QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

DIVISION OF ANIMAL INDUSTRY BULLETIN No. 169

FORTIFIED MOLASSES FOR STEERS GRAZING NATIVE PASTURE IN NORTH QUEENSLAND

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SUMMARY

The effect of feeding molasses-phosphorus-urea during the dry season and molasses-phosphorus during the wet season *ad libitum* to steers grazing native pasture in the dry tropics of north Queensland was studied over 6 years.

Animals consumed less than 1 kg head^{-1} day^{-1} supplement during the early wet season, increasing to 4 to 6 kg head^{-1} day^{-1} during the late dry season. In four of the five dry seasons studied, supplementation improved ($P < 0 \cdot 05$) liveweight performance, responses ranging from 0·10 to 0·28 kg head^{-1} day^{-1}. In general, there were no responses to supplementation during the wet season. Conversion ratios calculated as kg supplement consumed per kg additional liveweight gain during the dry season ranged from 12:1 to 30:1.

Final liveweights and cold carcass weights favoured the supplemented groups in five of the six drafts.

Feeding of this type of supplement to drought-stricken breeders and the inclusion of a 'by-pass' protein are areas requiring further study.

I. INTRODUCTION

The low quality of native pastures in northern Australia results in poor annual liveweight changes in grazing cattle with a corresponding high age of turn off (Alexander and Chester 1956; Norman and Arndt 1959). Nitrogen has been considered the primary limiting nutrient during the dry season and improved growth rates have been obtained in growing animals supplemented with either protein meals (Norman 1963) or molasses-urea (Winks, Alexander and Lynch 1970).

The role of energy supplementation has not been fully elucidated. Norman (1963) improved liveweight performance of heifers by feeding 1·4 kg sorghum grain during the dry season. Molasses fortified with nitrogen is fed in many tropical countries to improve liveweight performance and reduce age of turn off (Preston 1972). Molasses is readily available in Queensland and, in areas adjacent to sugar mills, is a relatively cheap energy source.

This paper reports the results of studies carried out at 'Swan's Lagoon' between 1972 and 1977 to examine the benefits of feeding molasses fortified with nitrogen and phosphorus *ad libitum* to steers grazing native pasture.

II. MATERIALS AND METHODS

'Swan's Lagoon' Cattle Field Research Station is situated 110 km south of Townsville, north Queensland. Most of the average annual rainfall of 800 mm falls in summer, resulting in a 4-month growing season.

The area used for the study was that used by Winks, Laing and Stokoe (1972). An area of native pasture had been divided into four paddocks which were disc-ploughed and fertilized with superphosphate in a factorial arrangement. A total of 500 kg ha^{-1} of superphosphate had been applied to the fertilized areas.

Before the commencement of the present study, the whole area was disc-ploughed with an offset tandem disc-plough to minimize previous discing effects. One of each of the previously fertilized and unfertilized paddocks was allocated to a supplemented or an unsupplemented treatment. This gave a 2 x 2 factorial of previous fertilizer application and supplementation with no replication.

The principal pasture species were black spear grass (*Heteropogon contortus*), giant spear grass (*H. triticeus*), cockatoo grass (*Alloteropsis* spp.), golden beard grass (*Chrysopogon fallax*), kangaroo grass (*Themeda australis*), tassel blue grass (*Dichanthium tenuiculum*) and forest blue glass (*Bothriochloa bladhii*). The legume, Townsville stylo (*Stylosanthes humilis*), invaded the trial area during the course of the study.

Six drafts of 40 steers grazed the area. Mean initial liveweights, genotypes, period of grazing and age of introduction are shown in table 1.

TABLE 1

PERIOD OF GRAZING, GENOTYPE, INITIAL LIVEWEIGHT AND AGE OF STEERS IN THE STUDY

Draft	Period of grazing	Genotype	Initial liveweight (± S.E.) (kg)	Age (mth)
1	Dec 71–May 72 ..	Brahman X ..	919 ± 1·6	18–24
		Shorthorn ..	205 ± 1·6	24–30
2	May 72–May 73 ..	Brahman X ..	228 ± 1·1	18–24
		Shorthorn ..	253 ± 1·1	24–30
3	June 73–May 74 ..	Brahman X ..	232 ± 1·0	18–24
4	May 74–June 75 ..	Brahman X ..	286 ± 0·4	24–30
5	June 75–June 76 ..	Brahman X ..	260 ± 1·3	15–18
		Sahiwal X ..	245 ± 2·0	15–18
6	June 76–July 77 ..	Brahman X ..	297 ± 0·5	15–18

Zebu-cross animals from different drafts ranged from 30 to 60% Zebu blood, with the exception of draft 5 where animals were either 75% Brahman–25% Shorthorn or 75% Sahiwal–25% Shorthorn. Group size was 10 animals. In drafts 1 and 2, there were five animals of each genotype and in draft 5, there were seven Brahman crosses and three Sahiwal crosses. Animals were allocated to treatments on the basis of initial fasted liveweight. During the course of the study, unfasted liveweights were recorded on a monthly basis.

Supplements were fed as shown in table 2. In drafts 1, 2, 3 and 4, molasses to which mono-ammonium phosphate (M.A.P.) was added (1% w/w), was fed *ad libitum* throughout the grazing period to two groups. In addition, a standard molasses (220 g)–urea (60 g) supplement was fed to all four groups in roller-lickers during the dry season.

TABLE 2

SUPPLEMENTS FED TO VARIOUS GROUPS DURING THE STUDY

Draft	Period	Supplements fed	
		Control Group	Supplemented group
1	Dec 71–May 72 ..	..	*Ad lib* (Mol + M.A.P.)
2	May 72–Nov 72 ..	Mol (220g) – Urea (60g) hd^{-1} dy^{-1}	*Ad lib* (Mol + M.A.P.) + M(220g) – U (60g) hd^{-1} dy^{-1}
	Nov 72–May 73	..	*Ad lib* (Mol + M.A.P.)
3	June 73–Nov 73 ..	M(220g) – U (60g) hd^{-1} dy^{-1}	*Ad lib* (Mol + M.A.P.) + M(220g) – U (60g) hd^{-1} dy^{-1}
	Nov 73–May 74 ..	..	*Ad lib* (Mol + M.A.P.)
4	May 74–Nov 74 ..	M(220g) – U (60g) hd^{-1} dy^{-1}	*Ad lib* (Mol + M.A.P.) + M(220g) – U (60g) hd^{-1} dy^{-1}
	Nov 74–June 75 ..	..	*Ad lib* (Mol + M.A.P.)
5	June 75–Nov 75 ..	..	*Ad lib* (Mol + M.A.P. + Urea)
	Nov 75–June 76 ..	..	..
6	June 76–Nov 76 ..	..	*Ad lib* (Mol + M.A.P. + Urea)
	Nov 76–July 77 ..	..	..

Earlier studies on the station (Winks, Alexander and Lynch 1970) had demonstrated that feeding of a standard molasses-urea supplement should eliminate dry season weight loss in steers. As no responses to molasses feeding were obtained during the wet season in these drafts, supplementation was restricted to the dry season in drafts 5 and 6. Molasses with M.A.P. (1% w/w) and urea (3% w/w) was fed *ad libitum*. Consumption was recorded twice weekly throughout.

At the musters, faecal samples were taken *per rectum* from animals in unsupplemented groups, bulked within treatments, dried at 100°C and analysed for nitrogen and phosphorus by the procedures of Moir (1960 *a*; 1960 *b*).

All animals except those from draft 1 were slaughtered when removed from the study and carcass weights obtained. Dressing percentages were calculated on the basis of cold carcass weight and unfasted liveweight.

Animal data were analysed by analysis of variance. Significant interactions between main effects were recorded for liveweight changes during the dry season for drafts 3, 5 and 6 so data are presented as four individual treatments. Where two genotypes were used, drafts 1, 2 and 5, there were no significant genotype x treatment interactions.

III. RESULTS

Seasonal conditions

Monthly rainfall registrations for 'Swan's Lagoon' and the 40-year mean for 'Woodhouse Station', the adjoining property (table 3), shows that rainfall during the study period was well above average. During 1972 and 1976, there was a period in excess of 6 months with no effective rainfall.

TABLE 3

MONTHLY RAINFALL REGISTRATIONS AT 'SWAN'S LAGOON', AND THE 40-YEAR MEAN FOR 'WOODHOUSE STATION'

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
							mm						
1972	541	260	160	12	4	19	. .	. .	1	. .	37	9	1 043
1973	161	195	131	51	9	15	10	4	61	61	241	372	1 311
1974	805	228	103	27	37	. .	. .	64	8	11	129	116	1 528
1975	308	48	126	29	23	2	. .	13	44	125	64	320	1 102
1976	159	253	212	. .	. .	6	. .	. .	. .	110	145	329	1 214
1977	53	369	100	57	128	. .	. .						
40 year mean*	195	222	173	41	26	32	26	9	10	17	44	87	882

* Woodhouse Station

Liveweight performance

In four of the five dry seasons, feeding of molasses-phosphorus or molasses-phosphorus-urea produced a significant ($P < 0{\cdot}05$) improvement in liveweight performance (table 4). In four of the six drafts, supplementation depressed liveweight ($P < 0{\cdot}05$) for 2 to 3 months after feeding commenced and September was the earliest month in which a positive response to feeding was obtained.

Feeding of a molasses-phosphorus supplement during the wet season produced no significant effect on liveweight change. In drafts 5 and 6, where feeding ceased following the summer storms, significant ($P < 0{\cdot}05$) differences in subsequent performance during the wet season were recorded. In draft 5, the supplemented groups continued to outgain the unsupplemented animals and, in draft 6, gains were higher in groups which had been unsupplemented during the dry season. Overall gains and final liveweights favoured the groups which had received *ad libitum* molasses in all except draft 1.

TABLE 4

EFFECTS OF MOLASSES SUPPLEMENTATION AND PREVIOUS FERTILIZER APPLICATION ON PERFORMANCE OF STEERS GRAZING NATIVE PASTURES (N.P.)

Draft	Period	Average daily gain (kg day^{-1})				S.E.
		N.P.	N.P. + Molasses	N.P. + Super†	N.P. + Molasses + Super	
1	Dec 71–May 72	0·38a*	0·39a	0·63b	0·53c	0·028
2	May 72–Nov 72	−0·14a	−0·14a	−0·07ab	−0·04b	0·024
	Nov 72–May 73	0·63	0·72	0·72	0·75	0·036
	May 72–May 73	0·26a	0·31ab	0·33b	0·37b	0·022
3	Jun 73–Nov 73	0·20a	0·46c	0·31b	0·41c	0·022
	Nov 73–May 74	0·48	0·46	0·51	0·51	0·034
	Jun 73–May 74	0·35a	0·46b	0·42b	0.46b	0·022
4	May 74–Nov 74	0·30a	0·46b	0·32a	0·42b	0·022
	Nov 74–Jun 75	0·62	0·63	0·67	0·63	0·025
	May 74–Jun 75	0·47a	0·55b	0·51ab	0·54b	0·017
5	Jun 75–Nov 75	0·26a	0·36b	0·29ac	0·31bc	0·016
	Nov 75–Jun 76	0·40a	0·50b	0·61c	0·67d	0·015
	Jun 75–Jun 76	0·33a	0·43b	0·46b	0·50c	0·012
6	Jun 76–Nov 76	−0·05a	0·23b	−0·01a	0·18b	0·019
	Nov 76–Jul 77	0·36ac	0·31a	0·47b	0·36c	0·019
	Jun 76–Jul 77	0·19a	0·27b	0·27b	0·29b	0·012

* Means within rows with a letter in common or with no letter do not differ significantly ($P < 0{\cdot}05$)

† Superphosphate

Previous fertilizer application had little effect on dry season performance but improved wet season gains in drafts 1, 5 and 6 ($P < 0{\cdot}05$). Overall weight gains and final liveweights mirrored this effect.

Significant interactions between *ad libitum* molasses feeding and previous fertilizer application occurred in drafts 3, 5 and 6, the parameter most affected being weight change during the dry season.

In drafts 1 and 2 Brahman-cross steers gained more weight ($0{\cdot}61$ v $0{\cdot}36 \pm 0{\cdot}020$ kg day^{-1} ($\pm$ S.E.); $0{\cdot}82$ v $0{\cdot}59 \pm 0{\cdot}026$ kg day^{-1}) during the wet seasons and lost less weight ($-0{\cdot}06$ v $-0{\cdot}14 \pm 0{\cdot}017$ kg day^{-1}), during the dry season ($P < 0{\cdot}05$) than Shorthorn steers. Performance of Brahman-cross and Sahiwal-cross steers in draft 5 was similar during the dry season ($0{\cdot}30 \pm 0{\cdot}010$ v $0{\cdot}31 \pm 0{\cdot}015$ kg day^{-1}) but Brahman-crosses gained more ($P < 0{\cdot}05$) weight than Sahiwal-crosses during the wet season ($0{\cdot}55 \pm 0{\cdot}009$ v $0{\cdot}52 \pm 0{\cdot}014$ kg day^{-1}). Overall gains were similar in the two genotypes.

Carcass data

In all drafts, there was a trend for cold carcass weight to be increased by *ad libitum* molasses-phosphorus or molasses-phosphorus-urea feeding (table 5). This difference was significant ($P < 0{\cdot}05$) in drafts 3, 4, 5 and 6 on areas previously unfertilized. However, differences failed to reach significance in any draft on previously fertilized areas.

TABLE 5

EFFECTS OF MOLASSES (M) SUPPLEMENTATION AND PREVIOUS FERTILIZER (S) APPLICATION ON CARCASS WEIGHTS OF STEERS GRAZING NATIVE PASTURE (N.P.)

Draft	Parameter	N.P.	N.P.+M.	N.P.+S.	N.P.+M.+S.	S.E.
1	Final liveweight .. (kg)	262·2a*	266·9a	308·1b	292·0c	5·00
	Cold carcass weight (kg)	..	..	..	..	..
	Dressing %	..	..	..	..	..
2	Final liveweight .. (kg)	331·5a	349·4ab	357·6b	368·8b	7·19
	Cold carcass weight (kg)	155·7a	164·9a	180·7b	185·2b	4·05
	Dressing %	47·0a	47·1a	50·5b	50·2b	0·49
3	Final liveweight .. (kg)	359·8a	396·7b	381·5b	394·8b	7·47
	Cold carcass weight (kg)	174·9a	198·5b	189·4b	199·4b	4·32
	Dressing %	48·6	50·0	49·7	50·5	0·47
4	Final liveweight .. (kg)	460·9a	492·9b	474·6ac	485·4bc	6·26
	Cold carcass weight (kg)	229·7a	250·4b	238·5ac	247·6bc	3·46
	Dressing %	49·8	50·8	50·2	51·0	0·37
5	Final liveweight .. (kg)	379·2a	416·8b	425·2bc	437·3c	5·15
	Cold carcass weight (kg)	176·2a	196·0b	206·3c	209·7c	3·07
	Dressing %	46·5a	47·0ac	48·5b	48·0bc	0·42
6	Final liveweight .. (kg)	376·3a	410·8b	409·7b	416·5b	4·83
	Cold carcass weight (kg)	170·4a	195·6b	192·2b	201·1b	3·42
	Dressing %	45·3a	47·6b	46·9ab	48·1b	0·71

* Means within rows with a letter in common or with no letter do not differ significantly ($P < 0{\cdot}05$).

Previous fertilizer application increased cold carcass weights in most drafts but the differences reached significance only in drafts 2, 5 and 6.

Dressing percentages tended to be higher in molasses groups than in unsupplemented groups but differences were generally non-significant.

Cold carcass weights were higher for Brahman-cross than for Shorthorn steers (180·1 v 163·2 ± 2·86 kg) ($P < 0{\cdot}05$) but dressing percentages did not differ significantly (49·0 v 48·4 ± 0·35%). Brahman-cross steers produced significantly ($P < 0{\cdot}05$) heavier carcasses than Sahiwal-crosses (200·7 ± 1·90 v 188·5 ± 2·90 kg) and dressing percentages were similar (47·7 ± 0·25 v 47·0 ± 0·38%).

Molasses consumption

Animals accepted the supplement readily and daily intakes increased steadily until the initial storms.

In all years, molasses intakes were low, 1kg head^{-1} day^{-1}, during the early wet season and reached peak values, 4 to 6 kg, during the late dry season. Total consumption was higher during the dry than the wet season (table 6). Conversion ratios (that is, kg molasses consumed per kg reduced liveweight loss or increased gain) were extremely variable and overall values were high.

TABLE 6

MEAN MOLASSES CONSUMPTION AND CONVERSION RATIOS

Draft	Molasses consumed (kg head $^{-1}$)			Conversion ratio*		
	Start–Nov	Nov–End	Start–End	Start–Nov	Nov–End	Start–End
1	..	250	250	..	−32·7	−32·7
2	488	235	723	171·8	32·7	50·9
3	468	327	795	15·9	−155·7	29·0
4	477	460	937	22·0	−235·9	47·4
5	323	..	323	29·8	..	12·2
6	476	..	476	12·1	..	22·4

*kg molasses fed per kg reduced liveweight loss or increased liveweight gain.

Faecal analyses

Faecal protein and phosphorus levels followed a seasonal pattern with highest values during the wet season and lowest during the dry season. Peak protein levels were 10 to 13% and minimum values were approximately 7%. Corresponding values for phosphorus were 0·40 and 0·12%.

Values from the areas previously fertilized were slightly higher than from the unfertilized areas, especially for phosphorus.

IV. DISCUSSION

The feeding of a molasses-phosphorus-urea supplement *ad libitum* to steers grazing native pasture during the dry season in this study has improved liveweight performance. In general, no responses were obtained when a molasses-phosphorus supplement was fed during the growing season. A similar pattern of response was obtained by Mott *et al.* (1967) with ground ear corn for steers on a similar pasture.

The depression in animal liveweights following commencement of feeding and the absence of positive liveweight responses until September may be the result of a number of factors. Energy may not have become the primary limiting nutrient in the diet until September. Alternatively, molasses feeding may have reduced rumen fill which would have counteracted responses obtained in the first 2 months of feeding. In a feedlot study with steers fed maize roughage, Thurbon and Winks (1968) showed that rumen fill was 7·5 kg greater in groups receiving a complete roughage diet than in those receiving 32% of their daily dry matter intake as maize grain.

The rapid change from an all-roughage diet to one containing a significant amount of readily fermented sugars would have encouraged high lactic acid production in the rumen (Annison and Lewis 1959). This could have resulted in reduced performance but the condition would have been short-lived as the rumen microflora adapted to the change of diet. Effective conversion ratios during the dry season expressed in terms of kg molasses consumed per kg additional liveweight gain recorded, 12:1 to 30:1 were of a similar order to the 24·8:1 and 24·6:1 reported by Mott *et al.* (1967) and Bisschoff *et al.* (1967), respectively. The energy provided in the supplement is far in excess of that required to produce the additional gain indicating that a high degree of substitution of supplement for pasture in the animal's diet was occurring.

This substitution effect has been reported by numerous workers (McClymont 1956; Campling 1964; Bisschoff *et al.* 1967; Mott *et al.* 1967). The effective reduction in nutrient intake from pasture during the wet season was greater than during the dry season in line with the results of Bisschoff *et al.* (1967). Under intensive conditions where forage is of high quality and may be limited in quantity, stocking rates are normally increased to take advantage of this reduced forage consumption. In our situation, pasture quality rather than quantity appears to be the major limit to production, and the practice of increasing stocking rate does not apply.

The peak molasses intakes of 6 kg head^{-1} day^{-1} would have comprised 25 to 30% of the daily dry matter intake of the steers. This level agrees closely with the 26 to 42% contribution of molasses to total metabolisable energy intake recorded with steers supplemented on pasture by Preston and Willis (1970). Preston (1972) suggests that forage allowance should be restricted to force cattle to eat molasses and obtain satisfactory animal performance. The poor response to supplementation in our study may result from a deficiency of some essential amino acids in the lower digestive tract (Preston 1972). Provision of natural protein which is protected from degradation in the rumen could be expected to improve efficiency.

The superior performance of animals on previously fertilized areas over those on unfertilized areas towards the end of the study may be a function of the invasion of the areas by Townsville stylo. Winks *et al.* (1974) showed that animals grazing native grass areas oversown with Townsville stylo and fertilized with superphosphate outperformed those grazing similar unfertilized areas. Faecal protein and phosphorus levels were generally higher on the fertilized area indicating that a higher quality diet was selected on those areas.

In keeping with other genotype comparisons in tropical Queensland (Mawson 1956; Dowling 1960), Brahman-cross steers out-performed Shorthorn steers demonstrating the better adaptation of the crossbreds to the environment. The failure of overall growth rate differences to appear between three-quarter Brahman and three-quarter Sahiwal steers is in line with the similar rates of growth observed in half-bred steers by Winks, O'Rourke and Smith (1978).

The results of this study indicate that energy and/or nitrogen was limiting animal performance during the dry season. A supplement of molasses-phosphorus-urea fed *ad libitum* improved the liveweight performance of steers but responses were small. There is scope for feeding restricted quantities of this supplement to drought-stricken stock in areas adjacent to sugar mills, especially where available roughage is exhausted. This aspect warrants investigation as does the incorporation of a 'by-pass' protein source in the molasses.

V. ACKNOWLEDGEMENTS

We thank the staff of 'Swan's Lagoon' who assisted in the conduct of the trial and officers of Biochemistry Branch who did the chemical analyses. The Australian Meat Research Committee provided financial assistance.

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(Received for publication 10 November 1978)

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