MOLASSES AND UREA AS A SUPPLEMENT TO LOW QUALITY PASTURE HAY FOR CATTLE

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SUMMARY.

Three groups of four Hereford heifers were fed individually in stalls for 16 weeks on rations of low quality hay, hay plus molasses, and hay plus molasses and urea. Hay was fed ad lib.**, molasses at 1.5 lb. per day and urea at 3.6 oz. per day. The hay was low in crude protein (3.5 per cent.) and high in crude fibre (38.5 per cent.).**

Body weight losses in the group receiving molasses and urea were negligible. The average daily body weight losses in the groups receiving hay alone and hay plus molasses were 1.20 and 0.85 lb. respectively. There was no significant difference between these two rates but both were significantly greater than that in the group receiving molasses and urea ($P<0.01$). This last group made slower weight gains on pasture after the conclusion of the experiment.

Molasses had little effect on hay intake, whereas molasses plus urea increased hay intake by 38.8 per cent. ($P<0.01$).

Both molasses and molasses plus urea tended to increase the apparent digestibility of the hay. Apparent urea nitrogen digestion was 85–90 per cent.

I. INTRODUCTION.

During the winter and spring months in many areas of Queensland, the only feed available for grazing cattle is mature grass, the low nutritive value of which is often further reduced by frosts. This type of feed is low in protein, net energy and phosphate. In some areas either a phosphate lick or molasses is fed as the sole supplement. Such supplements would seem to be of limited value where animals are grazing standing hay which has a protein content insufficient to replace even the metabolic faecal nitrogen loss. Harvey (1952) showed that in some Queensland grasses fed to sheep—e.g. *Chloris gayana* (Rhodes grass) and *Astrebla* spp. (Mitchell grasses)—protein digestibility decreases with crude protein content until, in grass of approximately 4 per cent. crude protein, the apparent protein digestibility is zero. Thus, it would appear that before a marked response can be obtained from energy or phosphate supplements, nitrogen must be provided.

Nitrogenous supplements can be provided in the form of roughages (legume hays), concentrates (meatmeal and oilseed meals), and non-protein nitrogen (N.P.N.) In Queensland, roughages are generally an expensive source of protein, especially in winter and spring. In descending order of cost come oilseed meals and meatmeal, with N.P.N. as the cheapest source of nitrogen.

Much work has been done on the feeding and utilisation of N.P.N. but there has been comparatively little done on its use as the sole source of nitrogen in a supplement for ruminants on poor quality pasture. This aspect was studied in South Africa by Clark and Quin (1951) with sheep and by Clark and Barrie (1954) with cattle. In the experiment of Clark and Quin, various sources of N.P.N. were investigated and the two most promising were urea and sodium nitrate. As urea is the cheaper source of nitrogen in Queensland, it was considered more suitable for use in the present investigation. Molasses was used as the source of carbohydrate, being cheaper on a starch equivalent basis than grains.

An experiment was undertaken to determine whether carbohydrate supplementation alone is effective in reducing weight losses of cattle on low quality roughage or whether the addition of nitrogen is also necessary. No attempt was made to investigate the addition of nitrogen without carbohydrates.

Three groups of four heifers were fed hay alone, hay plus molasses, and hay plus molasses and urea respectively for a period of 16 weeks. Body weight changes and feed intakes were recorded and apparent digestibilities were determined.

II. MATERIALS AND METHODS.

(1) Animals.

The experimental animals were maiden Hereford heifers 2½–3 years old in forward store condition, bred and reared in southern Queensland on predominantly paspalum (*Paspalum dilatatum*) pastures.

(2) Housing.

The animals were kept under cover in individual stalls with concrete flooring and troughing. The stalls were separated by a tubular steel framework, and the troughing, which was continuous, had ¼ in. steel-plate dividers. Softwood shavings were supplied as bedding except during the digestibility trial, when the floors were left bare. Consumption of bedding was negligible.

(3) Ration Components.

Pasture Hay.—The hay was obtained from the Central Highlands of Queensland. The major species present were *Dichanthium sericeum* (Queensland blue grass), *Eriochloa* sp. near *pseudoacrotricha, Thellungia advena* (coolibah grass), *Panicum decompositum* (native millet), *Paspalidium globoideum* (shot grass), *Aristida leptopoda* (white spear grass), and *Iseilema membranaceum* (small Flinders grass).

Molasses.—Cane molasses was obtained from the Moreton Sugar Mill, Nambour, Queensland.

*Urea**.—The urea was chemically pure and contained 46·5 per cent. nitrogen.

Salt-Phosphate Supplement.—This was a 50/50 coarse salt-bonemeal mixture. The bonemeal was degelatinised (phosphorus 12·2 per cent., calcium 31·2 per cent., crude protein 10·2 per cent.). Cobalt chloride was incorporated to supply 17 mg. cobalt per head per day.

(4) Analytical Methods and Techniques.

Feed and faeces were analysed by the official A.O.A.C. methods (Association of Official Agricultural Chemists 1955), molasses as in Laboratory Manual for Sugar Mills (Bureau of Sugar Experiment Stations, Queensland 1954), and plasma vitamin A and carotenoids by the method of Pierce (1945).

In the digestibility trial, faeces were collected by harness based on the design of Ballinger and Dunlop (1946), the only major modification being that the urine conduit was replaced by a rubber apron on a wire frame fastened to the animal by rubber strips and black "Bostick"† cement. This cement was not entirely satisfactory as it is irritant and also loses its adhesive properties rapidly when used as described.

III. EXPERIMENTAL.

Fifteen heifers in fat condition were stalled seven weeks prior to the commencement of the experiment and were fed a sub-maintenance ration of 8 lb. medium quality lucerne chaff per head per day to reduce body weight (from average 834 lb. to average 778 lb.). During the last two weeks of this pre-experimental period all animals were also given limited amounts of hay, molasses and urea to accustom them to these feedstuffs. From these 15 heifers, 12 were chosen on the basis of weight and behaviour, allotted by stratified random sampling with respect to body weight into three groups of four, and individually fed the following rations:—

Group I: Hay *ad lib.*

Group II: Hay *ad lib.* + 1·5 lb. molasses per head per day.

Group III: Hay *ad lib.* + 1·5 lb. molasses + 3·6 oz. urea per head per day.

All animals were fed daily 2 oz. of the salt-bonemeal supplement in separate containers.

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*"Ureafol". Kindly donated by Imperial Chemical Industries of Australia and New Zealand Ltd.

†B.B. Chemical Company of Australia Pty. Ltd., Abbotsford, N.9, Vic.

The molasses and the molasses-urea mixture were fed twice daily in tins separately from the hay. These supplements were prepared weekly by mixing with water (molasses 2 : water 1; and molasses 2 : water 1 : urea 0·3 respectively). Over this period of one week the mixture showed no deterioration.

Hay was fed out twice daily and was before the animals at all times. To facilitate ease of weighing and handling and to minimise wastage, the hay was chaffed in a cutter set to half-an-inch. Hay residues, which were collected daily before the morning feed, were weighed, sampled for chemical analysis and discarded. Proportionate samples of the hay as fed were collected daily.

There were no residues from the molasses and molasses-urea mixtures.

Plasma vitamin A was determined for two animals from each group at the conclusion of the experiment.

Body weight was recorded fortnightly at 9 a.m. on scales accurate to 2 lb. There was no period of starvation or water restriction before weighing.

Towards the conclusion of the experiment, a digestibility trial was done on two animals from each group. Over the pre-collection and collection periods, feed presentations were slightly below the estimated respective unrestricted intakes. No data on nitrogen balance were obtained.

The duration of the experiment was 16 weeks. The cattle were then put onto a predominantly paspalum pasture, which for the first month was in short supply because of dry weather but thereafter provided good grazing. Body weight was recorded for the first 15 weeks on pasture.

IV. RESULTS.

(1) Analyses.

Analyses of the hay as fed, hay residues and molasses are given in Tables 1a and 1b.

Table 1a

ANALYSES OF HAY AND HAY RESIDUES.

—	Percentage of Hay Presented.	Percentage Composition.							
		Moisture.	Dry-matter Basis.						
			Protein.	Ether Extract.	Fibre.	N.F.E.	Ash.	Ca.	P.
Hay as fed ..		4·9	3·5	1·0	38·6	47·0	9·9	0·43	0·12
Hay Residues—									
Group I. ..	17·0	5·3	3·8*	1·0	35·8*	47·5	11·9*	†	†
Group II. ..	18·4	5·3	4·1*	1·0	35·2*	48·4	11·3*	†	†
Group III. ..	12·8	5·3	3·9*	1·0	36·3*	47·3	11·6*	†	†

* Significantly different ($P < 0{\cdot}01$) from hay as fed.
† Not analysed.

Table 1b

ANALYSIS OF MOLASSES.

	Per cent.		Per cent.
Moisture	25·5	Potassium (K)	1·99
Sucrose	34·6	Nitrogen (N)	0·8
Reducing Sugars	9·4	Phosphorus (P)	0·05
Ash	14·6	Calcium (Ca)	0·81

The residues were significantly higher in protein and ash and lower in fibre than the hay fed. These residues were dusty and probably contained a higher proportion of leaf, seed and soil. Average daily air-dry residues for Groups I, II and III were 2·10, 2·20 and 2·10 lb. respectively.

(2) Body Weight.

Initial and final body weights are given in Table 2, and fortnightly changes are shown in Fig. 1.

Table 2

BODY WEIGHT CHANGES AND HAY CONSUMPTION OVER 16 WEEKS' EXPERIMENTAL PERIOD.

Group.	Mean Body Weight (lb.).				Net Mean Daily Air-Dry Hay Consumption (lb.).
	Initial.	Final.	Change Per Day.	After 15 Weeks on Pasture.	
I.	785	650	−1·20	851	10·26
II.	762	667	−0·85	847	9·78
III.	787	778	−0·09	910	14·24
Between I. and II.			N.S.		N.S.
Between I. and III.			*		*
Between II. and III.			*		*

N.S. Not significant.
* ($P<0·01$).

The animals receiving hay without supplement (Group I) showed a steady decline in liveweight, with an average loss of 1·20 lb. per day. Those receiving a supplement of molasses (Group II) lost weight at an average of 0·85 lb. per day. However, the difference between Group I and Group II was not significant and for most of the experimental period rate of body weight loss in these two groups was similar (Fig. 1). Those animals supplemented with molasses and urea (Group III) had a mean weight loss of 0·09 lb. per day. This weight loss in Group III was significantly less ($P<0·01$) than in Group I and Group II.

Post-experimental weight gains on pasture were greater in Groups I and II than in Group III. The first two groups made average body weight gains of 201 and 180 lb. respectively over the first 15 weeks, while Group III gained only 132 lb. in the same time.

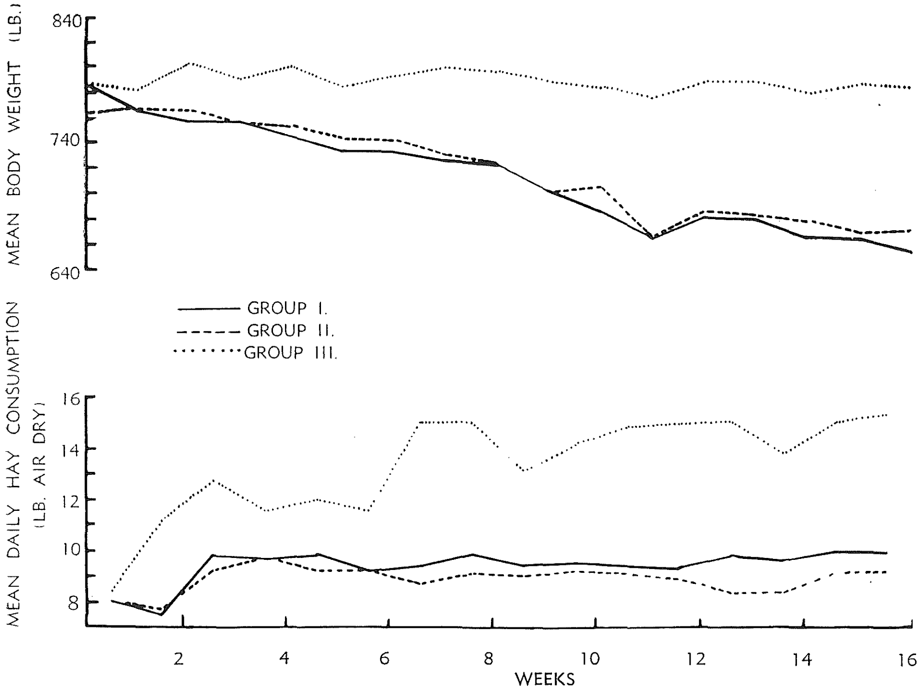

Fig. 1.

Body Weight Changes and Hay Intakes of Heifers in Group I (Hay Only), Group II (Hay and Molasses) and Group III (Hay, Molasses and Urea).

(3) Feed Intake.

The average daily hay consumptions are given in Table 2, and progressive changes are shown in Fig. 1.

In Group II the feeding of molasses decreased hay intake by approximately 0·5 lb. per head per day (Table 1). This decrease was not significant. When urea was incorporated in the supplement (Group III), the hay intake was significantly increased by 38·8 per cent. ($P<0{\cdot}01$).

(4) Digestibility Trial.

The results of the digestibility trial on the two animals from each group are presented in Table 3. These data were not statistically analysed because of the small number of cattle used.

Average dry matter digestibility was increased in the supplemented rations (from 32·5 per cent. in Group I to 44·9 per cent. and 43·0 per cent. in Groups II and III respectively). Addition of molasses increased the average apparent protein digestibility, which was 10·1 per cent. for Group II, compared

Table 3

RESULTS OF DIGESTIBILITY TRIAL.

Animal No.	Average Dry Matter Intake Per Day (lb.).	Digestibility Coefficients.			
		Dry Matter.	Protein.	N.F.E.	Fibre.
Group I.					
Number 32	8·6	30·6	4·5	28·2	44·2
Number 34	11·6	34·4	0·9	34·6	43·6
Average	10·1	32·5	2·7	31·4	43·9
Group II.					
Number 4	9·8	44·7 (25)†	9·2	46·6 (2)†	56·6 (28)†
Number 6	13·0	45·2 (8)†	11·1	44·0 (16)†	47·4 (8)†
Average	11·4	44·9	10·1	45·3	52·0
Group III.					
Number 8	15·8	41·4 (10)†	51·4 (86)*	42·4 (14)†	52·5 (16)†
Number 10	16·3	44·6 (20)†	53·6 (91)*	43·7 (16)†	54·1 (22)†
Average	16·0	43·0	52·5	43·0	53·3

* Apparent urea-N digestibility percentages.
† Apparent increases in digestibility coefficients of respective components in the hay.

with 2·7 per cent. for Group I. Apparent urea nitrogen digestibility was 85–90 per cent. The average apparent fibre digestibility was increased from 43·9 per cent. to 52·0 per cent. by the addition of molasses and to 53·3 per cent. by the addition of molasses and urea.

(5) Vitamin A.

Plasma vitamin A levels for two animals from each group were within the range 20–31 μg. per 100 ml. at the end of the experimental period. These levels were within the normal range.

V. DISCUSSION.

In this experiment, maiden heifers in forward store condition, fed low quality pasture hay *ad lib.* and supplemented with 1·5 lb. molasses and 3·6 oz. urea per head per day, maintained body weight for 16 weeks. Similar animals without supplement, or supplemented with molasses only, lost considerable weight.

There are at least three applications of these findings. The first is the use of conserved pasture hay, supplemented or sprayed with molasses and urea, as a maintenance fodder for cattle. The second is the spraying of a molasses-urea mixture on low quality pasture, provided the density of the plant cover is adequate and the sprayed material can be consumed within a few days. This procedure has been described by Kellermann and Groenewald (1956). A third application, which so far has not been extensively investigated, is the provision of a molasses-urea mixture in troughs, either *ad lib.* or under controlled conditions. Mechanical means or additives would be necessary to reduce rate of intake and so avoid toxicity. Additives would make the mixture similar in nature to a protein meal-salt supplement of the type used extensively in America (Riggs, Colby and Sells 1953). Feeding from troughs under controlled conditions has been practised (Kellermann and Groenewald 1956), while *ad lib.* feeding in U.S.A. has been mentioned by Hale (1954).

Molasses was fed with the urea to increase palatability and provide cheap, readily available carbohydrate. This provision of readily available carbohydrate conforms with most recommendations on urea feeding and is supported by the *in vivo* studies of Mills *et al.* (1942), who showed that urea is not utilised efficiently when superimposed on a ration of hay alone. They demonstrated that the presence of starch allows for a more rapid conversion of ammonia nitrogen to bacterial protein. However, Arias *et al.* (1951), measuring urea utilisation by the breakdown of urea to ammonia in the artificial rumen, found that corncobs were as effective a source of energy as molasses, dextrose, sucrose or starch. As urea utilisation should be measured by the increase in bacterial protein, these results do not necessarily conflict with those of Mills *et al.* (1942).

Digestibility data (Table 1) show that molasses tends to increase fibre digestion in the hay, but this difference was not reflected in the weight changes. This is similar to results obtained by Hoflund, Quin and Clark (1948), who showed that sucrose levels of less than 9 per cent. improved cellulose digestion in sheep but gave no improvement in body weight. Briggs and Hiller (1943, 1945) could not demonstrate this effect and in some cases even observed a reduction in fibre digestibility of sheep fed various levels of molasses. This lack of effect conforms with the reasoning of Crampton and Maynard (1938), who maintained that lignin content of hay controls digestibility of cellulose. Clark and Quin (1951) also were unable to show improvement in cellulose digestibility by the addition of a 12 per cent. molasses–4 per cent. urea supplement to a sheep ration of veld hay (4·7 per cent. crude protein) and maintained that percentage digestibility of cellulose is not sufficient as an index of utilisation, where rate of digestion also must be considered. In general, opinion tends to be against any substantial beneficial effect of carbohydrate supplementation on fibre digestibility.

In this experiment the addition of molasses and molasses-urea increased the average digestibility of fibre by 18·5 and 21·5 per cent. respectively. As this increase in fibre digestibility in the group receiving molasses did not improve hay intake, it would not be justifiable to assume that the increased fibre digestibility in the group receiving molasses-urea was contributing to the 38·8 per cent. increase in hay intake. Nor can the increased intake in this latter group be attributed to palatability, as the supplements were fed separately from the hay. The differences in intake, therefore, must be correlated to a large extent with rate of digestion.

The apparent digestibility of urea nitrogen in Group III was 90 per cent. This is similar to figures obtained by Nehring and Schramm (1939), who found that by adding urea to a sheep ration the apparent digestibility of urea nitrogen was 95 per cent.

The effect of supplementing poor quality hay with molasses and molasses-urea on liver copper levels was studied concurrently with this experiment and is described by Beames (1959).

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