Sodium and steam-treated sugarcane bagasse in low and high fibre fattening diets for lambs

G.A. Jacobs*

Tongaat Milling Limited, P.O. Box 13, Maidstone, 4380 Republic of South Africa

B.D.H. van Niekerk

Epol, Box 3006, Johannesburg, 2000 Republic of South Africa

*To whom correspondence should be addressed

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The purpose of this trial was to evaluate two methods of roughage treatment and two levels of treated roughage in complete rations for weaner lambs. A 3 × 2 factorial arrangement of treatments was used. Untreated, sodium hydroxide-treated, and steam-treated sugarcane bagasse were tested either at 19% or 40% inclusion levels. All low-fibre rations were formulated to contain (per kg) 130 g crude protein, 130 g crude fibre, 8,1 g Ca, and 3,4 g P whereas the high-roughage rations were formulated to contain (per kg) 102 g crude protein, 173 g crude fibre, 8,5 g Ca, and 2,2 g P all on air-dry basis. Because of the different bagasse treatments ,the rations within each roughage level varied in concentration of digestible energy. The trial was performed with 84 Dohne Merino lambs fed *ad libitum* in groups of 12. Sodium hydroxide treatment improved live average daily gain (ADG), efficiency of live feed conversion (FCR), and efficiency of carcass FCR at both low (44 g, 5,6% and 8,8%, respectively) and high (19 g, 2,3% and 5,5%, respectively) roughage inclusion levels. The response to sodium hydroxide was thus bigger in the high energy production type diet. Steam treatment of bagasse only improved live ADG, live FCR, and carcass FCR at the lower inclusion level (14 g, 2,6% and 14,1%, respectively). At the higher levels of inclusion steam treatment had a negative effect on all parameters mentioned.

Die doel van hierdie proef was om twee metodes van ruvoerbehandeling by twee insluitingspeile van behandelde ruvoer in volledige rantsoene te vergelyk by lammers. In 'n 3 × 2-faktoriale-uitleg is onbehandelde, natriumhidroksied-behandelde en stoombehandelde suikerrietampas elk by 19%- en 40%-insluitingspeile getoets. Alle rantsoene is op 'n lugdroë basis geformuleer om (per kg) 130 g ruproteïen, 130 g ruvesel, 8,1 g Ca en 3,4 g P in die laeruvoerrantsoene en 102 g ruproteïen, 173 g ruvesel, 8,5 g Ca en 2,2 g P in die hoëruvoerrantsoene te bevat. As gevolg van die verskillende behandelings van die ampas, het die rantsoene binne elke ruvoerpeil verskillende verteerbare-energiewaardes gehad. Vier-en-tagtig Dohne-Merino-lammers is in groepe van 12 elk verdeel en is *ad libitum* gevoer. NaOH-behandeling het lewende daaglikse massatoenames (GDT), doeltreffendheid van lewende voeromsetting (VO) en doeltreffendheid van karkasvoeromsetting by beide hoë ruvoerpeile (19 g, 2,3%, 5,5%, onderskeidelik) en tot 'n groter mate by lae ruvoerpeile (44 g, 5,6%, 8,8%, onderskeidelik) verbeter. Die reaksie op NaOH-behandelde ruvoer was dus groter in die hoë-energieproduksierantsoene. Stoombehandelde ampas het slegs teen die laer insluitingspeil lewende GDT, lewende VO en karkas VO verbeter (14 g, 2,6% en 14,1%, onderskeidelik). By die hoër insluitingspeil het stoombehandeling 'n negatiewe invloed op produksie gehad.

Keywords: Sodium hydroxide, steam roughage treatment, fattening lambs.

Treatment of roughages with sodium hydroxide has been widely investigated as a means of improving digestibility and feed intake (Klopfenstein & Woods, 1970; Klopfenstein, Krause, Jones & Woods, 1972; Jackson, 1977; Owen, 1978; and Chicco, Garcia, Fernandez & Prays, 1983). Much less information is available on roughage improvement by exposure to high-pressure steam (Hart, Walker, Graham, Hanni, Brown & Kohler, 1981; Garrett, Walker, Kohler, Hart & Graham, 1981; and Harris, van Horn, Manookian, Marshall, Taylor & Wilcox, 1983). In only one of these experiments Garret, *et al.* (1981) compared a method of steam treatment with sodium hydroxide treatment of roughage. Thus comparitively little is known about the relative value of these two methods of roughage treatment, particularly in high-energy diets.

The purpose of this trial was to investigate the value of sodium hydroxide and steam treatment of sugarcane bagasse on feed intake and animal performance in both low and high-energy complete diets.

A total of 84 Dohne Merino wethers, 3 – 4 months old (average mass 22 kg), were stratified according to livemass and were randomly allocated to six treatment groups of 12 animals each, as well as an initial slaughter group of 12 sheep. Livemass was recorded after 15 hours of starving without feed and water on two successive days, before the start and end of the trial. Averages of these successive measurements were used to determine the livemass gains over the test period of 56 days. Finally all animals were slaughtered and cold carcass mass was compared with the estimated initial cold carcass mass. The latter was calculated from initial livemass by means of regression analysis from the results of the initial slaughter group.

A 2 × 3 factorial arrangement of treatments was used. The treatment variables consisted of roughage level, either 19% or 40% of the diet on a natural air-dry basis, and roughage treatment which consisted of a control treatment with 5% sodium hydroxide or treatment with steam for 15 minutes at 12 bar with a quick release of pressure. In both cases the roughage was in fine physical form, comparable to hammer milling through a 6 mm screen.

All low-roughage rations were formulated, on an air-dry basis, to contain (per kg) 130 g crude protein, 130 g crude fibre, 8,1 g calcium, and 3,4 g phosphorus whereas all high-roughage rations were formulated (air-dry basis) to contain, per kg, 102 g crude protein, 173 g crude fibre, 8,5 g calcium, and 2,2 g phosphorus. All low-roughage rations contained 14,2% molasses, 4,3% oilcake meal, 58,9% cereals and cereal byproducts, 1% urea, 2,2% buffers, ionophores, salt, antibiotics and mineral premix, and 19,4% sugarcane bagasse.

Table 1 Growth and performance of Dohne Merino lambs fattened for 56 days in groups of 12.

Measurement	Roughage treatment and inclusion level					
	Untreated		NaOH		Steam	
	Low	High	Low	High	Low	High
Feed intake (kg/day)	1,364	1,490	1,558	1,609	1,418	1,466
Initial livemass (kg)	21,9	22,3	22,8	22,2	22,5	22,5
Final livemass (kg)	33,8	32,8	37,2	33,8	35,2	30,8
Livemass gain (kg)	11,9	10,5	14,4	11,6	12,7	8,3
Daily live gain (g)	213	188	257	207	227	148
Live gain/kg feed (kg)	6,42	7,95	6,06	7,77	6,25	9,89
Initial carcass mass (kg)	9,6	9,8	10,1	9,7	9,9	9,9
Final carcass mass (kg)	15,3	14,7	17,4	15,3	16,8	14,0
Carcass mass gain (kg)	5,7	4,9	7,3	5,6	6,9	4,1
Daily carcass gain (g)	102	88	130	100	123	73
Final dressing percentage (%)	45,3	44,8	46,8	45,3	47,7	45,5
Percentage of livemass gain which was carcass (%)	47,9	46,7	50,7	48,3	54,3	49,4

All high-roughage rations contained 16,4% molasses, 5,9% oilcake meal, 33,9% cereals and cereal byproducts, 1% urea, 2,8% limestone and salt, and 40% sugarcane bagasse. In doing these formulations, treatments were assumed to have no influence on the crude fibre contents of the roughage. Because of the treatments imposed, the energy concentrations of the diets varied within each of the two levels of roughage inclusion. The trial was thus laid out to show differences in animal performance which might result from improvement in the energy concentration of the diet as well as from differences in intake. All rations were fed *ad libitum* in groups and air-dry feed intakes were recorded fortnightly. The data were analysed using *t* tests and analysis of variance as for the general two-factor experiment (Snedecor & Cochran, 1967, p. 347).

The effects of each treatment upon voluntary diet, live and carcass gain, live and carcass feed conversion, and dressing percentages are illustrated in Table 1. An analysis of variance of livemass change showed a highly significant ($P < 0,01$) interaction between roughage level and roughage treatment. Therefore roughage treatment effects should be compared separately for each roughage level.

NaOH treatment increased feed intake at both low and high roughage inclusion levels by 14,2% and 8,0%, respectively. Steam treatment on the other hand only increased feed intake at low roughage inclusion levels and by only 4,0%, whereas intake actually decreased by 1,6% on the high-roughage diet. Animal performance, measured in terms of mass gain and feed conversion, followed the same trend as feed intakes. NaOH improved live average daily gain (ADG), efficiency of live feed conversion rate (FCR), and efficiency of carcass FCR at both low (44 g, 5,6% and 8,8%, respectively) and high (19 g, 2,3% and 5,5% respectively) roughage inclusion levels. The response to NaOH treatment was therefore about twice as great in the low roughage production type of ration. This is contrary to the findings of Chicco, *et al.* (1983) who tested lamb growth with diets containing 22% and 46% NaOH-treated bagacillo. This difference might be due to the fact that they used 6,75% NaOH and molasses was the only other energy source in their rations. The fact that no ration energy was supplied from cereals limited growth to a larger extent in their low-fibre rations.

The *in vitro* digestibility of organic matter of the steam-treated bagasse, determined according to the method of Engels and Van der Merwe (1967), was 55,0% as compared to 34,9 ± 1,1% (mean ± *SD*) of four determinations for untreated material. The higher digestibility of steam-treated roughage is in agreement with the findings of Hart, *et al.* (1981) who used an *in vitro* enzyme method as a measure of digestibility.

Steam treatment only improved live ADG, live FCR and carcass FCR at the lower roughage inclusion level (14 g, 2,6% and 14,1%, respectively). This agrees with the findings of Harris, *et al.* (1983) that 25% steam-treated bagasse gave good results with dairy cows. At the higher inclusion level, steam treatment had a negative effect on live ADG ($P < 0,05$), live FCR and carcass FCR (−40 g, −24,4% and −17%, respectively). This is in agreement with the results of Garrett, *et al.* (1981), who reported no improvement in growth when rations with 65% steam-treated roughage were used. They suggested that phenolic compounds, possibly produced from lignin during the process of steam treatment, might be responsible for this negative effect in spite of the improvement in digestibility of organic matter.

As would be expected, diet concentration had a marked effect on animal performance. Increasing the level of roughage inclusion from 19% to 40% drastically reduced live ADG and efficiency of both live and carcass gain. Referring, respectively, to untreated, NaOH-treated and steam-treated bagasse, live ADG dropped by 25 g, 50 g and 79 g; live FCR dropped by 24%, 28% and 58%, and carcass FCR dropped by 27%, 35% and 75%. It is clear that the rate of decrease in gain and efficiency of feed use due to increased roughage levels was more marked where NaOH and particularly where steam-treated bagasse was the source of roughage.

It can thus be concluded that both steam and sodium hydroxide treatment of bagasse resulted in improved animal performance where such roughages were used in concentrated diets containing only 19% bagasse. At higher levels of roughage inclusion (40%) the response to NaOH treatment was less marked while steam-treated bagasse actually had a negative effect on animal performance.

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