UREA-MOLASSES AND COTTONSEED-MOLASSES SUPPLEMENTS FOR DAIRY GOATS

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Summary

Crossbred dairy does were fed a roughage diet (IVOMD 56%, N 2.27%) *ad libitum*, and supplemented with urea-molasses (3% W : W) (UM) at levels on an air dry basis of 1.5% or 3% of liveweight or an iso-energetic, iso-nitrogenous mixture of cottonseed meal and molasses (25 : 75 w : w) (CM). Eight does, four lower-producers and four higher-producers (1.9 and 2.5 kg/day respectively in week 7 of lactation) arranged in two Latin Squares, received each of the four diets for three weeks. Dry matter, digestible organic matter and N intakes were higher for high-producers and high levels of supplement but did not differ between nitrogen sources. Milk production was higher by high-producers; interactions were significant between level of supplement and production group and between level of supplement and N-source, with maximum production by high producers on high levels of CM. The main effects of level of supplement were only significant for production of protein and total solids; N-source did not have significant effects on liveweight, milk production or composition. We conclude that does of moderate capacity for milk production, receiving a diet of two-thirds moderate quality roughage, one third urea-molasses, will not respond to increased level of supplementation or to replacement of urea with cottonseed meal.
(**Key Words**: Goats, Milk, Urea, Cottonseed)

Introduction

A dairy industry based on goats is developing in Indonesia and other S. E. Asian countries where traditionally the major objective of goat husbandry has been meat production. Meat goats are able to survive and produce in a low-input and low-output system using roughage diets of a quality quite unsuitable for the high nutrient demands of dairy animals which will require inclusion of high quality forages such as legumes, or concentrates. Leguminous tree leaves are in widespread use to improve diets of crop residues and other low quality roughages. *Leucaena leucocephala* appeared to be a suitable nitrogen rich forage for dairying but, since 1986, has lost its pre-eminence as a tropical legume due to infestation with psyllid so that alternative sources of energy and protein are needed. Molasses is often the most readily available, high-density source of digestible energy. However it is a low nitrogen content needs to be augmented with soluble nitrogen such as urea and possibly also with oilseed meals to supply true protein.

In dairy cattle, diets containing a high proportion of molasses have often resulted in poorer performance than would be predicted from the apparent digestible energy content of the diet (Preston and Leng, 1987). It has been suggested that microbial protein synthesis is not sufficient to supply the amino acid requirements of medium to high producing cows and that supply of glucose precursors for lactose may also be limiting. A dietary source of rumen-undegradable protein such as cottonseed meal (CSM) may increase milk production much more than urea-molasses (Preston and Leng, 1987).

There appears to be little information on the utilization of molasses by lactating goats, in which ruminal retention times, fermentation patterns, microbial protein synthesis and fibre digestibility differ from those of sheep and cattle (Doyle and Egan, 1980; Devendra and Burns, 1983) so that evidence from these latter species may not be

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relevant to dairy goats. Under S.E. Asian smallholder conditions, low levels of milk production usually occur (Devendra and Burns, 1983), nutrient requirements may be lower than those of dairy cows and the amino-acid requirement may be met solely from microbial synthesis. The present experiment compared urea plus molasses with CSM plus molasses as nitrogen and energy sources for lactating goats fed a roughage diet.

Materials and Methods

Animal and Management

Eight multiparous dairy does (crosses of Saanen, Toggenberg and British Alpine) ranging from two to five years of age, grazed dry summer pasture which was supplemented with high quality grass hay and lupin grain for the two months before kidding. They weighed 55 kg to 80 kg prior to parturition in mid-Autumn 1987. One week before predicted date of kidding, does were placed in 1 m by 2 m pens and fed a diet of lupin grain (250 g), CSM (140 g), molasses (100 g), with a mixture of lucerne hay and pasture hay (1 : 1) and minerals *ad libitum* until the fourth week of lactation. Does were milked by machine twice per day; kids were weaned at two days of age, kept in a separate pen and fed on the milk after measurement of volume and sample collection.

Design

On the basis of milk yield over the initial weeks of lactation, two groups of four does were formed. Higher producers weighed, on average, 54 kg and yielded 2.5 kg/day, lower producers weighing 52 kg, yielded 1.9 kg/day in the seventh week of lactation; both groups weighed 53 kg at the end of the trial. Does in each group received each of the four diets for three weeks, according to a Latin Square sequence. Milk yield and diet intake were recorded during the third week of each period while weight change was recorded for the second and third week.

Diets

The four diets consisted of 3% (w/w on air-dry basis) urea in molasses (UM) or an approximately iso-energetic and iso-nitrogenous mixture of cottonseed meal and molasses (CM), fed at either 1.5% or 3% of body weight (on air-dry basis). The roughage mixture (lucerne and pasture hay 1 : 1) fed *ad libitum* was of moderate quality with 2.25% N and 55.8% IVOMD; this mixture was chosen as being capable of supporting low production. Twice daily, CM and UM were warmed to reduce viscosity and mixed with the hay before feeding. Does received the allocated amount of molasses mixture, with the amount of hay varied to result in between 10% and 20% refusals. Does preferred and selected the molasses mixtures so that refusals were mainly of dry hay. All does received 30 g/day of dicalcium phosphate and had access to a commercial multi-mineral salt block.

Sampling and Measurements

Daily samples of feed and residues were bulked over three-week periods. Grab samples of faeces were collected twice daily for the third week of each period, bulked and stored frozen. All samples were analysed for ash, N (micro-Kjeldahl, A.O.A.C. 1975), lignin (Goering and Van Soest, 1970) and feeds for *in vitro* digestibility (McLeod and Minson, 1978, 1980). Intakes of digestible dry matter (DDM), digestible organic matter (DOM) and digestible N (DCP) were calculated using lignin as an indigestible marker.

TABLE 1. COMPOSITION OF DIETARY COMPONENTS ON DM BASIS (MEAN ± S.D. FOR VARIABLE COMPONENTS)

	DM %	OM %	N %	IVOMD %
Cottonseed meal	88.0	90.7	6.83	68.0
Molasses	83.4	87.3	1.01	100*
Lucerne chaff	84.4 ± .53	89.8 ± .13	2.98 ± .26	60.8 ± 2.4
Pasture hay	85.9 ± .34	95.3 ± .37	1.56 ± .08	50.9 ± 1.59
Urea-molasses	80.7 ± .77	89.6 ± .11	2.36 ± .11	100

* 100% solubility, not necessarily true digestibility.

Milk yield (g) was recorded after each milking and a 60 ml sample from each milking during the third week of each period was preserved with potassium dichromate. Bulked samples from each doe were measured for lactose, fat, protein and total solids by infra-red analysis ("Milkoscan 104"), using bovine milk as a standard.

Statistical Analysis

The standard methods of analysis of variance for Latin Squares were employed (Steele and Torrie, 1960).

Results

Intake

In all groups, the total dry matter intake was approximately 4.5% of LW per day. When UM or CM were fed at 1.5% of LW, the intake of roughage was about 3% of LW while when UM or CM were fed at levels of 3% of LW, intake of roughage was about 1.5% of LW (table 2). Total DM intake and N intake were significantly ($p < .01$) higher for does fed UM or CM at 3% of LW but only slightly higher ($p < 0.05$) for the CM diets than UM diets (table 3).

Digestibility

Urea and molasses were 100% "digestible" and CSM only 71.3% digestible by *in vitro* methods in this study. Digestibilities were significantly higher with UM diets than with CM diets for OM ($p < 0.01$), N ($p < 0.01$) and ADF ($p < 0.001$). OMD was significantly higher with higher levels of supplementation ($p < 0.01$). DOMI was almost identical between UM and CM diets. The intake of apparently digestible N was higher ($p < .01$) with the UM diets. The higher-production group ate significantly more DM ($p < 0.01$), N ($p < 0.01$) and DOM ($p < 0.05$) and digested ADF more completely ($p < 0.05$) than the lower-production group (table 3).

TABLE 2. INTAKE OF DIET INGREDIENTS (AIR-DRY MATTER) BY TYPICAL (53 kg) DOES FED HAY SUPPLEMENTED WITH UREA-MOLASSES OR COTTONSEED-MOLASSES AT A LOW LEVEL (1.5% OF LW OR HIGH LEVEL (3% LW)

Supplement level	Urea-molasses		Cottonseed-molasses	
	1.5%	3%	1.5%	3%
Molasses (g)	771	1,542	599	1,198
Urea (g)	24	46	—	—
CSM (g)	—	—	196	392
Hay (g)	1,467	926	1,463	987

Milk composition and production

Supplementation with CM at 3% of LW reduced milk fat content particularly in higher producers, but increased lactose content ($p < 0.05$); however these differences were small and of little significance in terms of dairy production. Protein content did not differ between diets. Milk production was highest in the first period (seventh week of lactation) at 2.5 and 1.9 kg/day for high and low producers, declining steadily to 1.7 and 1.55 kg/day respectively in the fourth period (16th week). The high-producers contributed almost all of the production responses to changes in level of supplementation and nitrogen source. Supplementation with CM at 3% of LW supported the highest milk production. High-producers responded more to additional supplement ($p < 0.05$). They increased production by 0.6 kg/day with increased CM versus 0.35 kg/day with increased UM ($p < 0.05$, table 4). Does produced 1.30 ± 0.06 g milk per g DOMI and 8.3 ± 0.77 g per g DCP intake with no significant difference between treatments. On all diets, the high producing does produced more milk (table 4) with slightly lower content of all solids; the yield of total solids from the high producing does (g/day) was greater.

Weight change

The expected trends for CM-fed does to gain

TABLE 3. NUTRIENT INTAKE (g/day) AND DIGESTIBILITY (g/g INTAKE) BY DOES FED HAY SUPPLEMENTED WITH UREA-MOLASSES (UM) OR COTTON-SEED-MOLASSES (CM)

Lactation capability	Low producers (L)				High producers (H)				SEM	L vs H	Nitrogen source	1.5% vs 3%	Interaction L, H × N
N supplement	UM		CM		UM		CM						
Supplement level	1.5%	3%	1.5%	3%	1.5%	3%	1.5%	3%					
DMI	1,806	1,925	1,746	1,990	1,970	2,215	2,084	2,376	124	**	NS	*	NS
$DMI^{0.75}$	92.4	99.1	92.8	103.2	89.2	115.0	104.5	120.5	5.5	*	NS	**	NS
N intake	42.6	49.7	38.2	45.0	46.5	57.1	43.3	53.7	2.91	**	+	**	NS
OMD	.809	.876	.733	.803	.811	.872	.790	.814	.026	NS	**	**	NS
N digestibility	.821	.827	.765	.778	.791	.859	.762	.751	.017	NS	***	NS	NS
ADF digestibility	.728	.675	.671	.675	.731	.760	.687	.673	.016	*	***	NS	**
DOMI	1,335	1,456	1,171	1,467	1,463	1,778	1,500	1,793	104	*	NS	***	NS
Digestible N	34.8	41.0	29.2	35.2	36.6	49.4	32.9	40.2	2.67	*	**	***	NS

+ $0.05 < p < 0.1$. * $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

TABLE 4. MILK PRODUCTION AND LIVE WEIGHT CHANGES IN DOES FED A ROUGHAGE DIET SUPPLEMENTED WITH UREA-MOLASSES (UM) OR COTTON-SEED-MOLASSES (CM) AT A RATE OF 1.5% OR 3% OF LIVE-WEIGHT

Nitrogen source	Low producers				High producers				SEM	Statistical significance					
										Main effects			Interactions		
	UM		CM		UM		CM			L vs H producers	N source	1.5% vs 3%	Low high × N source	Low high × level	N source × level
Supplement level	1.5%	3%	1.5%	3%	1.5%	3%	1.5%	3%							
Composition (%)															
Fat	4.41	4.33	4.48	3.95	4.28	3.89	4.25	3.45	0.20	NS	NS	NS	NS	*	*
Protein	3.26	3.37	3.33	3.44	3.09	3.02	3.12	2.97	0.08	*	NS	NS	NS	NS	NS
Lactose	4.33	4.36	4.28	4.47	4.29	4.38	4.27	4.40	0.05	NS	NS	NS	NS	NS	*
Total solids	13.06	13.06	13.11	12.89	12.68	12.17	12.68	11.80	0.30	NS	NS	NS	NS	*	NS
Milk															
Production (g/day)	1,660	1,760	1,660	1,890	1,890	2,240	1,940	2,540	88	*	NS	NS	NS	*	*
Production (g/kg $LW^{.75}$/day)	87	90	88	98	95	114	100	126	4.5	*	NS	NS	NS	*	*
Fat (g/day)	73	73	72	75	80	88	83	88	3.19	*	NS	NS	NS	NS	*
Protein (g/day)	54	59	54	64	58	65	60	75	2.95	NS	NS	*	NS	*	*
Lactose (g/day)	72	72	72	78	81	98	82	111	4.76	*	NS	NS	NS	*	*
Total solids (g/day)	215	225	215	243	238	273	245	300	9.23	*	NS	*	NS	*	NS
Live weight change (g/day)	−32	−9	68	50	−30	−68	−57	84	54	NS	NS	NS	NS	NS	NS

weight while UM fed does lost and for high producers to lose while low producers gained were not statistically significant.

Discussion

The supplements used in the experiment were selected as feedstuffs representative of those which are widely available in tropical regions where goats are common. They represent the extremes of a soluble carbohydrate and non-protein N mixture which would be rapidly and completely fermented in the rumen, and an oilseed-meal containing a protein of low degradability which would provide a high proportion of UDP. Australian solvent-extracted CSM similar to that used in the present experiment has nylon bag or *in vivo* degradability of 0.62 and 0.46 by Hosking et al. (1987) and SCA (1990), respectively.

CM diets would be expected to supply more amino acids to the animal than iso nitrogenous UM diets, since urea can only contribute to microbial protein formation via rumen ammonia, while a large proportion of CSM can escape ruminal degradation and yield amino acids directly to the small intestine (Preston and Leng, 1987). CM did not stimulate DM or DOM intakes. Greater milk production as a result of replacing UM with CM only occured with high producing does which were also losing weight while low-producers were gaining. Overall, the increase in milk production due to increased supplementation or change in the source of nitrogen was small. More productive does responded to replacement of urea with CSM by increasing milk production by 1 kg/1 kg CSM DM, while low producers gave almost no response. The response to increasing the level of concentrates from 1.5% LW to 3% LW was 0.5-0.7 kg/kg concentrate in high producers but only 0.1-0.2 kg/kg in the low producers. This response suggests that ruminal protein synthesis from urea was adequate to support the lactational and nutritional requirements of the lower production does, but was apparently not adequate for the higher production does. Supply of energy or glucose precursors would also have been more limiting in high producers. With high producers fed UM or CM supplements, increasing supplement intake from 1.5 to 3.0% of LW resulted in a depression in milk fat content similar to that often reported in dairy cows fed high levels of readily digestible carbohydrate (Church, 1972). These date confirm the report by Lindahl (1954) that at low levels of production, urea can partially replace true protein from linseed meal although urea fed animals also lost more weight in his trial.

In the tropics, it is rare for European breeds of goat, highly selected for milk production, to produce more than 2 kg/day over the whole lactation (Devendra and Burns, 1983) while indigenous tropical does, less intensively selected and often much smaller, generally produce 1 kg/day or less. Valid comparisons between breeds are frequently difficult or not possible due to inadequate definition of age, size, management and health status.

The results of this experiment suggest that it is unlikely that such does with low lactational capacity, consuming reasonable quality forage, will give an economic response to high levels of supplementation or to supplements high in UDP rather than RDP. Even if the limitations on production imposed by internal parasites and other diseases are eliminated, high ambient temperatures are likely to limit intake and production despite nutritional augmentation. We conclude that, in small-holder production systems where goats are fed diets based on forage of medium quality, moderate levels of concentrates such as urea-molasses which are largely fermented in the rumen will provide nutritionally adequate amounts of N for milk production, at least after the lactation peak, and this will usually be at a far lower cost than supplements high in UDP.

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