Paraformaldehyde-treated bird-resistant sorghum grain as energy source in fattening diets for beef steers

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Three groups of nine steers each were fed fattening diets, containing either non bird-resistant (NBR), paraformaldehyde-treated bird-resistant (PBR) or bird-resistant (BR) sorghum grain as the energy source, for 105 days. The BR group performed consistently worse than both the NBR and PBR groups. Although not statistically significant, there was a tendency for the NBR group to perform better than the PBR group.

Drie groepe van nege osse elk is vir 105 dae met afrondingsdiëte gevoer wat nie-voëlbestande (NBR), paraformaldiedbehandelde voëlbestande (PBR) of voëlbestande (BR) graansorghum as energiebron bevat het. Die BR-groep het deurgaans swakker presteer as beide die NBR- of PBR-groepe. Ten spyte daarvan dat die PBR- en NBR-groepe nie statisties betekenisvol verskil het nie, was daar tog 'n aanduiding dat die PBR-groep effens swakker presteer het.

Keywords: Sorghum, processing, beef steers, fattening diets

Maize is traditionally considered to be the prime energy source in South African fattening diets for beef cattle. The annual human and animal maize consumption is approximately 6,5 million tons, and the production thereof usually exceeds this figure. During disaster droughts, however, the availability of maize may become limiting. Alternative energy sources, such as sorghum, wheat, barley and oats, should therefore be considered as substitutes for maize. Of these, only sorghum grain, in terms of both price and availability, is normally considered to be an economically viable alternative. A further advantage — if the demand for sorghum can be increased — is that marginal areas currently utilized for maize production, may be planted with sorghum, which is more water-efficient than maize (Mies & Summers, 1980).

Numerous studies have indicated that the efficiency of utilization of sorghum grain may equal that of maize (Brown, Tillman & Totusek, 1968; Hall, Absher, Totusek & Tillman, 1968; Hale & Prouty 1980; Mies & Summers, 1980; Meissner, Van Staden, Janse van Rensburg & Slabbert, 1982). In contrast to this, some studies found a 5 – 15 % lower utilization efficiency than for maize (Hale, Taylor, Saba, Cuitum & Theurer, 1965; Newland, Reed, Cahill & Preston, 1973; Wagner, 1982). The reason for the lower efficiency of utilization may be linked to the method of processing (Wagner, 1982), the amount of tannin (polyphenol) in the pericarp (Maxson, Shirley, Bertrand & Palmer, 1973), or the degree to which the starch granules are shrouded in a protein matrix (Wagner, 1982). Morgan (1975) found that different processing methods may influence both the site and extent of starch digestion, which thus effects the efficiency of digestion. The amount of tannin however, influences the digestibility of starch (Waldo, 1973), crude protein (White & Hembry, 1978) and structural components in the diet (Ben-Ghedalia & Tagari, 1977). Intake also varied between experiments. Ben-Ghedalia & Tagari (1977) and Van der Merwe, Pienaar, Vermaak & Van Rensburg (1983) found decreased intakes, while Loyacano, Nipper, Pontiff & Hembry (1975) and Meissner *et al.* (1982) found increased intakes of bird-resistant sorghum grains. Pienaar & Renton (1980) found no differences in intake between formalin treated bird-resistant sorghum grain and the untreated controls. However, their diets contained only 44,8 % sorghum grain.

According to Daiber (1978) sorghum grain can be treated with formaldehyde (CSIR, 1976 — patent), either as a weak solution or by paraformaldehyde fumes. The polyphenols then form indigestible resins, thus apparently neutralizing their influence on protein digestibility (Kemm, Daiber & Ras, 1981).

In view of the aforegoing it was decided to investigate the use of either non bird-resistant (NBR), bird-resistant (BR) or paraformaldehyde treated bird-resistant (PBR) ground sorghum grain as the sole energy source in fattening diets for beef cattle.

Twenty-seven approximately one-year-old steers (mainly of the Simmentaler and Bonsmara breeds) were randomly divided into three groups of nine animals. They were fed *ad libitum* for 105 days. The feeding period included a 21-day adaptation period. The composition of the diets is shown in Table 1.

High crude protein levels of 14,9; 14,8 and 14,8 % for the NBR, PBR and BR groups respectively, were used in order to ensure sufficient available nitrogen in all the diets. Van der Merwe *et al.* (1983) fed fattening diets containing sorghum grain with crude protein levels of between 10,9 and 12,1 % (according to NRC, 1976 standards for maximum growth) and found low and even negative daily nitrogen retention values. The reason for this may be linked to the polyphenol content and therefore the lower apparent crude protein digestibility (McLeod, 1974; Ford, 1977). Hence the use of high crude protein diets in this study.

Table 1 Composition of the diets

Component	%
Eragrostis curvula hay*	18,0
Sorghum grain (NBR or PBR or BR)⁺	68,0
Sunflower oilcake meal	10,2
Salt	0,9
Limestone	1,0
Urea	1,6
Potassium sulphate	0,15
Vitamin and mineral premix	0,10
Monensin- Na (active ingredient)	33 p.p.m.
Zinc bacitracin (active ingredient)	10 p.p.m.

* 13 mm hammermilled. ⁺ 3 mm hammermilled.

The bird-resistant sorghum grain was treated with paraformaldehyde by mixing the grain and the chemical (0,5 % paraformaldehyde) thoroughly before storing in a sealed grain silo for 28 days. After being hammermilled through a 3 mm screen, the grain was incorporated into the diet. The total amount of feed needed was mixed before experimentation began.

The animals were fed twice daily and orts were collected prior to each meal. The dry matter and organic matter content of the orts were determined on bulked weekly samples. The animals were weighed at weekly intervals and slaughtered at the end of the experimental period. The relevant performance data of the groups are presented in Table 2.

From these results it is evident that, as was the case with Meissner *et al.* (1982), increased intakes were found on the BR diet. In this instance there was a 9 % higher intake than that of both the NBR and PBR diets — Meissner *et al.* (1982) reported a 30 % higher consumption. The reason may be linked to polyphenol content, which, in this experiment, was determined by the modified DMF – FAC procedure as described by Daiber (1975). Unfortunately Meissner *et al.* (1982) did not cite the polyphenol content, but since polyphenol content influences palatability adversely (Wagner, 1982), it can be said

Table 2 Performance of the steers

Parameter	NBR	PBR	BR
Number of steers	9	9	9
Initial live mass (kg)	255 ± 14[a]	252 ± 13[a]	246 ± 12[a]
Final live mass (kg)	376 ± 21[a]	366 ± 25[a]	354 ± 17[a]
Feeding period (days)	105	105	105
DM intake (kg/day)	7,80	7,79	8,57
Average daily gain (kg/day)	1,15 ± 0,14[a]	1,09 ± 0,17[a]	1,03 ± 0,14[a]
Feed conversion ratio (kg DM/kg live mass)	6,73	7,15	8,32
Initial carcass mass (kg)*	125 ± 6,8[a]	123 ± 6,2[a]	120 ± 6,0[a]
Final carcass mass (kg)	208 ± 9,2[a]	199 ± 14,2[ab]	187 ± 10,6[b]
Dressing percentage	55,4 ± 1,72[a]	54,5 ± 1,55[ab]	52,8 ± 1,12[b]
Carcass gain (kg/day)	0,79 ± 0,06[a]	0,72 ± 0,11[ab]	0,64 ± 0,07[b]
Feed conversion ration (kg DM/kg carcass)	9,82	11,68	12,05
Grading: Super A	4	5	3
1A	5	4	6

* Calculated as 49 % of live mass.

[a,b,c] Values in the same line bearing different superscripts differ significantly ($P \leqslant 0,05$).

that the polyphenol content of the grain used in this instance (1,57 %) was somewhat higher, hence the smaller intake. However, since polyphenols should depress intake (owing to decreased palatability), the reason for the apparent contradiction arising from increased intakes of the BR grain (*ipso facto* high in polyphenols) may be explained by the fact that intake increased as the steers compensated for the lower digestibility of the grain. This observation is also in accordance with Van der Merwe *et al.* (1983). It can therefore be postulated that although the steers tried to compensate, the high polyphenol content presented palatability problems.

The reason why no additional growth occurred in spite of the higher intake cannot be linked to lower protein utilization as was found by Van der Merwe *et al.* (1983) since the diets in this experiment provided approximately 30 % more than the recommended protein levels. It would rather seem that the polyphenol-protein matrix described by Wagner (1982) presented a physical barrier to starch digestion thus resulting in a poorer feedlot performance.

From Table 2 it is evident that no significant differences existed between the NBR and PBR groups in any of the performance parameters. There is however, some tendency for the PBR group to perform slightly worse than the NBR group. The reason for this may be differences in polyphenol content which were 0,39 and 0,19 % for the PBR and NBR grains respectively. These values suggest that the paraformaldehyde fumes were unable to break down the protein-polyphenol matrix completely, with the consequent effect on starch digestibility and hence performance of the PBR group.

In conclusion it can be said that paraformaldehyde treatment of bird-resistant sorghum grain gave good results, although it was unable to equal the performance obtained from non bird-resistant sorghum grain. It is also evident that the use of bird-resistant sorghum grain may in some instances lead to satisfactory feedlot performances while in others poor results may be obtained. This may, as many researchers have pointed out (White & Hembry, 1978; Meissner *et al.*, 1982 and Wagner, 1982), be due to the variability in polyphenol content both between and within different sorghum varieties. In view of the variable results both here and abroad, a sensible approach for future work would be to do a systematic study with the percentage polyphenol and the percentage crude protein as variables. This may lead to an acceptable relationship which could be used to predict the performance of sorghum grain from a laboratory test.

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