digested feed (about 22% dry matter) from the rumen. Possessing a very pungent, penetrating, and persistent odor, ruminal contents are a major waste stream for packing plants. A plant slaughtering 5,000 cattle daily must dispose of 175 ton of ruminal contents every day. Currently, most ruminal contents are spread on land as a fertilizer, although small amounts are processed through waste treatment plants or lagoons. At a few packing plants, the liquid is expressed and the residual solids are incorporated into feedlot diets. Withholding feed from cattle for 24 to 48 h prior to marketing would be expected to substantially reduce the quantity of ruminal contents that needs to be handled and disposed. Although feed withdrawal prior to marketing is a routine practice in the poultry industry, effects of feed withdrawal on composition of ruminal contents have never been measured with feedlot cattle. In addition to reduced waste disposal for packing plants, withdrawal of feed for 24 h would reduce feed use by 15 to 25 lb per animal. This would reduce production cost (at $170/ton of feed) by $1.30 to $2.10 per animal. The objective of this research was to determine the impact of feed withdrawal on weight and composition of ruminal contents.

Materials and Methods

Various diets and feed withdrawal times were used in three different trials. In Trial 1, an 84% concentrate diet containing rolled corn was fed. Feed withdrawal times were 0, 12, 24, and 36 h using 10 heifers in a 4-period Youden square for a total of 40 ruminal evacuations. In Trial 2, six heifers were fed the same diet with or without addition of monensin. Feed withdrawal times were 0, 24, and 36 h. For Trial 3, six heifers were transported to Goodwell, OK and fed feedlot diets (92% concentrate) composed of either high moisture corn or steam flaked corn. Feed withdrawal times were 0 and 24 h.

In each trial, ruminal contents were totally evacuated from heifers (750 to 850 lb) equipped with ruminal cannulas and filtered through a coarse screen to roughly separate liquids from solids. Animals were fed their diets for a minimum of 7 d prior to each evacuation to avoid carryover effects and rotated among withdrawl times on different weeks so animal-to-animal

differences could be removed. In all these experiments, cattle were fed 1 h before ruminal evacuation began. Because cattle in a feedlot usually eat regularly when fed and at sunrise and sunset, this 24-h feed withdrawal time may equate more closely with skipping one meal rather than two feedings for cattle fed twice daily. The liquids and solids were analyzed for dry matter, organic matter, starch, fiber, and chemical oxygen demand (APHA, 1985). These were used to calculate the total amount of each component in the rumen at each feed withdrawal time. Blood glucose concentrations were also measured in Trial 2.

Effects of time of feed withdrawal on quantities of each component in the rumen were compared after removing animal and week differences statistically. Time effects were then examined for linear and quadratic trends.

Results and Discussion

In Trial 1, weight of dry matter in the rumen decreased steadily for 24 h; rate of decrease was slower from 24 to 36 h. By 24 h after feeding, ruminal solids (dry matter, organic matter, fiber, screened solids) had decreased to about half those immediately after feeding (Table 1). In contrast, total weight of ruminal contents and liquid remained relatively stable or to increase over time. Ruminal pH also increased during fasting.

Comparisons of ruminal contents after feeding versus 24 h later for steers fed diets with or without monensin are presented in Table 2. In this trial, weights of ruminal contents, screened solids, dry matter, organic matter, fiber, and starch each decreased during the withdrawal period similar to observations in Experiment 1. However, liters of liquid in the rumen tended to increase with time and ruminal pH increased markedly, presumably because residual material remaining to ferment had decreased while input of salivary buffers had continued. Considering potential adverse effects of longer withdrawal times on carcass measurements, we concluded that 24 h was the most feasible and practical feed withdrawal time. No effects of monensin on ruminal measurements were detected; however, a trend was detected for blood glucose to increase during fasting with the control diet but to decrease with the diet containing monensin.

Comparisons of ruminal measurements after feeding versus 24 h later for heifers fed high moisture or steam flaked corn are presented in Table 3. Time effects again were detected for most measurements similar to those noted in previous trials. However, in this case, volume of dry material in the rumen was considerably lower than in earlier trials. This may be due to faster digestion in the rumen and less residue from previous meals when cattle were fed high moisture and steam flaked grain rather than dry rolled corn as used in earlier experiments. Quantity of liquid in the rumen increased over time. Effects of diet on most measurements were also detected as well as some interactions between diet and time. These indicate that rates of ruminal digestion and passage differed with grain form.

A summary of measurements over time across these three trials is presented in Table 4 and Figures 1 and 2. Total mass (liquid plus solids) in the rumen (Figure 1) remained nearly constant across these sampling times despite extensive decreases in organic matter (42 to 73%) and ash. This decrease in organic matter can be ascribed to digestion of soluble compounds whereas both organic matter and ash would disappear by flowing out of the rumen to the abomasum.

Rates of disappearance of organic matter, fiber, and chemical oxygen demand (Figure 2) decreased markedly with feed withdrawal at rates between 2% and 3% per hour. Note that pH increased during this time period into a range that fiber digestion could resume.

Rate of disappearance was lower for fiber (ADF) than for dry matter or organic matter, indicating that fiber was being concentrated slightly during feed withdrawal due to continued digestion of non-fibrous feed components such as starch. Chemical oxygen demand, closely reflecting organic matter, indicates that the "pollution potential" should be reduced by 40 to 60% by withholding feed from cattle for 24 h. In these studies, live weight was reduced slightly by withholding feed for 24 h. With the processed grain diets, live weight decreased by a smaller degree. Effects of 24 h of feed withdrawal on hot and cold carcass weights were studied in a companion trial (Janloo et al., 1998) to detect effects on carcass weights and characteristics.

Withholding feed from cattle decreased weights of ruminal dry matter, organic matter, and fiber

rapidly for the first 24 h and more slowly thereafter. However, water displaced much of this ruminal dry matter so that total weight of ruminal contents was not decreased consistently by a 24-h fast. Withholding feed for 24 h prior to harvest should decrease the quantity of organic matter at packing plants by about 50%. However, adverse effects on carcass quality may make feed withdrawals costly.

Literature Cited

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Janloo, S.M. et al. 1998. Okla. Agr. Exp. Sta. Res. Rep. P-965:109.

Table 1. Ruminal measurements at various times after feed withdrawal.

Feed withdrawal time, h	0	12	24	36	Effectsa
Ruminal content wt, kg	35.1	34.6	28.1	28.5	L
Screened solids, %	50.6	43.3	36.0	28.6	L
Screened liquid, %	49.4	56.7	64.0	71.4	L
Liquid, liters	27.7	28.3	23.8	24.8	L
Dry matter, kg	7.36	6.23	4.26	3.63	L
Organic matter, kg	6.89	5.77	3.85	3.25	L
Acid detergent fiber, kg	2.53	1.95	1.38	1.10	L
Ruminal pH	5.67	6.33	6.65	7.23	L
Blood glucose, mg/dl	71.2	76.2	72.2	80.7	
Rumen contents wt, %BW	9.81	9.78	8.03	8.29	L
Rumen dry wt, %BW	2.06	1.76	1.21	1.06	L

a Statistical effects of time are indicated by letters: Linear effect of time, L is P<.01.

Table 2. Ruminal measurements at various times after feed withdrawal with or without monensin in the diet.

Feed withdrawal time, h	0	24	0	24	
Dietary monensin, ppm	0	0	33	33	Effectsa
Ruminal content wt, kg	38.6	32.5	39.7	30.7	T
Screened solids, %	43.2	25.0	43.0	23.8	T
Screened liquid, %	56.8	75.0	57.0	76.2	T
Liquid, liters	29.0	29.6	31.3	27.8	
Dry matter, kg	9.54	2.97	8.41	2.94	T
Organic matter, kg	8.90	2.66	7.78	2.60	T
Acid detergent fiber, kg	2.24	1.18	1.91	1.04	T
Starch, kg	3.57	.20	3.49	0.25	T
Ruminal pH	5.52	6.36	5.59	6.20	T
Blood glucose, mg/dl	62.6	58.8	44.5	67.9	

a Statistical differences are indicated by letters: Time effects, T is P<.01.

Table 3. Ruminal measurements at various times after feed withdrawal from heifers fed high moisture (HMC) or steam flaked (SFC) corn grain diets.

Feed withdrawal time, h	0	24	0	24	
Grain form	HMC	HMC	SFC	SFC	Effects
Ruminal content wt, kg	30.9	28.2	27.9	26.5	
Screened solids, %	30.8	16.5	44.3	19.5	T,D,t*d
Screened liquid, %	69.2	83.5	55.7	80.5	T,D,t*d
Liquid, liters	26.9	25.8	22.7	23.8	D
Dry matter, kg	3.67	2.22	4.89	2.45	T,D,T*D
Organic matter, kg	3.01	1.74	4.27	1.83	T,D,T*D
Starch, kg	0.63	0.12	1.82	0.23	T,D,T*D
Ruminal pH	5.38	6.92	5.44	7.12	T

a Statistical differences are indicated by letters: Time effects, T is P<.01; t is P<.05; Diet effects, D is P<.01; interactions, T*D is P<.01; t*d is P<.05.

Table 4. Ruminal contents 24 h after the last meal, % of amount immediately after feeding.

Measurement	Total weight	Dry matter	Water	Organic matter	Fiber	COD
Trial 1	80.1	57.8	85.9	55.9	54.5	58.8
Trial 2	80.8	32.8	95.1	31.5	53.6	58.9
Trial 3-High moisture corn	91.2	60.5	95.9	57.8		55.8
Trial 3-Steam flaked corn	94.8	50.1	104.8	42.8	-	50.6

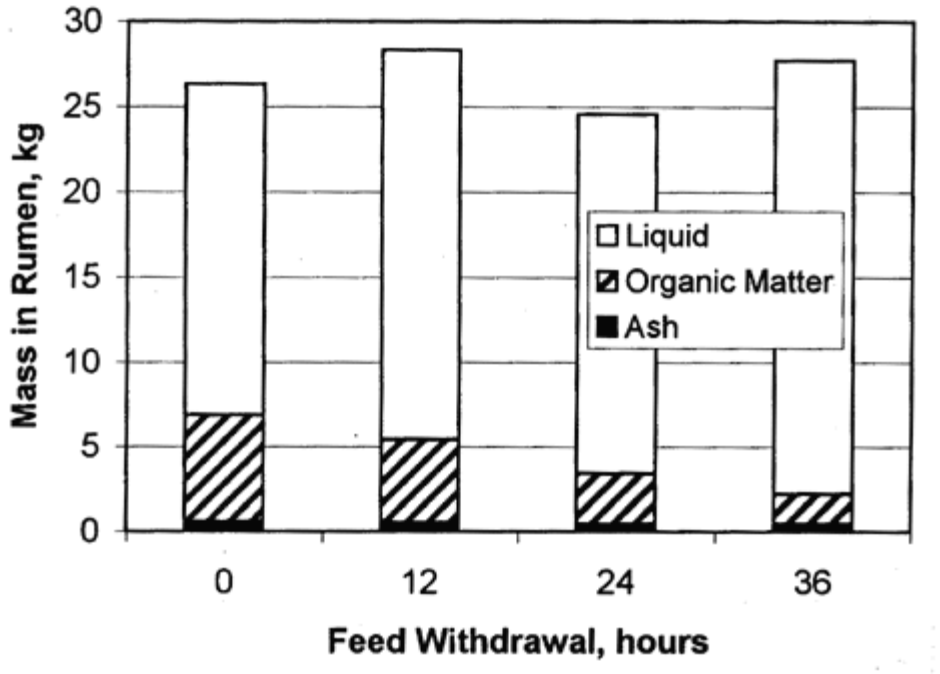

Figure 1. Impact of feed withdrawal on liquid, organic matter, and ash mass in the rumen of heifers.

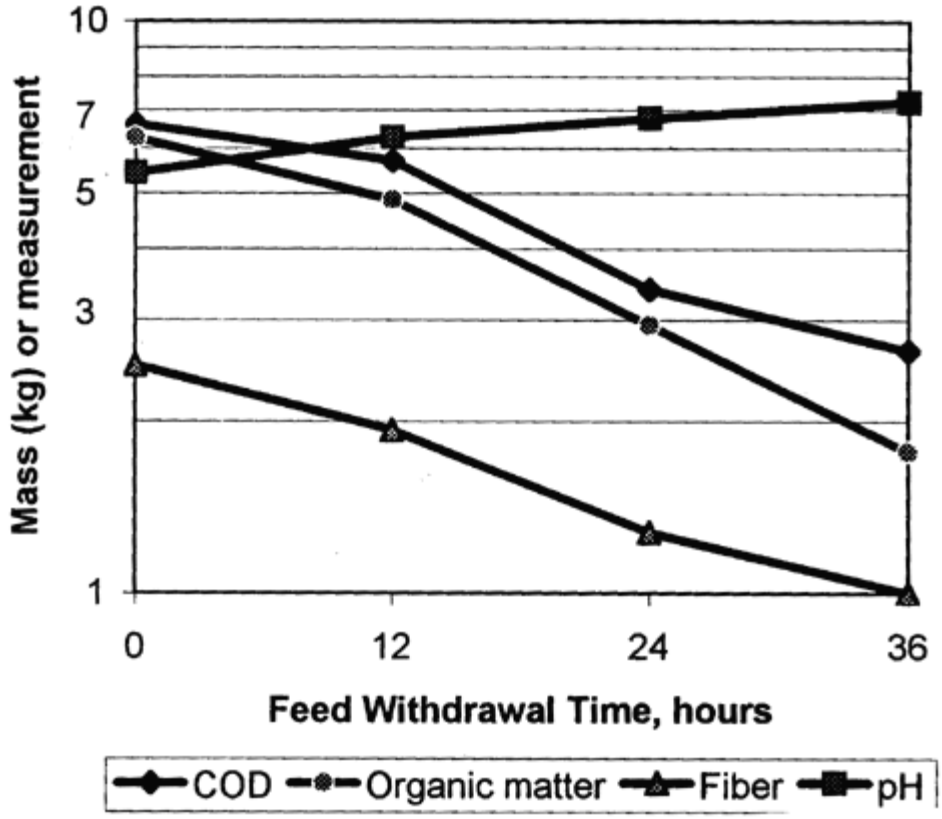

Figure 2. Effect of feed withdrawal time on ruminal pH, chemical oxygen demand, organic matter, and acid detergent fiber in the rumen.

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