RESPONSE OF GROWING CATTLE TO AMMONIATED WHEAT STRAW SUPPLEMENTED WITH UREA, BY-PASS PROTEIN AND BROKEN RICE

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SUMMARY

Sixty four young cattle in eight groups were offered a basal diet of thermo-ammoniated wheat straw (WS) over 42 days and then stack-ammoniated failed wheat crop (FWC) for a further 56 days. Supplements of urea (1.2% of roughage DM), 0.5 kg protein nuts and 0.5 kg of broken polished rice/head/day were given in a 2x2 factorial design. Urea supplementation depressed (P < 0.01) intake of straw and total ration and tended to reduce liveweight gain. Supplementation with protein nuts resulted in an increased (P < 0.001) liveweight gain of 200 g/hd/day. Broken rice resulted in a mean 139 g additional gain (P < 0.001), 75 g (n.s.) when fed with the WS and 187 g (P < 0.001) when FWC formed the basal diet. Rice did not enhance total DMI. This trial has shown that a ration which comprised 88% of ammoniated roughage, with judicious supplementation, can support a daily gain of 0.6 kg in cattle.

(Keywords: ammoniated roughages, urea, by-pass protein, broken rice, cattle).

INTRODUCTION

Ammoniation raises the digestibility and nitrogen content of straw and enhances its intake and utilisation by ruminants, especially with strategic supplementation (Sundstøl and Owen 1984). Supplements that potentially increase productivity on straw based diets include non-protein nitrogen (NPN), by-pass protein and by-pass starch (Preston and Leng 1984).

The objective of the experiment reported here was to measure the liveweight gain, feed intake and concentrations in the rumen liquor of NH₃-N and VFA’s of young cattle offered a basal diet of ammoniated wheat straw alone or supplemented with urea and/or a protein meal and/or broken polished rice. Supplementation with urea was done to test whether the N in the ammoniated roughage provided sufficient NPN to optimise voluntary intake and digestibility. The sources of protein and rice starch used had previously been shown to partially escape digestion in the rumen (Leng et al. 1984; Throckmorton and Leng 1983).

MATERIALS AND METHODS

Animals and diets

Sixty-four Friesian calves (43 heifers and 21 steers) of 10 months of age and weighing 191 ± 25 kg were allocated by stratified randomisation to eight partially covered feedlot pens each holding eight animals. Supplements of urea (1.2% of straw DM), 0.5 kg protein nuts/head/day and 0.5 kg broken polished rice/head/day were given either alone or in combinations according to a 2x2 factorial design.

The protein nuts consisted of 57% solvent-extracted cottonseed meal, 25% soyabean meal, 5% meat meal, 5% molasses and 8% minerals. This mixture was shown to contain approximately 60% by-pass protein as estimated by a woolgrowth assay (Leng et al. 1984). All animals were fed once a day at 0900h and besides the supplements, received ad lib thermo-ammoniated wheat straw during a 12 day adaptation period and the first 28 days of the main period.

For the next four days a thermo-ammoniated failed wheat crop (straw with a few
shrivelled grains in it) was used. Following problems of hyper-excitability (Perdok and Leng 1985) this was replaced by the original thermo-ammoniated wheat straw for 14 days. For the last 56 days of the trial, stack-ammoniated wheat crop was fed. On average roughage offered was 12% above the previous day's intake. Throughout the experiment, a mineral/vitamin mixture was spread over the straw at a rate of 100 g/head/day, to cover the ARC (1980) recommended levels of minerals and vitamins A and D. The urea was dissolved in approximately 1 l of water and sprayed over the roughage. A similar quantity of water was sprayed over the roughage of the non-urea groups to exclude an effect of water per se.

Preparation of roughage
Thermo-ammoniation was done with 3.5% (w/w) NH\(_3\) for 23 h in an oven (Am-StråVerter FMA, Fuglebjerg, Denmark 4250) in which a peak temperature of 85–90°C was reached. Stack-ammoniation was done by injecting 3.5% (w/w) NH\(_3\) gas into plastic covered stacks of 3 t baled material to which about 5% (w/w) water had been added.

Measurements
All separate feeds were analysed for DM, CP, ash and DM disappearance from nylon bags (pores of 25 μm, 18% open) suspended for 24 h in the rumen of steers. The cattle were weighed every fortnight before feeding and the gains were subjected to repeated measures AOV with orthogonal contrasts being examined. Separate analyses were done for the first 42 and last 56 days of the trial to test for differences in thermo-ammoniated wheat straw and stack ammoniated failed wheat crop as basal feeds. Separate analyses were also done for each fortnightly period. The main effects for the third period, during which hyper-excitability occurred, were similar to those of the other periods in which WS was fed and the data of the third period were included in the results. Results from two animals with health problems were excluded from the analyses.

DM intake was measured during days 19 to 23, 61 to 65 and 88 to 92. Roughage not eaten was included in the next day's feed. AOV was done on the data arising from the roughage and total DM intake. Rumen liquor was taken from all animals using a stomach tube before feeding on days 18, 70 and 98 and about one hour after feeding on days 29, 71 and 99. NH\(_3\)-N concentration was determined by autoanalyser (Crooke and Simpson 1971; modified by Bietz 1974) and VFA concentrations and proportions by gas liquid chromatography (Erwin et al. 1961; Geissler et al. 1976). NH\(_3\)-N and VFA concentrations were analysed using AOV with orthogonal contrasts being examined in the time variable defined by before and after feeding and the three stages in the experiment when samples were taken. Main effects were determined over the combined six sampling times.

RESULTS AND DISCUSSION
Feed Analyses
The composition and rumen degradability (Mehrez and Šrakov 1977) of the feeds used are given in Table 1. Thermo-ammoniation raised the N content (g/kgDM) in wheat straw from 5.8 to 16.9 and of the failed wheat crop (FWC) from 5.5 to 24.8. These increases are about double those reported from the U.K. (Ibbotson et al. 1984). Ammoniation of barley straw by Dryden and Kempton (1984) in Australia increased straw N content by 8 g/kg/DM. The higher recoveries of between 39% and 67% of NH\(_3\)-N injected in the study reported here can probably be partly explained by the method of N analysis which was done on fresh rather than on dried samples. High temperature drying, common in many laboratories, is likely to remove
The highest recovery in the stack-ammoniated FWC may have been due to the addition of 5% water (Sundstøl et al. 1978). The N content and relative digestibility of the forages as estimated by the nylon bag technique suggests that ammoniation in a stack results in a better product than ammoniation in an oven. The addition of water may also explain part of the higher digestibility of the stack-treated material (Borhami and Sundstøl 1982).

### Animal performance

The effects of urea, by-pass protein and broken rice on liveweight gain, DM intake and rumen fluid parameters are shown in Table 2.

#### Table 2. Main effect of supplements on liveweight gain, voluntary intake and rumen fluid parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Supplement</th>
<th>+</th>
<th>-</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liveweight gain (g/hd/day)</td>
<td>urea</td>
<td>407</td>
<td>434</td>
<td>-27 n.s.</td>
</tr>
<tr>
<td></td>
<td>protein nuts</td>
<td>517</td>
<td>317</td>
<td>200 ***</td>
</tr>
<tr>
<td></td>
<td>broken rice</td>
<td>492</td>
<td>353</td>
<td>139 ***</td>
</tr>
<tr>
<td>Total DM intake (% of lwt/day)</td>
<td>urea</td>
<td>3.00</td>
<td>3.27</td>
<td>-0.27 **</td>
</tr>
<tr>
<td></td>
<td>protein nuts</td>
<td>3.22</td>
<td>3.05</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>broken rice</td>
<td>3.12</td>
<td>3.15</td>
<td>-0.03 n.s.</td>
</tr>
<tr>
<td>Straw DM intake (% of lwt/day)</td>
<td>urea</td>
<td>2.79</td>
<td>3.06</td>
<td>-0.27 **</td>
</tr>
<tr>
<td></td>
<td>protein nuts</td>
<td>2.91</td>
<td>2.94</td>
<td>-0.03 n.s.</td>
</tr>
<tr>
<td></td>
<td>broken rice</td>
<td>2.81</td>
<td>3.04</td>
<td>-0.23 **</td>
</tr>
<tr>
<td>Rumen fluid NH₃ (mg N/litre)</td>
<td>urea</td>
<td>173</td>
<td>118</td>
<td>55 ***</td>
</tr>
<tr>
<td></td>
<td>protein nuts</td>
<td>151</td>
<td>139</td>
<td>12 **</td>
</tr>
<tr>
<td></td>
<td>broken rice</td>
<td>139</td>
<td>151</td>
<td>-12 **</td>
</tr>
<tr>
<td>Total VFA conc. (mmoles/litre)</td>
<td>urea</td>
<td>69</td>
<td>61</td>
<td>8 ***</td>
</tr>
<tr>
<td></td>
<td>protein nuts</td>
<td>64</td>
<td>66</td>
<td>-2 n.s.</td>
</tr>
<tr>
<td></td>
<td>broken rice</td>
<td>67</td>
<td>69</td>
<td>3 n.s.</td>
</tr>
</tbody>
</table>

* = P < 0.05; ** = P < 0.01; *** = P < 0.001; n.s. = non significant

Urea supplementation tended to depress daily gain, probably because it depressed (P < 0.01) total DM as well as straw DM. This indicates that supplementation with urea is unnecessary when roughages are ammoniated and fed without aeration.

By-pass protein nuts increased liveweight gain by 0.2 kg/hd/day (P < 0.001) probably because of an increased DM (P < 0.05). In this study, by-pass protein did not stimulate intake of the basal diet.

Supplementation with broken rice resulted in an additional gain of 0.139 kg (P < 0.001). However, the rice consumed replaced straw in the total feed intake.
Rumen NH levels were raised by supplements of NPN (P < 0.001) and true protein (P < 0.01) and depressed by broken rice (P < 0.01). Urea was also associated with a higher VFA concentration (P < 0.001). Rumen NH and VFA levels before feeding were 113 mg N and 61 mmoles/l respectively and rose (P < 0.001) to 175 mg N and 69 mmoles/l respectively after feeding. Levels of both NH and VFA differed (P < 0.001) during the three stages (S₁, S₂ and S₃) in the experiment when samples were taken. Mean concentrations of NH were 771, 177 and 149 and of VFA 61, 65 and 69 during S₁, S₂ and S₃ respectively.

Wheat straw versus failed wheat crop

A comparison between the liveweight gain during the periods when thermo-ammoniated wheat straw (WS) and stack-ammoniated FWC were fed showed a greater overall gain of 70 g/hd/day in the FWC period but no difference in main effects of urea and protein nuts. However, broken rice resulted in an additional gain of only 75 g (P < 0.11) when WS was the basal diet which increased to 187 g (P < 0.001) when FWC formed the basal diet.

Conclusion

Ammoniation of wheat straw or a FWC can improve the feeding value of these roughages such that when fed alone, a daily gain of 0.25-0.3 kg can be obtained in cattle. Supplementation with 0.5 kg by-pass protein nuts and 0.5 kg brokenpolished rice increases growth to 0.6 kg and improves the efficiency of feed utilisation from a FCR of 23 to 12. Ammoniation and judicious supplementation could turn straw and failed crops into potentially valuable drought feeds for cattle.

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REFERENCES