A comparison between sodium hydroxide treated and untreated bird-proof sorghum in pig growth diets

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A digestion and a growth trial was conducted, (i) to determine the effect of sodium hydroxide (NaOH) treatment of bird-proof sorghum (BPS) on nitrogen and energy digestibility, and (ii) to compare treated with untreated BPS as grain components in a pig growth diet. The polyphenol content of BPS was reduced from 1,33 to 0,01% by NaOH treatment. NaOH treatment increased dietary nitrogen digestibility highly significantly ($P \leq 0,01$) from 65,5% to 77,1%. Nitrogen retention was also increased from 12,0 to 14,7 g/day ($P \leq 0,01$). Apparent digestibility of energy was improved ($P \leq 0,01$) from 76,7% to 81,9% resulting in a highly significant ($P \leq 0,01$) increase in dietary DE content from 13,85 MJ/kg DM to 14,83. Pigs fed NaOH-treated grain had livemass gains 8% higher ($P \leq 0,05$) than pigs fed the untreated BPS-containing diet. Although DE utilization did not differ between treatments, pigs on the treated grain diet had a significantly ($P \leq 0,05$) better feed conversion ratio (3,31 *vs* 3,56 kg feed/kg gain).
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'n Verterings- en 'n groeistudie is uitgevoer om (i) die effek van natriumhidroksied (NaOH)-behandeling van voëlproef-graansorghum (BPS) op die stikstof- en energieverteerbaarheid te bepaal en (ii) om behandelde BPS met onbehandelde BPS te vergelyk as graankomponent in 'n varkgroeidieet. Die polifenol-inhoud van BPS is deur NaOH-behandeling vanaf 1,33 na 0,01% verlaag. NaOH-behandeling het die verteerbaarheid van stikstof hoogs betekenisvol ($P \leq 0,01$) vanaf 65,5% na 77,1% verhoog. Stikstofretensie is ook verhoog ($P \leq 0,01$) vanaf 12,0 na 14,7 g/dag. Skynbare energieverteerbaarheid is verbeter ($P \leq 0,01$) vanaf 76,7% na 81,9% met 'n gevolglike verhoging ($P \leq 0,01$) van die VE-inhoud van die dieet vanaf 13,85 MJ/kg DM na 14,83. Varke gevoer met die dieet wat NaOH-behandelde graan bevat het, het 8% vinniger gegroei ($P \leq 0,05$). Hoewel VE-benutting nie tussen die twee behandelings verskil het nie, is voerverbruik betekenisvol ($P \leq 0,05$) deur NaOH-behandeling (3,31 teenoor 3,56 kg voer/kg toename) verbeter.
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Kemm, Ras & Daiber (1984) compared a high polyphenol content class KF bird-proof sorghum (BPS) cultivar with a normal sorghum (NS) class KM cultivar. They found the NS not only to be higher in apparent protein digestibility and DE content, but to induce growth rates that were 2 – 13% higher and feed-efficiency ratios that were 5 – 13% better. Although formaldehyde treatment of the BPS grain substantially increased both the apparent protein digestibility and DE content of the grain, N retention by the animal was adversely affected, which confirms the results of a previous paper (Kemm, Daiber & Ras, 1981). These authors also found formaldehyde treatment to have no beneficial effect on the feedlot performance of the growing pig.

In the study of Kemm, *et al.* (1984) it was also found that when BPS was fed in combination with sunflower oil cake as a protein supplement, feedlot pigs grew appreciably slower (11%) and with an 8% poorer feed-utilization ratio than pigs fed NS and sunflower oil cake.

According to Chavan, Kadam, Ghonsikar & Salunkhe (1979), NaOH can also be used to remove the polyphenols and to improve protein digestibility in sorghum grain. In a trial with sheep, Meissner (1981, unpublished) increased protein digestibility of BPS from 68,3 to 81,5% with NaOH treatment. This experiment was therefore conducted to determine the effect of NaOH treatment of a high polyphenol BPS (class KF, cultivar SSK 32) on (i) the apparent digestibility of nitrogen and energy of a BPS-sunflower oil cake growth diet, and (ii) to evaluate the effect of treated and untreated grain in the diet on the performance of growing pigs.

Experimental procedures

Class KF sorghum of the cultivar SSK 32 with a polyphenol content of 1,33% was used as experimental material. The polyphenol content was determined by the modified Jerumanis procedure as described by Daiber, 1975. One half of the grain was treated with NaOH to reduce the polyphenol content to a level normally found in non-bird-proof varieties. After the conditions for NaOH treatment to reduce the polyphenol content of BPS were determined in a preliminary trial, 25 kg batches of grain were soaked for 2 hours in a NaOH solution made up of 500 g NaOH dissolved in 25 l of water. After decanting the NaOH solution the grain was spread out on plastic sheeting and allowed to dry in the sun for 3 days. The treated material was then milled and stored in bags until the start of the digestion and growth trials.

Digestion trial

The two experimental diets (Table 1) were fed to 12 Landrace-

Table 1 Percentage composition of experimental diets containing untreated and NaOH-treated bird-proof sorghum (BPS)

Component	Diet: Untreated BPS	Diet: NaOH-treated BPS
Untreated BPS	58,1	–
Treated BPS	–	58,1
Maize meal	22,4	22,4
Sunflower oil cake	15,5	15,5
Feed lime	1,66	1,66
Mono calcium phosphate	0,63	0,63
Salt	1,0	1,0
Lysine (synthetic)[a]	0,5	0,5
Minerals & Vitamins[b]	0,2	0,2

[a] Lysine monohydrochloride was used.
[b] A commercial mineral and vitamin mixture was added.

type boars, having a mean livemass of 53,1 ± 3,6 kg.

The pigs were subjected to a 14-day trial period consisting of a 7-day preliminary period and a 7-day collection period, during which faeces and urine were collected in metabolism crates. The pigs had free access to water at all times. A daily amount of 1 500 g of air-dry meal was fed to each pig in two equal portions at 08h00 and 15h00. The procedures followed in collecting and analysing faeces and urine samples were described in detail by Kemm & Ras (1971).

The diets fed were chemically analysed for DM and nitrogen by standard AOAC methods. Energy content of the feed and faeces were determined using an adiabatic bomb calorimeter.

Growth trial

Fourty Landrace-type pigs (20 gilts and 20 boars) were randomly allotted to the two experimental treatments when 56 days old and 15,2 ± 1,9 kg in livemass. The experimental diet mixed with either treated or untreated BPS as grain source (Table 1) was fed to 20 pigs per diet (10 of each sex). The trial terminated when the pigs were slaughtered at a livemass of 84,8 ± 1,7 kg.

Pigs were individually housed in flat deck type cages (1,6 m × 1 m), fitted with a self-feeder and an automatic water nipple. Temperatures in the building were controlled to the extent that minimum temperatures never dropped below 20°C, while maximum temperatures seldom rose above 30°C. Pigs were fed *ad libitum* at all stages. Feed intake and livemass were recorded every 4 days. Feed and water were not withdrawn before mass determinations were done.

Statistical analyses

The statistical procedures followed were identical to those described by Kemm, *et al.* (1984) except that livemass gains were calculated for the livemass growth interval 25 – 85 kg.

Results and Discussion

Treatment of the grain with NaOH reduced the polyphenol content of the BPS from 1,33 to 0,01%, a figure appreciably lower than the 0,32 and 0,38% found by Kemm, Daiber & Ras (1981) and Kemm, Ras & Daiber (1984) when treating BPS with formaldehyde.

The nitrogen and energy metabolism data for the untreated and NaOH-treated BPS-containing diets fed during the digestion trial are summarized in Table 2.

Table 2 Means ± SD (n = 6) for nitrogen and energy metabolism data for diets fed to 12 Landrace-type boars during the digestion trial

Measurement	Diet: Untreated BPS	Diet: NaOH-treated BPS
Dietary N content, %	2,31	2,36
Daily DM intake, g	1362,8 ±0,9	1354,5 ±0,2
Daily N intake, g	31,5 ±0,01	32,0 ±0,01
Daily N excretion:		
Faeces, g	10,9 ±0,7	7,3 ±0,8[b]
Urine, g	8,6 ±0,9	10,0 ±0,6[b]
Apparent N digestibility, %	65,5 ±2,3	77,1 ±2,6[b]
N retention, g/day	12,0 ±1,3	14,7 ±1,1[b]
N retention as a % of intake	38,1	45,9
N retention as a % of digested N	58,2	59,6
Apparent energy digestibility, %	76,7 ±1,2	81,9 ±0,4[b]
Dietary DE content, MJ/kg DM	13,85 ±0,2	14,83 ±0,4[b]

[b] Difference statistically highly significant ($P \leq 0,01$).

Apparent digestibility of nitrogen of the treated diet was significantly ($P \leq 0,01$) higher (17,7%) as a result of a significantly ($P \leq 0,01$) lower faecal excretion rate. Consequently N retention increased significantly ($P \leq 0,01$) from 12,0 to 14,7 g/day (22,5%) despite a 16,5% increase in urinary N excretion (significant at $P \leq 0,01$). Hence, N retention when expressed as a percentage of either N intake or digested N increased with NaOH treatment, a finding which is in contrast to that found for paraformaldehyde treatment (Kemm, *et al.*, 1981; 1984). Apparent digestibility of energy was improved from 76,7 to 81,9% with NaOH treatment ($P \leq 0,01$) and consequently the DE content of the diet containing treated grain was significantly ($P \leq 0,01$) increased from 13,85 MJ/kg DE to 14,83.

The statistical parameters calculated from the growth data were subjected to a two-way analysis of variance. The mean values of the statistical parameters used are presented in Table 3. A significant difference ($P \leq 0,05$) was found between treatments in the value of ρ, therefore the parameters calculated for each pig were used to calculate DE intakes, livemass gain, and utilization efficiencies of feed and DE as summarized in Table 4 and Figures 1 and 2.

Pigs fed treated grain (Treatment 2) had higher DE intakes

Table 3 Statistical parameters used in calculating the data presented in Table 4 and Figures 1 and 2

Treatment	Statistical parameters: $\ln\bar{\rho}$ per 4 days	$\bar{\alpha}$ ln (MJ)	$\bar{\mu}$ ln (MJ)	$\bar{b}$ (DE × mass)	$\bar{a}$ (DE × mass)
Boars					
Untreated BPS	0,94965	8,91952	6,5091	0,76407	−1,81852
Treated BPS	0,94313	8,89004	6,6513	0,76595	−1,83291
Gilts					
Untreated BPS	0,95218	8,97165	6,53415	0,7496	−1,72015
Treated BPS	0,94589	8,86915	6,6223	0,75037	−1,72326

Table 4 Means ± SD (n = 10) for growth, feed, and DE utilization data calculated for the growth interval 25 – 85 kg livemass for 20 gilts and 20 boars of Landrace-type pigs

Measurement	Diet	
	Untreated BPS	NaOH-treated BPS
Livemass gain (g/day)		
Boars	644 ± 45	717 ± 77[a]
Gilts	619 ± 89	652 ± 61[a]
Treatment means	632 ± 70	685 ± 75[a]
	(100)	(108)
Feed utilization (kg/kg gain)		
Boars	3,50 ± 0,36	3,25 ± 0,18[a]
Gilts	3,62 ± 0,27	3,37 ± 0,33[a]
Treatment means	3,56 ± 0,32	3,31 ± 0,27[a]
	(100)	(93)
DE utilization (MJ/kg gain)		
Boars	44,1	43,6
Gilts	45,6	45,2
Treatment means	44,8	44,4
	(100)	(99)

[a] Difference statistically significant ($P \leq 0,05$).

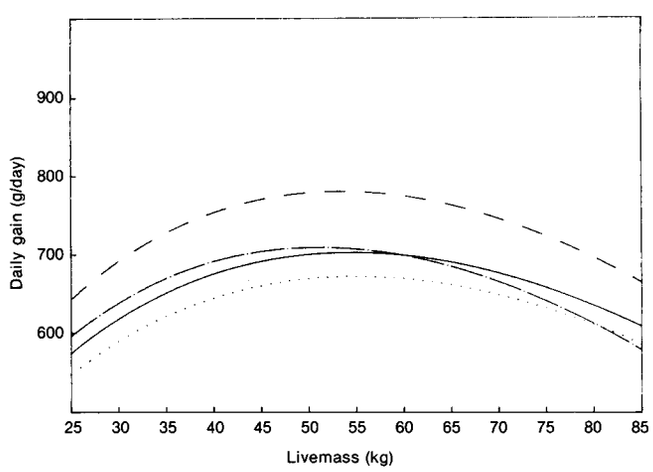

Figure 1 Daily DE intakes at different livemasses for untreated BPS fed to boars (—) and gilts (. . . .) and for NaOH-treated BPS fed to boars (----) and gilts (-.-.-.-.).

(Figure 1), with virtually no difference in DE utilization (Table 4). Consequently pigs fed NaOH-treated grain not only gained 8% more in livemass (significant at $P \leq 0,05$) than pigs fed untreated grain (Table 4 and Figure 2), but also had a 7% better feed utilization (significant at $P \leq 0,05$), because the diet containing treated grain had a higher DE content (14,83 MJ/kg as against 13,85 MJ) than the untreated grain diet.

In conclusion it seems that although NaOH treatment of BPS improved growth and feed utilization performance by 7 – 8%, the price of NaOH treatment (presently about 7%

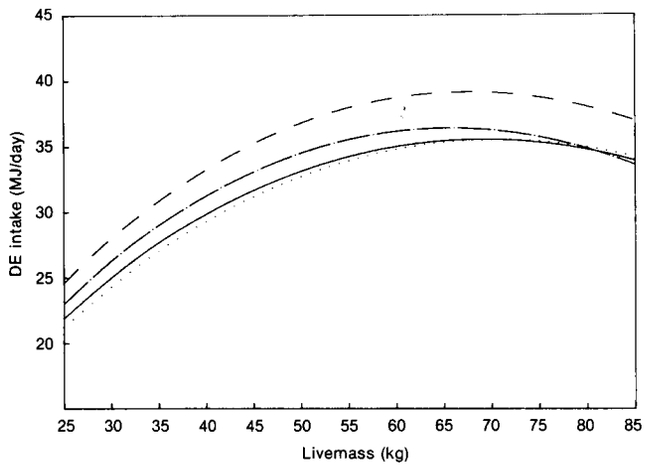

Figure 2 Daily livemass gains for untreated BPS fed to boars (—) and gilts (. . . .) and for NaOH-treated BPS fed to boars (----) and gilts (-.-.-.-.).

of dietary cost) and the trouble incurred in treating the grain may not justify treatment at present. It must furthermore be stressed that pigs fed a NS class KM sorghum (NK 283) by Kemm, *et al.* (1984), performed appreciably better than the pigs fed the treated diet in the present study. Pigs in the above-mentioned trial gained 796 g/day and had a feed-conversion ratio of 3,16 which was respectively 16,2 and 4,7% better than the figures obtained in this study with treated BPS. The use of BPS can therefore only be recommended if not fed in combination with sunflower oil cake (Kemm, *et al.*, 1984) and if bought at a price that will compensate for its lower DE content and protein digestibility relative to normal sorghum and maize.

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