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EFFECT OF SALT/UREA BLOCKS ON BODY-WEIGHT, BODY COMPOSITION AND WOOL PRODUCTION OF SHEEP FED LOW-PROTEIN NATIVE GRASS HAY

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SUMMARY

Four groups of 20 two-tooth Merino wethers were group-fed *ad lib.* on low quality pasture hay (3·5% crude protein) for 16 weeks. One group (control) was fed the hay without a supplement. Two other groups were fed salt blocks containing 10% molasses, and 5% pollard with either 35 or 20% urea. The fourth group was fed a block containing 20% urea without molasses or pollard.

The control group lost 20% of their initial body-weight over the 16-week feeding period. All three groups with access to urea-containing blocks lost significantly less body-weight than the control group. Groups fed molasses-pollard blocks with either 35 or 20% urea lost less than 10% of their initial body-weight, while the group fed the block without molasses and pollard lost 12% of the initial body-weight.

The voluntary intake of pasture hay and the faecal dry matter output were increased by urea block supplementation. Weight of clean scoured wool was increased, though not significantly, in groups given urea-containing blocks.

The comparative slaughter technique showed that the energy reserves of the bodies of sheep fed pasture hay were depleted to a greater extent than would be indicated by body-weight change. The total body fat was depleted to a greater extent than body protein, while total ash remained relatively static.

When the survivors from pasture hay feeding were fed a high quality ration for 8 weeks, compensatory growth occurred in those groups which lost the greatest body-weight and final group mean body-weights were similar.

I. INTRODUCTION

Blocks and licks are the most frequently employed means of providing urea to grazing ruminants in Australia. Altona, Rose, and Tilley (1960) in South Africa first demonstrated the value of urea blocks and licks and these are now commonly employed to supplement cattle on winter veld in that country (Louw 1960; Pieterse 1961; Pieterse and De Kock 1962). In Australia, Beames

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(1963) obtained positive responses in feed intake and body-weight to a salt/urea/molasses block fed to cattle in yards on a basal ration of pasture hay of 3·5% crude protein content. To the authors' knowledge there are no published results on the use of salt/urea blocks for sheep.

The results of an experiment to study the performance of sheep fed three types of urea-containing blocks as a supplement for low-protein pasture hay are presented in this paper. In addition to measurements of body-weight, feed intake and wool production, body composition changes were determined by the comparative slaughter technique.

II. MATERIALS AND METHODS

Animals.—Eighty-five 2-tooth Merino wethers from Toorak Sheep Field Research Station in north-western Queensland were used as experimental animals. On arrival at the Animal Husbandry Research Farm, Rocklea, Brisbane, the wethers were fed in yards for 2 weeks on lucerne chaff *ad lib.* and then for 1 week on the experimental pasture hay *ad lib.* At the commencement of this period the sheep were drenched with phenothiazine and drenching was continued thereafter at 3-weekly intervals.

Facilities.—Groups of 20 wethers were kept in bare yards (40 ft x 48 ft) of identical design. Shade was provided in each yard and water supplied *ad lib.* Iron troughs, 34 in. long and 11 in. deep, accessible from both sides, were used for the feeding of hay and the blocks. These troughs were kept under shelter, two being used in each yard for hay, and, when required, one for the block. The trough for the block was provided with a drain-hole through which liquid effluent could be collected.

Ration components.—The hay, harvested in south-eastern Queensland, had the following botanical composition expressed on a percentage basis:—*Aristida ramosa* 19·0, *Bothriochloa intermedia* 53·3, *Heteropogon contortus* 12·7, *Paspalum dilatatum* 7·7, *Paspalidium gracile* 5·0, and mixed species plus unidentifiable material 2·3. To facilitate weighing and handling, the hay was chaffed in a cutter to a mean length of ½ in.

Three blocks with the following compositions were used:—

Ingredient	Percentage Composition		
	Block A	Block B	Block C
Urea	35	20	20
Molasses	10	10	..
Salt	48·63	63·63	78·63
Pollard	5	5	..
Cobalt sulphate ($CoSO_4 \cdot 7H_2O$)	0·07	0·07	0·07
Rock phosphate	1·3	1·3	1·3

During the period in which individual block intakes were estimated, chromic oxide was added to the block as a marker at the level of 1 part of chromic oxide to 29 parts of block by weight.

Chemical analyses.—The pasture hay and the nitrogen in the effluents were analysed by the methods of the Association of Official Agricultural Chemists (1960). Faecal chromic oxide concentration was measured by the method of Schürch, Lloyd, and Crampton (1950).

Wool production.—All sheep were shorn at the beginning and the end of the period of pasture hay feeding, and clean scoured wool production was determined by correcting the greasy weight of the whole fleece by a factor obtained from the percentage clean scoured wool in a mid-side sample (Lockart 1954).

Body composition.—Body composition was measured directly by the method of Morris and Moir (1964). This method involves grinding the whole sheep (less the wool and contents of the gastro-intestinal tract) and reducing it to a single sample suitable for chemical analysis. Changes in body composition were measured by the comparative slaughter technique. Calorific value of the total body was computed from the chemical composition and the heats of combustion of protein and fat as suggested by Blaxter and Rook (1953).

Body condition.—Body condition was assessed by the method of Jefferies (1961). This scale ranges from 0 (sheep near death and extremely emaciated) to 5 (very fat sheep).

Body-weight.—Body-weight was measured on cattle-weighing scales with an accuracy of $\pm$ 1 lb.

III. EXPERIMENTAL

Design.—Four groups, each of 20 sheep, were selected by stratified random sampling on the basis of body-weight and body condition and fed the basal diet of pasture hay *ad lib.* with the following supplements:—

Group I: Nil (control).

Group II: Block A containing 35% urea, 10 % molasses.

Group III: Block B containing 20% urea, 10% molasses.

Group IV: Block C containing 20% urea, no molasses.

Duration of this phase of the experiment was 16 weeks and at its conclusion a ration of 50/50 lucerne chaff and sorghum grain was fed *ad lib.* for 8 weeks.

As a measure of changes in body composition due to feeding the pasture hay alone and with blocks, five sheep were slaughtered at the commencement of hay feeding (pretreatment slaughter group) and five sheep from each of the four groups at its conclusion. Each sheep slaughtered at the beginning of the experiment was matched on the basis of body-weight and condition with a sheep to be slaughtered later in each of the other four groups. The body of any sheep withdrawn during the experiment was also analysed.

Measurements.—Initial and final body-weights were obtained on a shrunk (18 hr after feed and water removed) and on a non-shrunk basis. During the experiment progressive body-weights were measured at 2-weekly intervals at 8.30 a.m. on a non-shrunk basis. Body condition scores were assessed initially, after 10 and 16 weeks of feeding pasture hay, and after 8 weeks on the recovery ration. The chaffed pasture hay was weighed and sampled before feeding to the sheep. Residues were collected twice weekly, weighed, sampled for chemical analysis, and discarded.

Blocks, and effluents from the blocks, were weighed weekly. The effluents after sampling for chemical analysis were discarded. In order to measure the variation of block intakes within groups, blocks containing chromic oxide were fed for 2 weeks before and during a period in which the sheep were fitted with faecal collection harnesses. The block intake of each sheep was determined from the total chromic oxide content of its weekly faecal output.

IV. RESULTS

Hay analysis.—Analyses of hay as fed and hay residues are given in Table 1.

TABLE 1

Analyses of Hay and Hay Residues

—	Residue (as % of the feed presented)	Percentage Composition (dry-matter basis)						
		Protein	Ether Extract	Fibre	N.F.E.	Ash	Ca	P
Hay as fed (8·8% moisture) ..	..	3·5	1·2	41·7	45·1	8·5	0·21	0·15
Hay residues—								
Group I	15·2	2·9	1·0	42·2	46·4	7·5	n.a.	n.a.
Group II	10·7	3·1	0·9	42·3	46·3	7·4	n.a.	n.a.
Group III ..	10·2	2·9	0·8	43·9	44·9	7·5	n.a.	n.a.
Group IV ..	10·6	3·4	0·7	41·9	46·4	7·6	n.a.	n.a.

n.a. = Not analysed

Withdrawals.—Information on withdrawals of sheep from the experiment is presented in Table 2. All animals, except R112 in group II, were withdrawn because of their inability to rise. Sheep R112, which had a higher condition score and was heavier than the other sheep withdrawn, was found dead in the yard.

TABLE 2

BODY-WEIGHT AND CONDITION OF ANIMALS WHICH WERE WITHDRAWN DURING EXPERIMENT

Group	Animal No.	Time of Withdrawal (days after commencement)	Body-weight (lb non-shrunk)		Body Score	
			Initial	Final	Initial	Final
I	R138	68	49	44	0·5	0·25
I	R099	74	59	52	0·5	0·25
II	R112	104	66	67	1·0	1·5
II	R113	103	53	55	0.5	0·25
III	R101	78	56	58	1·0	1·0
IV	R129	111	56	47	0·5	0·5

Body-weight.—Body-weight data presented in Table 3 show that the loss in weight expressed on both a shrunk and a non-shrunk basis over the 16-week feeding period was significantly less in groups II, III and IV than in group I. On a non-shrunk basis, the loss in group III was also significantly less than in group II, and on a shrunk basis the loss in group III was also significantly less than in group IV. Body-weight gains after 8 weeks on a ration of 50% lucerne chaff, 50% crushed sorghum grain fed *ad lib.* were greatest in the group that lost most weight during the hay feeding (group I) and least in the group that lost the least (group III). Body-weight differences at the end of this 8-week period were not significant.

TABLE 3

BODY-WEIGHT CHANGES OF SHEEP FED PASTURE HAY AND SALT/UREA BLOCKS FOR 16 WEEKS AND THEN A RECOVERY RATION FOR 8 WEEKS

Group	Initial Shrunk (lb)	Loss After 16 Weeks on Pasture Hay		Gain After 8 Weeks on Recovery Ration	
		Shrunk (lb)	Non-shrunk (lb)	Shrunk (lb)	Non-shrunk (lb)
I	67·2	13·6	11·2	19·0	18·5
II	65·6	6·5	3·2	13·4	12·5
III	66·5	5·2	0·2	12·1	8·4
IV	67·6	8·3	2·9	15·6	13·1
Differences between—					
I and II		***	***	***	***
I and III		***	***	***	***
I and IV		***	***	***	***
II and III		—	*	—	—
II and IV		—	—	*	—
III and IV		*	—	**	**

*, **, *** indicate $P < 0{\cdot}05$, 0·01 and 0·001 respectively
— = Not significant at $P < 0{\cdot}05$

Body condition.—The mean body condition scores for groups I to IV initially were 1·33, 1·00, 1·13 and 1·10 respectively and at the conclusion of the experiment were 0·81, 0·92, 0·95 and 0·76 respectively. This represented a reduction in score of 0·52 for group I, 0·08 for group II, 0·18 for group III and 0·34 for group IV. Decrease in score was significantly greater in group I than in groups II, III and IV ($P<0 \cdot 001$, 0·01 and 0·05 respectively).

Wool production.—The clean scoured wool growth and quality, together with changes in fibre diameter during the experiment, are given in Table 4. There was a significant decrease in the fibre diameter of the wool from all groups after the feeding of pasture hay. However, the differences between groups for fibre diameter and crimp were not significant at the 5% level.

TABLE 4

MEAN WOOL PRODUCTION OF FOUR GROUPS OF WETHERS DURING 16 WEEKS' PASTURE HAY FEEDING AND QUALITY OF WOOL AT BEGINNING AND END OF THIS PERIOD

Group	Clean Scoured Wool (g)	Mean Fibre Diameter (μ)		Crimps per Inch	
		Initial	Final	Initial	Final
I	459	19·7	15·1	13·9	14·5
II	473	19·0	14·7	13·8	14·6
III	523	19·0	14·6	13·4	15·3
IV	453	18·2	14·0	13·1	14·6

Hay and block intakes.—The mean daily group intakes of hay and block presented in Table 5 show that the consumption of hay was greater in all groups receiving lick than in the unsupplemented group. The mean daily intakes of block in groups II, III and IV were 20, 26, and 16 g per head respectively, resulting in respective gross urea intakes of 7·1, 5·1 and 3·4 g.

TABLE 5

HAY AND BLOCK INTAKES OF SHEEP DURING 16 WEEKS' PASTURE HAY FEEDING

Group	Daily Mean per Animal (g)					Proportion of Net N Intake from Block (%)
	Hay (air-dry)	Block (air-dry)	Urea (including effluent)	Loss of N in Effluent	Net Intake of N	
I	560	—	—	—	3·14	0
II	680	20	7·1	0·62	6·46	41
III	700	26	5·1	0·05	6·29	38
IV	670	16	3·4	0·68	4·59	18

Urea supplied 41, 38, and 18% of the total nitrogen intake of groups II, III and IV respectively. Urea intakes and faecal dry matter excretions for the period when the sheep were fitted with faecal collection harnesses are presented in Table 6. Mean daily urea intakes of 9·1, 9·4 and 3·7 g for groups II, III and IV respectively for this period were greater than the corresponding values of 7·1, 5·1 and 3·4 g for the whole 16-week period. Faecal dry-matter outputs in groups II, III and IV were significantly greater than in group I.

TABLE 6

MEAN, STANDARD DEVIATION AND RANGE OF UREA INTAKE AND FAECAL DRY-MATTER OUTPUT FOR THE WEEK WHEN SHEEP WERE FITTED WITH FAECES COLLECTING HARNESS

Group	*Urea Intake (g)			Faecal Output (g dry matter)		
	Mean	S.D.	Range	Mean	S.D.	Range
I	—	—	—	320	73	141–437
II	9·1	3·5	2·4–13·7	448	77	320–648
III	9·4	4·1	3·0–17·9	502	76	352–618
IV	3·7	2·0	0·7–7·8	473	123	292–635

* Calculated from faecal chromic oxide excretion

Differences in faecal dry-matter output:—

II > I ($P < 0{\cdot}01$)

III, IV > I ($P < 0{\cdot}001$)

III > II ($P < 0{\cdot}05$)

Differences between II and IV and between III and IV not significant

Body composition.—The means and standard deviations of the total body composition of the pretreatment slaughter group, the four groups after pasture hay feeding, and sheep which died during the experiment are presented in Table 7. An examination of the individual components shows that, as a result of pasture hay feeding, there was a group mean decline in total body water of 13–25% of the pretreatment group level. The percentage decrease in total body fat was even greater. The maximum loss occurred in groups I and IV, where the body fat content was 80% below the pretreatment level. The reduction in total body protein was of a magnitude similar to the fall in total body water. The lowest level, which occurred in group I, was 36% below that of the pretreatment group.

The mean calorific value of the bodies of the sheep withdrawn from the experiment was much lower than that of the survivors.

TABLE 7

MEAN AND STANDARD DEVIATION OF THE COMPOSITION OF SHEEP BODIES BEFORE AND AFTER FEEDING LOW QUALITY PASTURE HAY

Group	Mean and Standard Deviation				
	Water (kg)	Protein (kg)	Fat (kg)	Ash (kg)	Megacalories
Pretreatment ..	15·45±0·93	4·21±0·36	4·13±0·98	1·29±0·15	61·1±8·4
I	11·57±0·74	2·68±0·18	0·80±0·52	1·14±0·10	21·7±5·1
II	12·51±0·97	3·11±0·32	1·32±0·56	1·11±0·09	28·9±6·4
III	13·45±1·19	3·02±0·24	0·98±0·56	1·13±0·08	25·3±5·8
IV	12·38±0·76	2·94±0·15	0·83±0·55	1·11±0·07	23·4±5·4
Sheep listed in Table 2	11·91±1·17	2·54±0·44	0·23±0·15	1·05±0·14	15·7±3·5

V. DISCUSSSION

The native pasture hay used in this experiment is comparable in chemical composition to that available as standing roughage for grazing sheep in northern Australia at the end of the summer growing period. Wethers, when fed this hay as the sole ration, lost 13·6 lb, representing 20% of their initial body-weight (shrunk basis), over a period of 16 weeks. The provision of blocks containing either 35% or 20% urea with 10% molasses reduced this body-weight loss to less than half that of the unsupplemented group. The block containing 20% urea without molasses was not as effective in reducing body-weight loss as those with molasses, but prevented 39% of the body-weight loss of the unsupplemented group. These results suggest that urea-containing blocks may be of practical use in sheep husbandry for the reduction of body-weight loss and the prevention of death in periods of nutritional stress when there is an adequate supply of low quality roughage.

The three groups which had access to the urea-containing blocks all had a greater voluntary intake of pasture hay than the group fed hay alone. This finding is in agreement with the experience of other workers (Clark and Quin 1951; Franklin, Briggs and McClymont 1955; Morris 1958*a*, 1958*b*; Beames 1959; Williams *et al.* 1959; Coombe and Tribe 1963), who have shown that urea supplements for low quality roughages enhance feed intake by sheep and cattle.

The intake of block was greatest in the group receiving the 20% urea, 10% molasses block (group III), but because of the higher percentage of urea in block A (35%), group II had the greatest urea intake. Group IV, which was fed block C (20% urea and no molasses), had a lower block and urea intake than either groups II or III, which had access to molasses-containing blocks. It appears that under these conditions molasses increases the attractiveness of blocks to sheep.

The superior body-weight of sheep in groups II and III fed the molasses-containing blocks appears to have resulted from the greater daily intake of urea. The contribution of the molasses and pollard as an energy source was minor—2·0 and 2·6 g molasses and 1·0 and 1·3 g pollard for sheep in groups II and III respectively. Molasses and pollard may, however, have been contributing essential nutrients, e.g. higher volatile fatty acids (Hemsley and Moir 1963). South African workers (Altona, Rose, and Tilley 1960; Pieterse 1961; Pieterse and De Kock 1962) have obtained favourable responses with urea-containing licks without molasses.

The clean scoured wool growth of the unsupplemented sheep and those fed a urea block without molasses was similar. It appears that the amount of urea ingested was either not sufficient to promote wool growth or that it was ineffective at this level in the absence of additional carbohydrate. Pierce (1951) found that 7 g of urea nitrogen alone did not increase wool production, but with the addition of 100 g or more of carbohydrate as potato starch, wool production increased in proportion to the starch added. However, no response to urea in wool production was obtained with 50 g of potato starch without urea.

Although the mean wool production for groups II and III fed blocks containing molasses and pollard was greater than that in the control group, the differences were not significant at the 5% level. Table 6 shows considerable variability within these groups in the intake of urea by individual animals; this may have prevented a significant response being recorded. The significantly finer wool of the sheep following the feeding of low quality hay is in agreement with the findings of Ferguson, Carter, and Hardy (1949) on the effect of nutrition on wool fibre diameter.

During the period when all sheep were fitted with faecal collection harnesses there was a large variation in both urea intake and faecal output. Although it has been shown that variation in dry-matter digestibility can be considerable for sheep on rations based on low-protein roughage (Hemsley and Moir 1963), the extent of this variation is very small in comparison with that for faecal output within groups found in the present experiment. Thus the major part of the variation in faecal output must be accounted for by variations in feed intake. No correlation could be found within groups between urea intake and faecal output; this is understandable in view of the large variation in faecal output in the unsupplemented group I. With this large variation, it is evident that an efficient assessment of response to urea supplementation requires that each sheep act as its own control.

In a preliminary trial, sheep were observed to bite a commercial salt/urea/molasses block containing 35% urea. The post-mortem findings of sheep R112 in group II suggested that urea toxicity may have been the cause of death, and indicated that caution should be exercised with the 35% urea block in its present formulation. This mortality, occurring 104 days after the block was first offered, is at variance with field experience with cattle, where any deaths usually occur within 2 days of presentation of the block (Beames 1963).

The components of the body expressed on the basis of water, protein, fat and ash did not contribute equally to the loss in body-weight. The fat component declined to the greatest extent, followed by protein and water. The quantity of ash in the bodies was relatively stable and increased on a percentage basis as the other components decreased.

It is apparent that the decline in gross energy of the bodies, which in all groups was over 50% of the pretreatment values, was of a greater magnitude than would be indicated by the group body-weight changes. These findings illustrate the serious limitation of body-weight as a criterion in animal experimentation. Gross measurement of body-weight is unable to differentiate between a change due to tissue of high calorific value, e.g. fat, and a change due to tissue of low calorific value, e.g. muscle.

The levels of fat in the bodies of three of the six sheep that died during the experiment were 0·6, 0·8 and 0·9% of body-weight. This indicates the "essential lipid" fraction of the body, a concept proposed by Behnke, Osserman, and Welham (1953), to be probably less than 1% of body-weight. The extremely low mean fat reserve of 230 g of the six sheep withdrawn from the experiment indicates a possible complete exhaustion of metabolizable fat.

Body condition scoring in this experiment was not sensitive enough to detect quite large differences in total body composition. Significantly different scores were found to exist between group I and groups II, III and IV, but these differences were apparent from other measurements, e.g. body-weight. The body-weight gains of the four groups of sheep during the 8-week recovery period on a high quality ration were proportional to body-weight losses during the 16 weeks on pasture hay. That is, during the recovery phase compensatory gain overcame the advantage in body-weight of sheep fed the urea-containing blocks.

In conclusion, it appears that urea-containing blocks, under conditions similar to those prevailing in this experiment, would be useful in reducing rate of loss of body-weight. For the blocks to be effective in promoting an intake of nutrients adequate for maintenance, it appears that the quality of hay or pasture would have to be superior to that used in this experiment.

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