FORMALDEHYDE TREATMENT OF SORGHUM GRAIN WITH OR WITHOUT SODIUM BENTONITE FOR GROWING FATTENING STEERS

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SUMMARY

Formaldehyde treatment of ground cereal grains (3 g formaldehyde/100 g cereal protein) decreased VFA concentrations and effected a significant reduction in the proportion of propionic acid in in vitro incubations with rumen liquor.

The performance of 48 Hereford steers housed in groups of four offered formaldehyde-treated, ground sorghum was compared with that of 48 steers given untreated, cracked sorghum. Sodium bentonite was mixed with the cereal grains at levels of 0, 2 or 4%. Eight steers were adapted to their respective high grain rations over 7 days or 14 days. Results of the experiment indicated that neither grain processing, length of adaptation nor level of bentonite inclusion affected growth rates. Key words: cattle, sorghum grain, bentonite, formaldehyde.

INTRODUCTION

The endosperm of cereal grain consists of discrete microscopic starch granules held in a protein rich matrix (Armstrong 1972). Formaldehyde treatment of protein at the appropriate concentration results in condensed cross linkages between amino acids which markedly reduces the degradation of protein in the rumen but does not reduce digestibility of the material in the post-ruminal tract (Ferguson 1975).

In the first of two experiments described below, the effect of formaldehyde treatment of cereal grains to "cross-link" starch and protein in order to reduce the rate of ruminal digestion was studied in vitro. The effect of formaldehyde-treated sorghum grain on the liveweight gain and feed intake of steers in feed lot condition was subsequently evaluated in a second experiment. Previous work (H. Peiris unpublished) showed that the pH of formaldehyde-treated grain was 5.3 and it was decided therefore to evaluate the efficacy of the feed additive sodium bentonite in animals fed the grain diets.

Reduction in the rate of starch availability to the rumen microbes through treatment of cereal grain with formaldehyde may be of value when animals are unaccustomed to cereal grain diets. It is not known whether temporary acidosis and lactaemia, which frequently occur when animals initially enter feed lots, affects long term productivity of the animal. It was therefore decided to superimpose two further treatments in the experiment to compare rapid or lengthy adaptation of animals to the high grain rations.

MATERIALS AND METHODS

Experiment 1. In vitro fermentation

Dried cassava tuber, maize, sorghum and wheat grain were individually hammer-milled to pass through a 2 mm screen and the N content of the material determined. The samples (1 kg) were then mixed with a formaldehyde solution (500 mls) at a rate equivalent to 3 g formaldehyde/100 g CP in the grain, left overnight in sealed containers and then dried for 48 hrs in a force-draught oven at 60°C.

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A small quantity (2 g) of each material was placed in plastic tubes to which 50 ml of strained rumen liquor was added. The tubes were sealed and incubated at 38°C for 24 hr. Free formaldehyde was also added to additional tubes of rumen liquor in quantities corresponding to the amounts associated with the cereal grain.

Experiment 2. Feed lot experiment

(i) Grain preparation

(a) Formaldehyde treatment of finely ground sorghum Sorghum grain (11% CP) was hammermilled to pass through a 2 mm screen and mixed with formaldehyde solution (3 g formaldehyde/100 g CP). The formaldehyde solution (9 kg of formaldehyde in 50 litres of water) was sprayed on to one tonne of grain in a horizontal mixer and left to mix for 30 mins. The grain was then stored in sealed vertical silos (5 tonne capacity) for 3 days before being mixed with the other ingredients (see below) and offered to the steers.

(b) Coarse grain This was prepared by passing whole sorghum grain through the roller to crack and split the grains.

(ii) **Animals and experimental design** Ninety-six Hereford steers with a mean liveweight of 228 ± 22 kg were confined in open, concrete floored yards (18 m^2 with 4 m of trough space), at the Animal Husbandry Farm, Rocklea, Brisbane. The animals were offered diets consisting of 90% cracked or finely ground, formaldehyde-treated sorghum and 10% hammermilled Rhodes grass (*Chloris gayana*) hay (5.8% CP). Prior to feeding, the following materials were mixed with the grain component: cotton seed meal (5%), molasses (3%), urea (1%), limestone and minerals (1%). Sodium bentonite (Cudgen Pty Ltd) was included in the diets at levels of 0, 2 or 4%.

Eight steers, in two replicates of four, were changed to each of the 90:10 high grain diets over 7 days (fast adaptation) or 14 days (slow adaptation) by progressively increasing the grain component and decreasing the roughage. The animals were offered their respective diets ad 'libitum and were weighed at weekly intervals. They were slaughtered in a commercial abattoir when the mean liveweight in each yard exceeded 370 kg. Throughout the experiment feed refusals were left in the troughs and removed for weighing at weekly intervals.

(iii) Analytical procedures Dry matter content of feeds and refusals were determined by drying the samples at 80°C in a force-draught oven for 48 hours. Gas chromatography was used to measure amounts and proportions of the volatile fatty acids produced in the in vitro incubations.

RESULTS AND DISCUSSION

Formaldehyde treatment of the cereal grains resulted in a reduction in the total concentrations of VFA and a marked reduction in the proportions of propionic acid during in vitro incubations (Table 1). In contrast, formaldehyde treatment of cassava meal failed to reduce VFA concentrations or proportions. It appeared from the in vitro studies that the formaldehyde was able to reduce the break-down of starch in the cereal grains.

Despite a reduction in the fermentation of starch (in vitro), there was no improvement in liveweight gain of steers as a result of treating the grain with formaldehyde (Table 2). Potter et al. (1971) reported extensive breakdown of sorghum proteins in the rumen, but formaldehyde treatment to reduce this did not increase productivity in the present experiment.

Table 1. The effect of formaldehyde on the production of volatile fatty acids in vitro

	Cassava starch		Wheat		Sorghum		Maize	
	UT	T	UT	T	UT	T	UT	T
VFA concentration (mmol/L)	94.5	93.2	88.9	52.3	82.4	61.0	61.6	40.2
S.E.M.	0.12	0.10	0.11	0.10	0.07	0.10	0.12	0.09
Propionate/ acetate ratio Ratio	0.17	0.69	0.75	0.61	0.79	0.69	0.75	0.65

Values with different superscripts differ significantly ($P < 0.01$)
UT - HCHO Untreated, T - HCHO Treated.

Table 2. Mean daily liveweight gain* (kg/head/day) and dry matter intake (kg/head/day) of -steers fed ground formaldehyde-treated or cracked grain with and without bentonite.

Bentonite inclusion (% Diet)	Ground, formaldehyde-treated grain			Cracked grain		
	0	2	4	0	2	6
Slow adaptation (14 days)						
Liveweight gain	1.16	1.04	1.02	1.24	1.13	1.14
S.E.M.	0.212	0.314	0.360	0.391	0.397	0.235
Dry matter intake	8.54	8.15	9.27	7.98	8.17	8.56
S.E.M.	0.382	0.292	0.373	0.171	0.184	0.183
Fast adaptation (7 days)						
Liveweight gain	1.08	1.00	1.14	1.26	1.20	1.05
S.E.M.	0.262	0.294	0.381	0.293	0.314	0.391
Dry matter intake	8.54	8.55	8.99	7.74	8.11	7.65
S.E.M.	0.371	0.270	0.291	0.150	0.172	0.161

* Average daily gain calculated as difference between initial and final fasted liveweight

Normally around 10-15% of the sorghum grain eaten by steers in feed lot conditions is voided in the faeces. It was hoped that, by finely grinding the grain followed by formaldehyde treatment, the material would be more digestible, but that the reduced rate of fermentation would prevent possible rumen acidosis. Although none of the animals fed the ground, treated sorghum exhibited symptoms of bloat or acidosis, the feed intake and liveweight gains were similar to those recorded in animals fed cracked grain. Five of the steers fed cracked grain did exhibit bloat during the experiment, but did not require treatment to alleviate the condition.

The speed of dietary adaptation of animals to the full feed lot rations in this experiment did not affect overall productivity nor did the inclusion of the rumen buffer sodium bentonite achieve any improvement in animal performance. Previous' studies indicated that sodium bentonite could improve rumen fermentation and nitrogen retention in ruminants (Colling and Britton 1975) and improve performance of intensively fed steers (G.D. Tudor unpublished data). More recently, however, Moate et al (1985) reported little effect of bentonite on rumen fermentation patterns and milk yields in dairy cows. Moate and Rogers (1985) also reported that digestibility and nitrogen balance in sheep were also unaffected by bentonite supplementation.

In conclusion, formaldehyde treatment of ground sorghum for steers in feed lot conditions did not result in increased productivity above levels obtained by feeding coarse cracked grain. Previously Lloyd Davies and Faichney (1973) reported that steers fed formaldehyde-treated barley grain tended to eat less feed and did not gain as rapidly as their controls. More recently, however, Kassem et al, (1987) reported that formaldehyde treatment of barley supplements did effect significant improvements in milk yield from cows fed silage diets. Any nutritional advantages in the use of sodium bentonite as an additive for cattle fed sorghum diets are also questionable, but this compound may be beneficial in diets based on other types of cereal grains.

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