The Supplementation of Low Quality Hay and Pasture with Molasses and Molasses Urea Mixtures

BY R. M. BEAMES*

SUMMARY

Four experiments, designed to give information on the trough feeding of molasses and molasses urea mixtures, are described. The estimations of molasses intakes of cattle were made under grazing conditions whereas the remainder of the data were obtained on cattle kept in either yards or stalls and fed on a ration of pasture hay of 2.2 to 2.7 per cent. crude protein content.

It was found that grazing Hereford cows, when given access to molasses ad lib., consumed a mean of 7.9 lb. of molasses per day with a range of 0-12.1 lb.

The effect of increasing urea concentration in a molasses urea mixture presented ad lib. in troughs was to increase the intake of hay and decrease the intake of mixture, resulting in a relatively constant intake of urea. At all but very low urea concentrations the urea intake was considered in excess of requirements.

Under the experimental conditions, the mixture proved toxic only when cattle, which had become accustomed to high intakes of molasses alone, were abruptly changed over to a mixture containing a high concentration of urea.

When the mixture was fed twice weekly, rate of consumption decreased with increasing concentrations of urea.

In a comparison between daily and twice weekly supplementation with a molasses urea mixture, the group supplemented daily ate more hay and made greater weight gains. These differences, although consistent, did not prove to be significant.

INTRODUCTION

In most years, cattle on native pastures in the beef producing areas of Queensland lose weight during winter and spring (Alexander and Chester, 1956). One method of preventing or reducing this weight loss is supplementation. Experimental evidence is available that a production response can be obtained from supplements containing high levels of nitrogen. This has been shown with both grazing sheep (Marston, 1932) and cattle (Qd. Dept. Ag. & Stock, 1958-59, p. 79) and also with cattle hand fed on low quality pasture hay (Morris, 1958; Beames, 1959). Similar results have been obtained from South Africa (Clark and Quin, 1951). However, more work is needed under grazing conditions to determine the roles played by both protein and energy in this response.

Of the sources of high nitrogen feeds, non-protein nitrogen (N.P.N.), particularly in the form of urea, warrants investigation because of its low price and ready availability in comparison with conventional proteins. Urea has the additional advantage of high solubility, allowing for greater scope in methods of administration. It has the disadvantage of being toxic when the rate of consumption is high.

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Normally N.P.N. is fed with a source of readily available carbohydrate (e.g. molasses, starch) both to improve utilisation (Mills et al., 1942) and reduce toxicity (Clark, Oyaert and Quin, 1951; McNaught and Smith, 1947-48), although this latter point needs further clarification. Molasses urea mixtures have been fed to grazing animals in several ways — sprayed on the standing pasture (Kellermann and Groenewald, 1956; O'Bryan, 1960), sprayed on conserved roughage (Clark, 1952) and presented in troughs both free choice (Berry, 1951) and at intermittent periods (van La Chevallerie, 1959). Snook (1958) has reported on the supplying of urea to sheep in the drinking water and Beames (1960) has given details on the preparation of stable solutions of molasses and urea. The addition of urea to the drinking water probably has received little attention because of the risk of toxicity due to marked variation in the water intakes of animals. Experiments in the coastal areas of Queensland have shown a lack of response in animals grazing either paspalum pastures (Qd. Dept. Ag. & Stock, 1958-59, p. 67) or mat grass pastures (O'Bryan, 1960) which were sprayed with molasses urea at weekly intervals. This lack of response may be due to grazing selectivity (Raymond, 1954). However, in areas of Queensland which have a greater frequency and intensity of both frost and drought, this ability to select may avail little where the quality of the pasture is uniformly poor. Under these conditions the consumption of molasses urea should effect some response.

Ad. lib. feeding of molasses urea has the disadvantage of a possible excessive intake with a resultant waste of mixture and/or loss by death (Kellermann and Groenewald, 1956). Daily and twice weekly feeding are possible means of overcoming this wasteful intake. However daily feeding on the larger properties could be too expensive on labour, Berry et al. (1958) when feeding a 30 per cent. protein equivalent molasses urea mixture ad. lib. report a mean intake of 3.44 lb. per head per day by range cattle. This would correspond to 5 oz. urea per head per day, yet no symptoms of toxicity were noticed.

This paper summarises the results of four experiments designed to measure ad. lib. intakes of molasses under grazing conditions, to observe the effects of feeding various concentrations of urea in molasses under both ad. lib. and twice weekly feeding conditions, and to compare daily with twice weekly supplementation.

**MATERIALS AND METHODS**

The experiments were done at the Animal Husbandry Research Farm, Rocklea.

Although no botanical analyses were made on the pastures grazed by experimental cattle, typical analysis of the pastures in late spring is Paspalum dilatatum 66 per cent., Cynodon dactylon 17 per cent., Digitaria didactyla 3 per cent., native grasses 8 per cent., native legumes 4 per cent., weeds 2 per cent. The basal ration used in Experiments 2, 3, and 4 was pasture hay from Central Queensland of botanical composition similar to that described by Beames (1959). The hay was long chaffed before feeding. Feeds were analysed by the official A.O.A.C. methods (Association of Official Agricultural Chemists, 1955). Molasses was from the same consignment as that used by Beames (1959). With the molasses urea mixtures the urea was always premixed with 1.5 times its weight of water.

The individual stall accommodation was the same as described by Beames (1959). The yards used for group feeding were 40 ft. square with earth surfaces. Methods of feeding and watering varied from trial to trial and these details are given below.
Experiment 1 — Molasses Intake of Grazing Cattle:

Before any attempt to feed molasses urea ad lib. was made, it was considered necessary to determine the mean and range of consumption of molasses alone when presented in this manner to grazing cattle. Molasses was, therefore, supplied ad lib. to twelve mature pregnant Hereford cows which exchanged paddocks fortnightly with a comparable control group of twelve. During the experimental period of 15 weeks (July 31 — November 14, 1957) the rainfall totalled 4.9 inches and the pasture was mature and of only fair quality. Group intakes of molasses were recorded daily, while bodyweights were obtained fortnightly. Individual intakes of molasses over a fortnightly period were estimated by the addition of chromic oxide to the molasses and the collection of grab faeces samples daily. The pooled sample for each beast was analysed to obtain comparative intakes. Over this period the mean intake for the group was 7.9 lb. per head per day with a range of 0-12.1 lb. When the mean for this period is compared with the maximum daily mean, and intakes recalculated, maximum individual intake could rise to 16.7 lb. This assumption is not necessarily correct, but would give a good indication of the maximum intake which could be achieved by a beast, and thus a basis for calculating concentrations of urea to incorporate with the molasses. Both groups maintained weight, there being no significant difference between groups.

Experiment 2 — Ad lib. Molasses Urea Feeding:

This experiment was designed to examine the effect of various combinations of urea in molasses on both intake and toxicity when these mixtures were presented in unrestricted amounts. The experimental animals were six Z-year-old maiden Hereford heifers which were fed in yards on a basal ration of bush hay (Table I). Ad lib. water was available. Urea concentrations in a urea molasses mixture were increased by small increments at weekly intervals from 0 per cent. to 50 per cent. of the weight of molasses. Intakes of the mixture and hay samples were measured. Results are given in Fig. 1.

<table>
<thead>
<tr>
<th>Moisture</th>
<th>Protein</th>
<th>Ether Extract</th>
<th>Fibre</th>
<th>N.F.E.</th>
<th>Ash</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.7</td>
<td>2.7</td>
<td>1.7</td>
<td>33.6</td>
<td>41.0</td>
<td>11.3</td>
<td>0.41</td>
<td>0.11</td>
</tr>
<tr>
<td>—</td>
<td>2.9</td>
<td>1.8</td>
<td>37.2</td>
<td>45.6</td>
<td>12.5</td>
<td>0.46</td>
<td>0.12</td>
</tr>
</tbody>
</table>

It is noted that after the third week the intake of mixture began falling steadily as the urea concentration increased until the end of the twelfth week, when the molasses urea was replaced by molasses. Consumption of molasses was higher than that of the 1:0.5 molasses urea mixture but there was a concomitant reduction in hay intake. At the end of the molasses feeding the 1:0.5 molasses urea mixture was again presented. Within 24 hours of this change one animal was found dead. No other deaths occurred, and hay intakes returned to a high level.

Experiment 3 — Twice weekly Molasses Urea Feeding:

As there is the possibility of engorgement by animals being supplemented intermittently, these observations were made to determine whether increasing concentrations of urea in molasses would
increase time of consumption and thus reduce possible toxicity. Six 2-year-old Hereford heifers were fed as a group in yards on a basal ration consisting of chaffed hay (Table I), the supplement being fed at 4-day intervals. Unlimited water was available.

**TABLE II.**

**Consumption Times of Molasses-Urea Mixtures When Fed Every Fourth Day**

<table>
<thead>
<tr>
<th>Period</th>
<th>MIXTURE PER CENT.</th>
<th>Urea/Molasses</th>
<th>Mixture lb. per Head</th>
<th>Mean Consumption Time (hr.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Molasses</td>
<td>Water</td>
<td>Urea</td>
<td></td>
</tr>
<tr>
<td>1 &amp; 2</td>
<td>100</td>
<td>—</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>3 &amp; 4</td>
<td>91.4</td>
<td>8.6</td>
<td>—</td>
<td>0</td>
</tr>
<tr>
<td>5 &amp; 6</td>
<td>86.5</td>
<td>8.1</td>
<td>5.4</td>
<td>0.0625</td>
</tr>
<tr>
<td>7 &amp; 8</td>
<td>76.2</td>
<td>14.3</td>
<td>9.5</td>
<td>0.0125</td>
</tr>
<tr>
<td>9 - 14</td>
<td>68.1</td>
<td>19.1</td>
<td>12.8</td>
<td>0.1875</td>
</tr>
</tbody>
</table>

Treatments and results are given in Table II. The amount of molasses presented at each feeding was kept constant. As in Experiment 2, increasing concentrations of urea resulted in corresponding decreases in consumption rate of both mixture and urea until the time taken to consume 6.0 lb. of a 1:0.185 mixture was $1\frac{2}{3}$ to 2 days. This time remained within the same limits over three feeding periods.

**Experiment 4 — Daily Compared with Twice Weekly Molasses Urea Feeding:**

In this experiment nine Hereford steers, 19 to 22 months old, were divided into three groups of three by stratified random sampling and were placed on the following treatments:—
Group  Treatment
I  Pasture hay.
II  Pasture hay plus 1.5 lb. molasses plus 3.6 oz. urea per head per day fed daily.
III  Pasture hay with the same rate of supplementation as Group II but fed Mondays and Fridays.

Hay and water were supplied ad lib. in individual stalls. Analysis of the hay is given in Table III. Duration of the experiment was 16 weeks. Feed intakes, bodyweight changes, and consumption times of the molasses urea were measured.

**TABLE III.**
Proximate Analysis of Hay Used in Experiment 4.

<table>
<thead>
<tr>
<th>Moisture</th>
<th>Protein</th>
<th>Ether Extract</th>
<th>Fibre</th>
<th>N.F.E.</th>
<th>Ash</th>
<th>Ca</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3</td>
<td>2.2</td>
<td>1.7</td>
<td>36.6</td>
<td>41.1</td>
<td>11.1</td>
<td>0.37</td>
<td>0.12</td>
</tr>
<tr>
<td>—</td>
<td>2.4</td>
<td>1.8</td>
<td>39.4</td>
<td>44.5</td>
<td>11.9</td>
<td>0.40</td>
<td>0.13</td>
</tr>
</tbody>
</table>

**TABLE IV.**
Bodyweight Changes and Hay Intakes of Cattle in Experiment 4.

<table>
<thead>
<tr>
<th>Mean Bodyweight</th>
<th>Mean Hay Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>Initial Basis</td>
</tr>
<tr>
<td>I</td>
<td>579</td>
</tr>
<tr>
<td>II</td>
<td>584</td>
</tr>
<tr>
<td>III</td>
<td>584</td>
</tr>
<tr>
<td>II &amp; III &gt; I t</td>
<td>II &amp; III &gt; I t</td>
</tr>
</tbody>
</table>

* Bodyweight obtained 16 hours after feed and water withdrawn.
† p < 0.01.

Results are given in Table IV. The mean time of consumption of molasses urea in the group fed daily was 11.5 hours (range 9.9 - 12.5), whereas for the group fed twice weekly the figure when given three days' supply was mean 37.5 hours (range 37 - 38) and when given four days' supply was 48 hours (range 46 - 51). These three and four day figures were calculated on the mean of the last evening observation and the first morning observation when consumption ended overnight. Bodyweight gains in Groups II and III were significantly greater than in Group I (p < 0.01). Also, the feed intakes of Groups II and III were greater than in Group I (II > I; p < 0.01; III > I; p < 0.05). Feed intakes were greater in Group II than in Group III. This difference, however, was not significant. The small advantage in weight gain in Group II over Group III also was not significant.

**DISCUSSION**

The results obtained in Experiment I indicate that molasses intakes of grazing cattle when given molasses ad lib. can be highly variable. Mean intakes are similar to those obtained by Kirk et al. (1956). Also, the fact that the molasses did not produce a bodyweight response when fed as a supplement to pasture providing a maintenance ration is similar to the findings with sheep (Clark and Quin,
1951) and cattle (Beames, 1959) where no responses were obtained in rations of poor quality pasture hay. From these experiments doubt is cast on the worth of molasses pasture hay as a supplement to subtropical pastures, except, perhaps, where impaction is a problem.

The ratio of molasses to urea in much of the supplementation work is as wide as 1:0.125, yet the results of Experiment 2 indicate that the ratio can be reduced 1:0.5 without any reduction in the response as measured by stimulation in feed intake. Theoretically this increase in intake should be a reflection of bacterial activity and hence urea utilisation within the rumen. A ratio of 1:0.5 would allow a great saving on molasses. However, even though the consumption of a molasses urea mixture declines as the molasses: urea ratio is reduced, with ad lib feeding urea consumption is still in excess of the usually recommended levels, viz. 2.5 — 3.5 oz. per head per day for cattle, depending on the pasture available and bodyweight. As shown in Table I the urea intake did not fall below 8.4 oz. per head per day over a wide range of ratios. From these results it would be considered desirable to look to other methods of reducing intake below wasteful levels, viz. change of consistency, addition of repellants or the use of mechanical feeders.

Towards the conclusion of Experiment 2 the cattle were returned to a 1:0.5 molasses urea mixture after one month on molasses alone. This was done in order to ascertain whether precautions should be taken to accustom the animals to such a concentrated mixture. The loss of one animal confirms the need to increase the urea concentration gradually, although the low viscosity of the 1:0.5 mixture, because of the necessity to premix the urea with water, may have been a contributory factor in this death.

The results of the twice weekly molasses urea feeding convey the same picture as ad lib feeding, i.e. as the molasses : urea ratio decreases the consumption rate of both the mixture and the urea it contains also decreases, thus allowing for more efficient utilisation of rumen ammonia (Head, 1959) and reducing the chances of toxicity (Dinning et al. 1948).

Experiment 4, designed to compare daily and twice weekly supplementation, gave a greater difference between the two methods than that obtained by Briggs (1956) who showed no difference in weight changes and only a 7 per cent. reduction in feed intake in the group supplemented twice weekly. In Experiment 4 there was a 15 per cent. reduction in feed intake and a small reduction in weight gains. Even though these differences were not significant they were consistent and deserve to be checked with larger numbers of cattle.

These results on trough feeding in stalls and yards require testing under grazing conditions before general recommendations can be made. Factors which would affect response in the field are grazing selectivity, and the behaviour of cattle in relation to consumption rate and frequency of feeding at the trough. Another possibility with trough feeding is that, even though appetite may be stimulated, feed intake may not be increased where pasture is sparse, because of the length of time spent by cattle at the troughs.

ACKNOWLEDGEMENTS

The author wishes to thank Mr. M. J. Radel for care of experimental animals, Mr. A. W. Beattie for statistical analysis of results and officers of the Biochemical Branch for chemical analyses.

REFERENCES


O'Bryan, M. S. (1960).—ibid. (in press).

**DISCUSSION**

J. Barnes (N.T.) asked for information on the feeding of molasses and urea in the drinking water.

**Answer.**—Limewater is prepared, giving a pH of over 10.5 and then 1% molasses and 0.2% urea are added. This could absorb CO₂ from the air, thus lowering pH and allowing bacterial growth. A seal of cetyl alcohol prevented this.

R. J. Moir (W.A.)—Micro-organisms may destroy the molasses and urea in water. He asked if salt could be used to control intake.

**Answer.**—Salt would be expensive (£20 per ton).

Dr. M. C. Franklin (N.S.W.) described work with grain supplements and urea feeding. No beneficial response to urea supplementation of roughage was obtained unless grain was fed. Intake of roughage treated with urea-molasses decreased as the concentration of urea increased though this was offset by a grain supplement.

Dr. G. I. Alexander (Qld.) suggested that in Queensland urea-molasses supplements may have to be fed in troughs, for example, with sorghum meal, since grasses do not cover more than 25% of the ground and spraying would be wasteful.

W. Stephens (Tas.) asked how the urea-molasses mixture was sprayed on to the pasture.

**Answer.**—Estimates were made of the dry matter content of the pasture and the amount of the mixture per beast and a suitable concentration was calculated. The solution was applied by boom spray.