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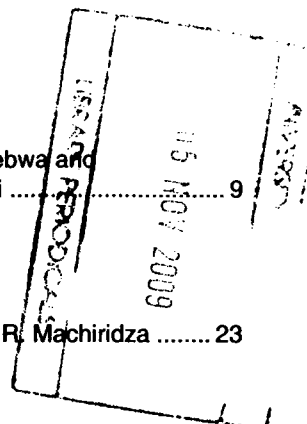
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Utilization of sorghum grain in high energy beef finishing diets

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A study was carried out in July 1996 to assess the potential of sorghum grain (high tannin) in high energy beef finishing diets. The effect of polyethylene glycol (PEG) on the utilization of sorghum grain based diets was also examined. Forty steers were blocked by weight and then randomly allocated to five treatments. One group was assigned to direct slaughter. The remaining groups were offered the following diets containing 33 percent grain: 1. 100 percent maize (100M); 2. 50 percent maize: 50 percent sorghum (50M:50S); 3. 100 percent sorghum (100S); 4. 100 percent sorghum + 3g PEG per day (100S PEG). Dry matter and metabolizable energy (ME) intake were highest with 50M:50S and lowest ($P<0.01$) with the 100S PEG diet. Steers on the 50M:50S diet had the highest ($P<0.05$) growth rates and carcass gains. PEG did not improve the utilization of the high tannin sorghum grain.

Keywords: cattle, sorghum grain, finishing diets, polyethylene glycol, tannin

Introduction

In Zimbabwe the standard high energy diet for fattening cattle is based on maize. Maize is becoming more expensive and is sometimes unavailable for stockfeeds. With the increase in human population, the competition between humans and livestock for maize will increase. Although sorghum grain is also a source of energy, it has not been routinely used because it has been considered less valuable than maize grain because of its highly variable chemical composition and feeding value. The lower feeding value of sorghum grain has been attributed to environmental and varietal differences (Hulse *et al.*, 1980).

Sorghum grain contains some antinutritional factors (secondary compounds). The presence of secondary compounds (mainly tannins) limits the feeding value of sorghum grain (Maxson *et al.*, 1973; Butler, 1989). In addition to effects on feeding value sorghum tannins exhibit toxic effects which require absorption from the digestive tract (Butler, 1989). Despite these limitations sorghum grain offers a substitute for maize in high energy diets for cattle in the drought prone areas of the country as it is more drought tolerant than maize. Sorghum can replace maize, on

average, with an efficiency of feed utilization of 89 percent (Topps and Oliver, 1993). Polyethylene glycol (PEG) has been shown to preferentially bind with tannins (Barry and Duncan, 1984) resulting in better utilization of nutrients, especially protein (Jones and Mangan, 1977). The objective of this study was to assess the potential of sorghum grain in high energy finishing diets. The effect of polyethylene glycol (PEG) on the utilization of sorghum based diets was also examined.

Materials and Methods

Animals and treatments

Forty steers (28 Hereford*Simmental and 12 Brahman*Simmental crosses) were, on arrival, dosed against endoparasites with 70 ml of a 2.5 percent Levamisole and 3.4 percent Oxyclozanide solution (TRAMIZAM). Their initial average live-weight was 304kg (range 286 to 325). The steers were blocked by weight and breed then randomly allocated to five treatments. One group was assigned to direct slaughter. The remaining groups were offered the following diets containing 33 percent grain:

1. 100 percent maize (100M).
2. 50 percent maize:50 percent sorghum (50M:50S).
3. 100 percent sorghum (100S).
4. 100 percent sorghum + 3g PEG per day (100S PEG).

The composition of the diets is given in Table 1.

Table 1: Diet composition (g/kg), chemical composition (g/kgDM) and metabolizable energy (ME MJ/kgDM) of diets containing 100 percent Maize (100M), 50 percent Maize:50 percent Sorghum (50M:50S) and 100 percent Sorghum (100S).

	100M	50M : 50S	100S
Cotton seed meal	71	70	70
Roughage component	70	70	70
Whole cotton	100	100	100
Maize	331	166	—
Sorghum	—	166	332
Wheat bran	300	300	300
Salt	3	3	3
Molasses	100	100	100
Limestone flour	27	27	27
Vitamins and minerals	1	1	1
Dry matter	927	929	929
Crude protein	140	142	145
Crude fibre	106	105	105
Fat	55	52	48
Ash	75	75	76
Tannin-Van-HCl (CE)	2	6	12
ME	12.1	11.9	11.8

Feeding and housing

The steers were individually penned. During the first two weeks of the experiment steers were offered eight kg (as fed) of the appropriate treatment diets only. After this initial period, the diets were fed *ad libitum* twice per day at 0800 and 1400 hours for 97 days. The amount of feed offered was adjusted to allow about 20 percent refusals. Refusals were collected daily prior to morning feed, weighed and subsampled and stored to await analysis. Water was available at all times.

Chemical analysis

Feed was analysed for dry matter (DM), crude protein (CP), crude fibre (CF) and ash (Association of Official Analytical Chemists, 1975). Tannins were estimated by the vanillin-HCl method (Burns, 1971; Broadhurst and Jones, 1978). Metabolizable energy (ME) of the feed was estimated according to equation 73 (Ministry of Agriculture Fisheries and Foods, 1984):

$$\text{ME (MJ/kgDM)} = 12 + 0.008\text{CP} + 0.023\text{EE} - 0.018\text{CF} - 0.012\text{ASH}$$

Statistical analysis

Analysis of variance was carried out using the SYSTAT Statistical package (Wilkinson, 1987). Differences among treatment means were tested for significance using Student's *t* test. A polynomial regression, with week as a dependant variable, was fitted for each animal using SAS (SAS/STAT, 1987). A polynomial of order one was significant ($P < 0.001$) for all animals. The gradient (*b*-value) which is the rate of weight gain was therefore, used in Least-squares analysis of variance using the General Linear Model (GLM) procedure of Statistical Analysis System (SAS) (SAS/STAT, 1987) and fitting a fixed model in which the effects were diet, breed, and initial weight. Rate of weight gain was fitted as an independent variable in the univariate analysis.

Results

One animal died from bloat in the PEG diet. Two other animals, one from the 100 percent maize diet and the other from the 50M:50S diet were removed from the experiment because they did not adapt to the treatments. The rest of the animals maintained good health throughout the experimental period.

Feedlot performance

The CP contents of the diets were as predicted and were similar for all treatment diets. The sorghum based diet contained the most tannins. The energy values were slightly lower for sorghum than for maize-based diets (Table 1).

Intake and growth performance of steers is shown in Table 2. Dry matter and ME intake were highest with the 50M:50S diet and lowest ($P < 0.01$) with the 100S PEG diet. The maize and sorghum-based diets had similar intakes. Steers on the 50M:50S diet had the highest growth rates and the sorghum plus PEG diet the lowest

($P < 0.05$). Although there were no significant differences between treatments ($P > 0.05$), feed conversion ratio was better with the 50M:50S diet and least with sorghum-based diets.

Table 2: Feedlot performance of steers fed sorghum based diets containing 100 percent Maize (100M), 50 percent Maize:50 percent Sorghum (50M:50S), 100 percent Sorghum (100S) or 100 percent Sorghum + PEG (100S PEG).

	100M	50M : 50S	100S	100S PEG	Sed
Number of animals	7	7	7	8	
Daily feed intake					
Dry matter (kg)	9.7 ^{ab}	10.7 ^b	10.0 ^{ab}	8.6 ^a	0.71
ME (MJ)	117 ^{ab}	127 ^b	118 ^{ab}	101 ^a	8.4
Liveweight changes					
Initial (kg)	305	304	302	305	5.90
Final (kg)	436 ^{ab}	456 ^b	430 ^{ab}	422 ^a	14.7
Daily gain (kg)	1.33 ^a	1.56 ^b	1.32 ^a	1.18 ^a	0.148
Feed conversion ratio					
KgDM/kg gain	7.3	6.8	7.8	7.8	0.68
ME MJ/kg gain	88.0	80.9	91.2	91.6	7.99

^{ab}Means in the same row with different superscripts are significantly different ($P < 0.05$).

Carcass traits

Carcass traits of the steers are shown on Table 3. Daily carcass gains were highest with the 50M:50S diet and lowest ($P < 0.01$) with the 100S PEG diet. Dressing proportions were similar for all treatments. Carcass fleshing grades were lower ($P < 0.01$) for steers offered 100S PEG compared to the other treatments.

Table 3: Carcass characteristics of steers fed sorghum based diets containing 100 percent Maize (100M), 50 percent Maize:50 percent Sorghum (50M:50S), 100 percent Sorghum (100S) or 100 percent Sorghum + PEG (100S PEG).

	100M	50M:50S	100S	100S + PEG	Sed
Carcass weight changes					
Initial (kg)	164	164	164	164	5.90
Final (kg)	246 ^{ab}	254 ^b	243 ^{ab}	233 ^a	7.8
Daily gain (kg)	0.84 ^{ab}	0.93 ^{ab}	0.82 ^{ab}	0.71 ^a	0.165
Dressing proportion (g/kg)					
Dressing proportion (g/kg)	586	580	580	572	9.4
Dressing proportion (g/kg)	586	580	580	572	9.4
Fleshing grade					
Fleshing grade	2.86 ^{ab}	2.14 ^a	2.75 ^{ab}	3.14 ^b	0.532
Back fat (mm)					
Back fat (mm)	9.14	7.71	10.0	7.00	1.829

^{ab}Means in the same row with different superscripts are significantly different ($P < 0.05$).

Fleshing grade was coded; A+ = 1, A- = 2, B+ = 3, ——— E+ = 9, E- = 10, where 1 = very well fleshed and 10 very poorly fleshed (Cattle Producers Association, 1991).

Discussion

The sorghum used in this experiment was brown in colour and high in tannins (61.6 g/kg DM). In sorghums, a significant correlation between seed colour and tannin content has been observed (McMillian *et al.*, 1972; Harris *et al.*, 1970). Brown sorghums tend to have a higher tannin content than white or red sorghums (Arora and Luthra, 1974). Amira (1992) recommends a maximum of 30 percent of brown sorghum inclusion and no upper limit or restriction for white sorghums in pen finishing diets. The grain inclusion in this experiment, at 33 percent, was in the range reported by Amira (1992).

The results (Table 2) are similar to the work by Smith *et al.*, (1992) who substituted maize with sorghum at the rate of 0, 25, 50, 75, 100 percent in pen finishing diets for steers at a grain inclusion rate of 70 percent. The 50:50 maize to sorghum diets gave the best animal performance. On the other hand, these results differ with those of Loyacano *et al.* (1973) who observed that the level of sorghum in the ration had a significant effect on average daily gains and feed conversion ratio both worsening as the level of sorghum in the ration increased. The rates of gain are comparable with those found by other workers in pen finishing trials. Meissner (1995) found an average daily gain of 1.5 kg per day in feedlot (range 0.9 to 2.1 kg). The best diet in this trial, 50M:50S, had a rate similar to the average and the others fell within the range.

The relatively poor performance on the PEG-containing diet is consistent with earlier report (Smith *et al.*, 1992). In other experiments PEG has been shown to improve intake and digestibility of high tannin feeds (Barry and Forss, 1983; Jones and Mangan, 1977). The amount of PEG given in these experiments is usually 1.5 parts per part condensed tannins (weight:weight) (Waghorn, 1990). The PEG offered in this experiment was below (3g/day vs 149.6g/day) the recommended level (Waghorn, 1990). In this experiment PEG might have destroyed the positive effects of tannins in protecting protein from deamination in the rumen. Barry and Manley (1986) observed increased nitrogen retention in sheep fed high tannin than low tannin *Lotus pedunculatus*. This was attributed to an increased supply of amino acids to the small intestines as a result of protection of protein from proteolysis in the rumen.

The results of this work indicate that high tannin sorghums are useful as a source of energy in pen fattening diets without adversely affecting animal performance. The potential of the mixed diets (maize with sorghum) in pen finishing rations needs further investigation.

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