Ammoniated maize residue for the fattening of lambs

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The use of ammoniated maize residue as a replacement for maize meal in the diet for fattening lambs, was investigated. Ammoniation of maize residue increased average daily DMI and ADG at the 0 and 20% concentrate levels. The feed conversions to carcass in lambs fed untreated maize residue with 40, 60 or 80% concentrate were 14,0; 10,1 and 8,1, respectively, and for the ammoniated residue with 0, 20, 40, 60 or 80% concentrate were 14,6; 11,6; 9,9; 9,4; and 8.5, respectively. Concentrate levels significantly affected digestibility in both untreated and ammoniated diets. Ruminal ammonia-N levels were between 180 – 250 mg/l and were significantly higher on ammoniated maize residue at the 40 and 80% concentrate levels. Ammoniation of maize residue increased lamb performance at low concentrate levels.

Die gebruik van geammonifiseerde mieliereste as 'n plaasvervanger vir mieliemeel in die rantsoen vir die vetmaak van lammers is ondersoek. Ammonifisering van mieliereste het die gemiddelde daaglikse DMI en ADG laat toeneem by die 0 en 20% konsentraatvlakke. Die omset van voer na karkas in lammers wat onbehandelde mieliereste met 40, 60 en 80% konsentraat ontvang het, was 14,0; 10,1 en 8,1 en vir die geammonifiseerde reste met 0, 20, 40, 60 of 80% konsentraat was dit 14,6; 11,6; 9,9; 9,4 en 8,5 onderskeidelik. Konsentraatvlakke het verteerbaarheid betekenisvol beïnvloed in die onbehandelde sowel as die geammonifiseerde rantsoene. Ammonium-N vlakke in die grootpens was tussen 180 – 250 mg/l en was betekenisvol hoër op geammonifiseerde mieliereste by die 40 en 80% konsentraatvlakke. Ammonifisering van mieliereste het die produksie van lammers op lae konsentraatvlakke verhoog.

Keywords: Ammoniation, maize residue, lamb growth and fattening, feed conversion, *in vivo* digestibility, nitrogen digestibility, rumen parameters.

Introduction

In South Africa meat production is traditionally practised on natural pastures with the semi-arid areas being the most important livestock producing areas. These areas are already showing signs of overgrazing and consequently deterioration. Owing to this problem and to the increases in demand and production of livestock, ruminant production is intensifying to the extent that ruminants will compete with monogastric animals and even with man for grain.

Eight to ten million tonnes of low quality roughage are produced annually in South Africa as a byproduct of the grain industry (Hofmeyr & Jansen, 1976). Owing to the problems involved with caustic soda treatment of straw, other alkalis have enjoyed attention recently. Ammonia is proving to be a viable alternative to caustic soda, both because of its simplicity of application and the added benefit of supplying non-protein nitrogen to the animal.

The object of this research was to ascertain to what extent maize meal in the diet of fattening lambs can be replaced with ammoniated maize residue while retaining similar performance and an attractive profit margin for the producer. A further objective was to find out more about the digestion and nitrogen availability of ammoniated maize residue.

Procedure

Ammoniation of maize residue

Maize residue obtained from a combine harvester was hammermilled through a 13 mm screen and ammoniated using the 'stack method' (Norsk/Hydro/Nofo, 1977). Before treatment, water was sprayed over the maize residue to increase its moisture content to approximately 35%. Anhydrous ammonia was injected into the stack at a rate of 4% of the roughage dry matter. After a treatment time of 50 days the roughage was dried and stored in hessian sacks.

Growth trial

The growth trial consisted of a 2 × 5 factorial design in which the ten groups of South Africa Mutton Merino wether lambs were offered diets containing either untreated or ammoniated maize residue and 0, 20, 40, 60 or 80% concentrate. All diets contained constant amounts of fish meal, molasses and minerals. The average initial mass of lambs in the growth trial was 21,5 kg. Lambs were slaughtered at 40 kg body mass corrected for rumen fill. Parameters measured were daily feed intake, average daily gain, feed conversion to liveweight and carcass, rumen digesta mass and dressing percentage.

Digestibility trial

In this trial ten ruminally cannulated wether lambs of the same breed were randomly allotted to two 5 × 5 latin square designs and offered the same diets as those in the growth trial. Each collection period was of ten-day duration and was preceded by an 18-day adaptation period. Parameters measured were average daily feed intake, apparent *in vivo* dry matter digestibility, ruminal pH, ruminal ammonia-N, retention time of water in the rumen and ruminal water volume. Ruminal pH and NH_3-N levels were measured as the average of six samples taken on the first and tenth days of each collection period. Cr-EDTA was used as a soluble marker for the determination of ruminal water volume and retention time of water.

Results

Ammoniation of this maize residue increased its *in vitro* organic matter digestibility from 55,8 to 67,0% and its crude protein content from 3,6 to 12%. The ammoniated material was darker in colour, softer in texture and had a distinctive, pleasant smell.

Growth trial

The mean average daily dry matter intake and the average daily gain measured after 91 days are shown in Tables 1 and 2. Ammoniation of maize residue increased ($P<0,01$) average daily dry matter intake and average daily gain at the 0 and 20% concentrate levels. In both these parameters level of concentrate had a significant ($P<0,01$) effect only when untreated maize residue diets were fed. Lambs fed ammoniated maize residue and 80% concentrate grew significantly less ($P<0,05$) than those fed untreated maize residue and 80% concentrate.

Table 1 Mean average daily dry matter intake of lambs fed untreated and ammoniated maize residue and different proportions of concentrate

Concentrate (%)	DMI (g)		Significance (Untreated vs Ammoniated)
	Untreated	Ammoniated	
0	496,3	827,9	$P<0,01$
20	547,9	858,0	$P<0,01$
40	749,0	796,8	NS
60	811,7	820,1	NS
80	830,0	779,6	NS
Significance (effect of concentrate level)	P = 0,0001	P = 0,3051	
S.E.	23,6	23,8	
C.V.	18,9	15,4	

Table 2 The mean average daily gain of lambs fed untreated and ammoniated maize residue and different proportions of concentrate

Concentrate (%)	ADG (g)		Significance (Untreated vs Ammoniated)
	Untreated	Ammoniated	
0	44,0	141,4	$P<0,01$
20	78,6	155,9	$P<0,01$
40	128,8	152,5	NS
60	142,7	165,4	NS
80	192,3	153,9	$P<0,05$
Significance (effect of concentrate level)	P = 0,0001	P = 0,6361	
S.E.	7,2	5,4	
C.V.	32,87	18,55	

The lambs receiving untreated maize residue and 0 or 20% concentrate were excluded at this stage owing to poor performance. All other lambs were slaughtered at 40 kg body mass corrected for rumen fill. Final feed intake and growth results were similar to those shown in Tables 1 and 2. The rumen digesta mass (kg), dressing percentage, and feed conversion to carcass measured in lambs offered untreated maize residue with 40, 60 or 80% concentrate and those fed ammoniated maize residue with 0, 20, 40, 60 or 80% concentrate were 5,30, 41,2, 13,97; 4,53, 43,4, 10,08; 4,21, 44,5, 8,09; 5,97, 41,2, 14,63; 4,79, 44,5, 11,59; 4,24, 45,2, 9,88; 4,08, 45,4, 9,35 and 3,93, 45,6, 8,50, respectively. Differences measured at the 40% concentrate levels were significant ($P<0,05$). Concentrate level had significant ($P<0,05$) effects on the above parameters in both untreated and ammoniated groups.

Digestibility trial

The apparent *in vivo* digestibility of the diets is shown in Table 3. Ammoniation significantly increased ($P<0,01$) digestibility at the 0 and 20% concentrate levels. Concentrate level significantly affected ($P<0,01$) digestibility in both untreated and ammoniated diets. Ruminal pH and ammonia-N levels (mg/l) measured in lambs fed untreated maize residue with the same concentrate levels, were 6,75, 229,1; 6,59, 223,5; 6,47, 202,7; 6,21, 214,2; 6,18, 179,9 and 6,44, 231,5; 6,44, 243,2; 6,24, 249,8; 6,06, 199,4; 5,94, 229,6, respectively. Ammoniation decreased ($P<0,05$) ruminal pH at all concentrate levels. The differences in ruminal ammonia-N were only significant ($P<0,05$) at the 40 and 80% concentrate levels. Increasing concentrate levels decreased ($P<0,001$) ruminal pH in both ammoniated and untreated maize residue diets but had no effect on ruminal ammonia-N levels.

The retention time of water was not significantly affected ($P>0,05$) by either concentrate level or ammoniation. Rumen water volume was slightly reduced by ammoniation at all concentrate levels with the reduction at the 0% level being significant ($P<0,05$). Increasing concentrate level significantly decreased ($P<0,05$) rumen water volume only in the untreated maize residue diets.

Table 3 Mean apparent *in vivo* dry matter digestibility of diets containing untreated and ammoniated maize residue and different proportions of concentrate

Concentrate (%)	DMD (g)		Significance (Untreated vs Ammoniated)
	Untreated	Ammoniated	
0	62,4	66,8	$P<0,01$
20	66,6	70,9	$P<0,01$
40	71,8	74,5	NS
60	76,9	75,3	NS
80	78,4	78,7	NS
Significance (Effect of concentrate level)	P = 0,0001	P = 0,0004	
S.E.	0,5	0,4	
C.V.	3,75	2,59	

Conclusions

The increased intake by lambs of diets containing ammoniated maize residue is in agreement with the results of most researchers (Solaiman, Horn & Owens, 1979). Am-

moniation of maize residue increased the feed intake, digestibility and digestible dry matter intake thereof by lambs with a commensurate increase in lamb performance at low concentrate levels. The failure of diets containing less than 60% ammoniated maize residue i.e. 80 and 100% concentrate, to produce significantly increased feed intake and lamb performance could be attributed to the fact that only a small proportion of the digestible dry matter intake of such diets consisted of ammoniated roughage.

When applying the prevailing dietary ingredient prices to the feed conversion figures it was concluded that in terms of feed cost per kg carcass gain, a balanced diet containing untreated maize residue and 67,6% concentrate could be replaced by a balanced diet containing ammoniated maize residue and no energy concentrate.

The increased dressing percentage and reduced ruminal digesta mass, pH and water volume owing to ammoniation, all indicate a greater fermentation rate, a higher ruminal molar percentage of propionic acid and a greater efficiency of utilization of metabolizable energy for fattening (Armstrong & Blaxter, 1957; Schwartz & Gilchrist, 1975).

The fact that the ruminal ammonia-N levels measured in lambs receiving ammoniated maize residue diets was not lower than that measured in lambs receiving urea containing untreated maize residue diets, indicates that ammoniated maize residue is a substantial contributor of ammonia to the ruminal pool.

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