# EFFECT OF DIET AND LEVEL OF INTAKE ON RUMEN LIQUID AND SOLID VOLUMES, PASSAGE RATES, AND WATER CONSUMPTION OF BEEF CATTLE

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## Story in Brief

Twelve Hereford x Angus heifers (1330 lb) fitted with large rumen cannulas were used to determine the effect of diet and feed intake level on rumen liquid and solid volumes. Animals were adapted to either concentrate or hay diets and fed once daily at one of three levels of intake (1.0, 1.4, 1.8% of body weight) for a minimum of 14 days. Rumen contents were evacuated and screened to separate solids from free liquid. Water intake tended to be greater with the hay diet. Rumen liquid volumes were higher for hay diets (71.3 liters vs 46.5 liters). Liquid outflow was higher with the hay than the concentrate diet (132 vs 75 liters/day). As dry matter intake was increased, water intake doubled and total solids in the rumen increased. Ruminal liquid volumes were not altered by feed intake but outflow increased linearly with intake. Blood hematocrit declined as feed and water intake increased.

(Key Words: Liquid Passage Rate, Rumen Evacuation, Water Intake.)

## Introduction

More knowledge about the interactions between level of feed intake, diet quality and ruminal digestion should aid in developing nutrition programs to improve the efficiency of livestock production. Level of feed intake presumably is one of the major factors regulating rumen turnover. Increased dry matter consumption, increasing turnover rate of both fluid and particulate digesta from the rumen, should shift site of digestion from the rumen to the intestines. Physical characteristics of the diet (bulk, particle size) also have an impact on rumen volume and gut fill, affecting not only ruminal turnover, but also mastication and rumination which in turn can increase saliva production. Both salivary secretion and water consumption can be affected by the nature of the diet, and might be expected to promote

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greater washout of smaller particles and soluble substances from the rumen. The objectives of this study were to determine the effect of diet type (concentrate vs hay) and three different levels of intake on water consumption, rate of passage and rumen liquid and solid volumes measured directly by ruminal evacuation.

## Materials and Methods

Twelve Hereford x Angus beef heifers (1330 lb) fitted with large ruminal and T-type duodenal cannulas were fed a concentrate diet or an 60% alfalfa: 40% prairie hay diet at three intake levels (1.0, 1.4, 1.8% of individual body weight daily). Animals were housed in individuals pens, adapted to their diets for a minimum of 14 days, and fed once daily at 8 a.m.; water intakes were recorded daily. Each animal received three levels of intake but remained on the same diet throughout the experiment. Blood and ruminal liquid samples were collected two hours after feeding, three days before ruminal evacuation for pH and hematocrit determination. At 21 h prior to ruminal evacuation, cobalt EDTA was administered into the rumen (CoEDTA acetate containing 1g of Co) of each animal. An equal volume of tap water was used to rinse residual marker left in the graduated cylinder and funnel. Total rumen contents were removed mechanically using a vacuum device at the end of each experimental period 21 h after the cobalt was dosed. Ruminal contents were screened twice (1/4 x 1/4 inch square pores) manually to separate the particulate solids from the liquid phase; each phase was weighed separately and representative samples were collected and frozen for subsequent chemical analysis. The remaining ruminal contents were returned to the rumen. All ruminal samples were analyzed for dry matter. Data were analyzed using general lineal model procedures and orthogonal contrasts were used to separate treatment means.

## Results and Discussion

Daily water intake tended to be greater (22%) with the hay diets (Figure 1) and increased ($P<.001$) with levels of feed intake for both the concentrate and the hay diets. Although information on water consumption by cattle under normal commercial management is scarce, Hicks et al. (1988) indicated that feedlot cattle fed during the summer consumed an average of 38 liters of water per day. They concluded that water intake was influenced by both dry matter intake and environmental temperature. Differences between the average water intake observed in our study and in Hicks'

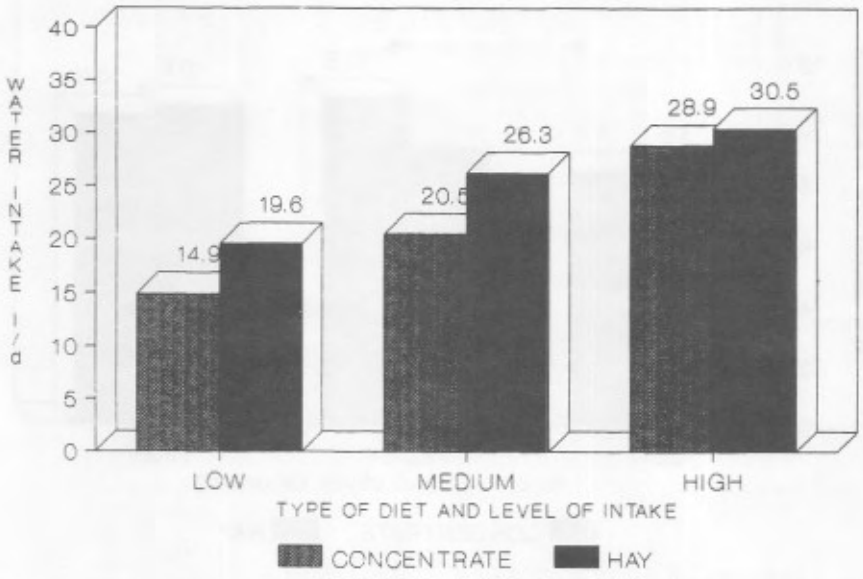


**Figure 1. Daily water consumption in beef heifers fed concentrate vs. hay diets.**

experiment can be explained, not only by lack of heat stress and lower level of feed intake in our study, but also by the fact that our observed daily water intakes were made on an individual basis while their intakes were determined as total water disappearance for pens of 16 animals.

Weights of dry matter in the rumen are shown in Figure 2. No differences ($P > .05$) were observed between the concentrate and the hay diet, however as level of intake increased, total weight of solids in the rumen increased.

Ruminal liquid volumes were much larger ($P < .001$) for the hay than the concentrate (71 vs. 46 liters; Figure 3), indicating that intake of fibrous materials increased rumen liquid volume markedly. This may increase residence time for more extensive microbial fermentation (Owens and Goetsch, 1988). However, level of feed intake did not affect rumen liquid volume ($P > .05$). Total outflow (Figure 4) from the rumen was estimated by the recovery of CoEDTA 21 hours after dosing. Water outflow was much higher for the hay than for the concentrate diet (132 vs 75 liters/day), similar to values reported by Owens and Goetsch (1988).

Ruminal liquid pH was lower ($P < .01$) with the concentrate than with the hay diet (6.0 vs 6.5; Figure 5). Differences in pH due to level of intake were not detected.

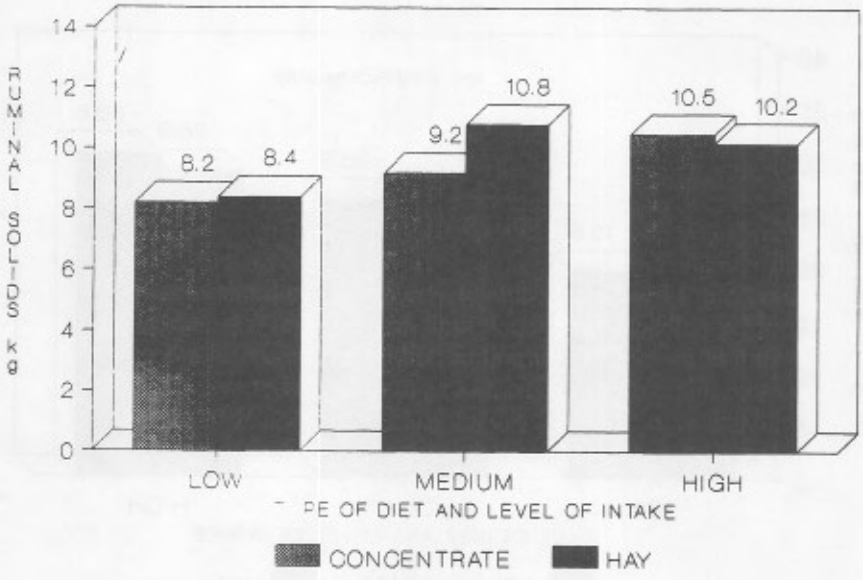


**Figure 2. Total ruminal solids, kg dry matter.**

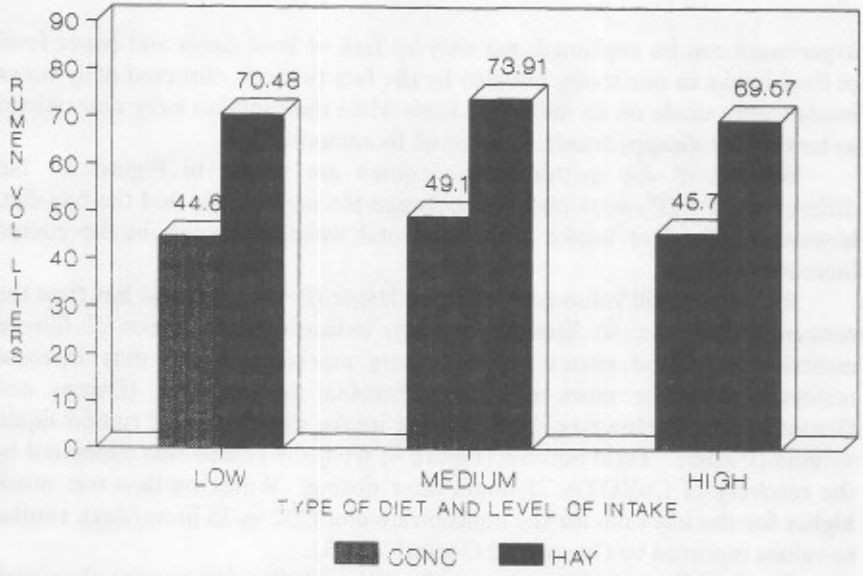


**Figure 3. Rumen liquid volume in heifers fed concentrate vs. hay diets.**

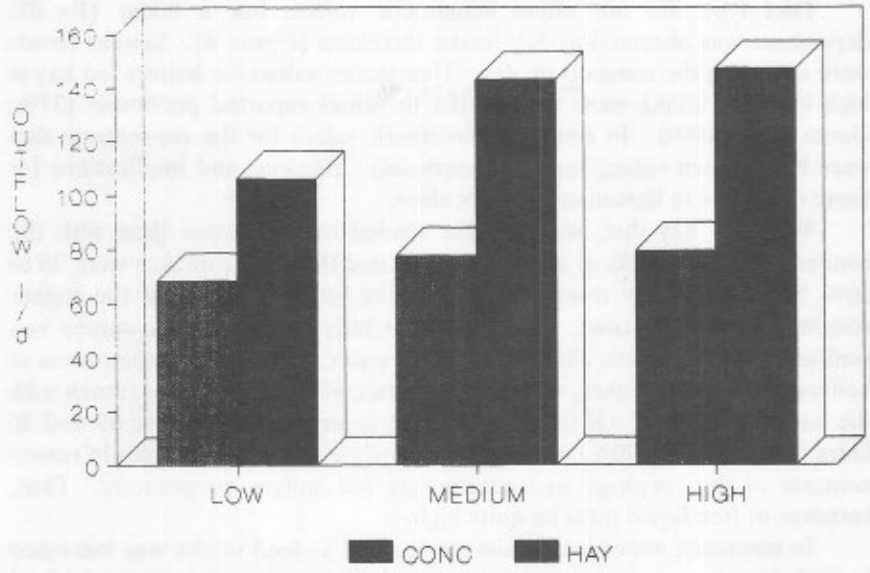


**Figure 4. Rumen water outflow (l/d).**

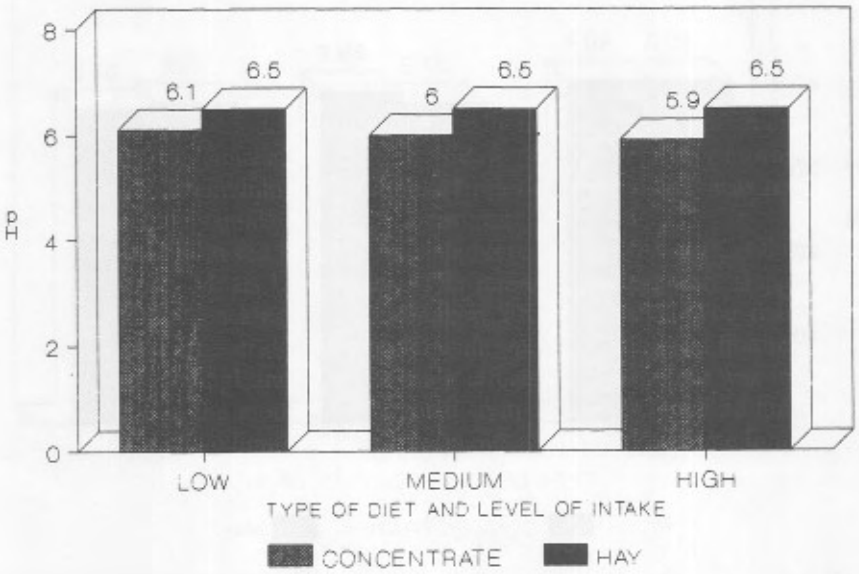


**Figure 5. Ruminal liquid pH in heifers fed concentrate vs. hay diets.**

Diet type did not affect hematocrit values, but a linear ($P<.01$) depression was observed as hay intake increased (Figure 6). Similar trends were seen with the concentrate diet. Hematocrit values for heifers fed hay at high levels of intake were very similar to values reported previously (37%; Garza et al., 1989). In contrast, hematocrit values for the concentrate diet were higher than values reported previously. Reasons and implications for these decreases in hematocrit are not clear.

With the hay diet, water intake tended to be greater than with the concentrate diet. Hicks et al. (1988) suggested that water intakes were 25 to 50% higher for dairy cows than for feedlot steers because of the higher roughage diet fed to cows. Though the quantity of solids in the rumen was similar for the two diets, almost 50% more water was present in the rumen of heifers fed forage. Hence, solids were more concentrated in the rumen with the concentrate diet. Of this liquid in the rumen, an average of 67 and 26 liters (over 90% and 70%) were closely associated with the particles in rumen contents of the roughage and concentrate fed heifers, respectively. Thus, turnover of free liquid must be quite high.

In summary, water intake almost doubled as feed intake was increased by 80% but changes in ruminal volume and dilution rate with increased feed and water intake were small. Ruminal solids tended to increase as feed and

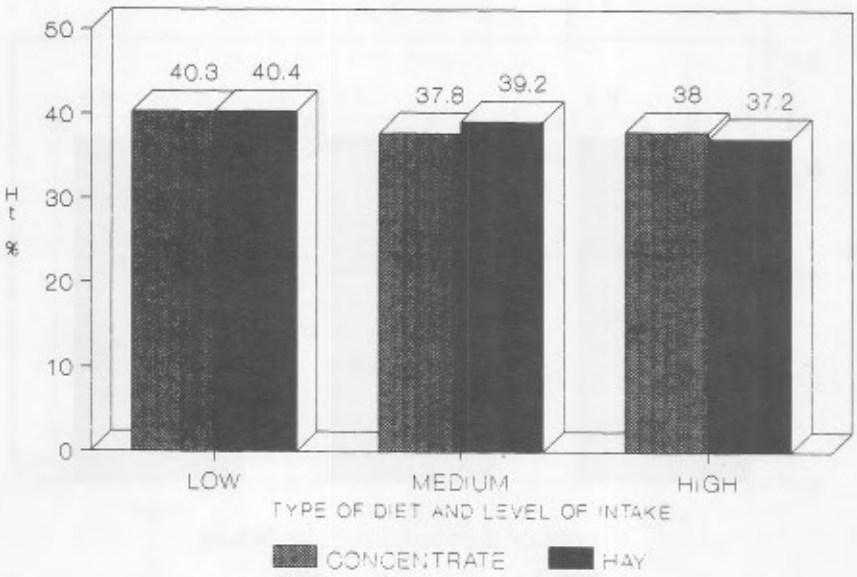


**Figure 6. Hematocrit of heifers fed concentrate vs. hay diets.**

water intake increased. Drops in hematocrit could reflect direct escape of drinking water or fluid absorption through the rumen wall. How flux of water in and out of the rumen changes with intake needs more study, as salivary flow and influx through the rumen wall would be expected to be altered by ruminal conditions which affect rumination and osmolarity.

## Literature Cited


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