Effects of Energy and Bypass Protein Supplementation on Feed Intake, Milk Yield and Composition of Crossbred Lactating Goats

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Abstract

Thirty crossbred lactating goats were assigned according to randomized complete block design in to five groups of six animals each to study the feed intake, milk production and composition for a period of 180 days. All groups received iso-ni-trogenious (18% CP) concentrate, but varied energy densities. Groups I was used as a control being fed about 720 g/d/animal of DM from concentrate to provide medium energy. Lactating goats in group II were provided similar feed to the control but varied by formaldehyde treatment of the protein concentrate. Group III were fed with 20 % higher, whereas groups IV and V were given 20% lower amount of concentrate than the control. However, the mustard cake for group V was protected with formaldehyde. Average daily milk yield of group III (1.37±0.06) was significantly higher ($P<0.05$) than those of groups I (1.20±0.05), IV (1.19±0.06), and V (1.18±0.06). Milk yield (1.26±0.05) in group II was similar ($P>0.05$) to other treatment groups. Fat corrected milk (FCM) yield and milk composition (fat, SNF, protein and formalin) were similar ($P>0.05$) among all the groups. The high and medium energy groups consumed significantly ($P<0.01$) higher dry matter (10%) as compared to the two low energy fed groups. However, there was no variation ($P>0.05$) in nutrient intake as percent of body weight, gross energy of lactation and net return from sale of milk among treatment groups indicating proportional consumption of nutrient to their performance. In conclusion, provision of higher energy than the control improved the milk yield by 15% per animal compared to animals fed on lower energy levels. However, they had higher nutrient intake leading to higher production cost, so that future work is suggested using large herd size to confirm the small variations obtained under this trial.

Keywords: bypass protein; energy; feed intake; goat; milk yield

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Introduction

The contribution and population of goat is immensely increasing world wide, especially in developing countries (Devendra, 2001; Olivier *et al*., 2005). These countries, however, face feed inadequacy with respect to quantity and quality (Adugna *et al*., 2000; Walli, 2005). Poor nutrition results in low production and reproductive performance, loss of body condition and increased susceptibility to diseases and parasites (Osuji *et al*., 1993).

Feeding strategies like supplementation of energy and/ or rumen bypass protein were suggested as a solution for improved ruminant animal productivity (Chatterjee and Walli, 2003; Walli, 2005). However, feed supplementation especially of protein concentrates incurs much cost and could be wasted during rumen degradation system. For this reason, several recommendations were suggested in facilitating proper utilization of highly degradable proteins through protection of their rumen degradability (Sampth *et al*., 1997; Sahoo and Walli, 2007). Moreover, Formaldehyde treatment (at 1.2 g/100 g CP) of mustard cake improved the rumen undegradable protein resulting in significant increase in milk production of cows (Morgan, 1985) and goats (Sahoo and Walli, 2005). Moreover, the feeding of goats at higher plane of energy improved the efficiency of feed utilization and milk production (Srivastava *et al*., 1994), optimizing growth and reproductive performance of female sheep under grazing condition (Hossain *et al*., 2003).

Formaldehyde treatment is not only effective in protecting protein degradation in the rumen, but is also cheap and required in small doses (Walli, 2005). Hence, it can be applied in developing countries like Ethiopia to improve the nutrient utilization from local oil feeds like noug seed cake. Sahoo and Walli (2005) reported net return per lactating goat per day was Rupees[†] (Rs) 7.30 in groups fed on formaldehyde treated mustard cake compared to Rs 4.8 in the control. There are also reports on non significant influence of supplementing bypass protein to various groups of lactating animals (Clark et al., 1975; Small and Gordon, 1990), which implies further verification of such controversies.

The effects of various levels of energy and the use of bypass protein technology have been studied independently to increase the productivity of animals. However, information is lacking on relative comparison of feeding bypass protein at different energy densities on performance of lactating goats. Therefore, the objectives of this study was to investigate the effect of varying levels of

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[†] 1 Ethiopian Birr= 5 Indian Rupees (in 2005)

energy and bypass protein on feed conversion efficiency, economic efficiency, milk yield and composition of crossbred lactating goats.

Materials and methods

Study site

The study was carried out at National Dairy Research Institute, Karnal (India) for a period of 180 days. National Dairy Research Institute, Karnal is situated in eastern zone of Haryana state at an altitude of 250 m above sea level on 29.42°N latitude and 79.54°E longitude. The minimum ambient temperature falls to near freezing point in winter and maximum goes approximately up to 45 °C in May / June months of summer. The annual rainfall is close to 700 mm, most of which is received from July to September (Prasad, 1994).

Experimental Design

Thirty Alpine-Beetal crossbred lactating goats were divided into five, having six animals in each following a completely randomized design (Gomez and Gomez, 1984), to study the influence of varying levels of energy and bypass protein on feed intake and production performances. The lactating goats were weighed using weighing scale with precision of 0.01 for seven days. Then six goats with average of 37.33±1.57 kg body weight and 1.36±0.05 kg/day were randomly allotted to the five treatment groups (Table 1). Care was taken to avoid variation in age and parity of the animals.

A concentrate mixture comprising maize grain, wheat bran, mustard cake, mineral mix and common salt was used for all treatments but with varied proportion (Table 1). All groups received concentrate mix made iso-nitrogenious (18% CP), but varied in energy densities. Groups I was used as a control being fed about 720 g/d/animal of DM from concentrate to provide medium energy adjusted per NRC (1981). Lactating goats in group II were provided similar feed to the control but varied by formaldehyde treatment of the protein concentrate (mustard cake). Group III were fed with 20% higher, whereas groups IV and V were given 20% lower TDN than the control and protecting the protein in group V. All animals were provided the concentrate at two installments per day (every morning at 9:00 AM and afternoon at 1:00 PM). Green fodder was provided *ad lib* from Berseem (*Trifolium alexandrium*). The ration was changed every two weeks depending on change in body weight, milk yield as well as feed dry matter. Mustard cake in the concentrate provided to groups II and V was treated with 1.2% formalin (40% formaldehyde) equivalent to 1.2 g of formaldehyde per 100 g CP of cake in accordance with Chatterjee and Walli (2003).

Table 1. Chemical composition (%) and level of ingredients offered for the different groups

Feed*	Chemical composition (%)						Average amount offered (g/d/animal)		TDN contribution (from both fodder and concentrate)	
	Ash	OM	CP	EE	CF	NFE	concentrate	fodder	(g/d/animal)	% of NRC
Maize fodder	9.40	90.60	8.50	1.78	27.10	29.72				
Berseem	6.80	93.20	14.63	30.40	31.20	2.65				
Concentrate *										
I	10.20	89.80	19.62	3.56	10.20	53.22	800	5537.03	576	100
II	11.42	88.58	19.42	3.78	13.47	49.34	800	5537.03	576	100
III	10.00	90.00	19.85	1.76	10.60	61.22	930	5537.03	692.75	120
IV	11.00	89.00	19.13	3.21	11.57	55.67	666.67	5277.78	460	80
V	8.80	91.20	19.64	2.96	8.60	58.07	666.67	5277.78	460	80

* Concentrates I, II, III, IV and V refer to the concentrates ration formulated for the respective groups

Feed intake was daily recorded from weighed quantity of feed offered and refusal per individual. The costs per quintal of feed as well as daily labour cost per animal per day were included to estimate total operational cost of milk production. The fixed costs were not used in the economic analysis since the farm is already well established and makes similar impact for all the groups. The daily average nutrient intakes of the animals and the relative feed conversion efficiency into milk were used to determine the feed utilization and economic efficiencies.

Milk yield of individual doe was recorded each day from pooled weights of the morning and evening milk production. However, the daily record of milk yield was pooled to obtain the weekly milk yield of individual goats for statistical comparison. Samples of morning and evening milk were collected every two weeks for the analysis of the chemical compositions. Each time 100 ml of milk sample was collected in clean plastic bottle after uniform mixing of total milk in bucket. Representative amount from each sample was used for estimation of fat, Solids non-fat (SNF), and protein (AOAC, 1995) and formalin content as per Bansal and Singhal (1990).

Statistical Analysis

The data on periodic effects of the treatment on feed intake, milk yield & composition and efficiency parameters were analyzed using Analysis of Variance (ANOVA) with Generalized Linear Model procedure of SYSTAT (SPSS, 1996). Means were separated using Tukey's HSD multiple comparison technique whenever ANOVA showed significant variation.

Results and Discussions

Feed utilization and economic efficiencies

The results for nutrient intake of lactating goats showed statistically significant (P<0.01) variation among the groups (Table 2). The high and medium energy groups had significantly (P<0.01) higher total dry matter, TDN and crude protein intakes as compared to the two low energy groups, regardless of the bypass protein. Moreover, lowering the energy level by 20% than NRC with or without bypass protein resulted in 10% reduction of dry matter intake than the medium and high energy groups. Therefore, variation in intake was attributed to energy level in the diet rather than protection of proteins.

Table 2. Least squares means ± SE for feed utilization and economics of the experimental feeds given to lactating goats

Intake	I	II	III	IV	V
DMI-g/d**	1471.25a±33.97	1482.17a±33.97	1545.65a±33.97	1367.27b±33.97	1352.33c±33.97
TDN Intake (g/d)**	966.65 a±18.52	973.20a±18.52	1027.28a±18.52	889.91 b±18.52	885.59 b±18.52
CP intake (g/d)**	238.08 a±5.90	239.76 a±5.90	249.73 a±5.90	227.83 b±5.90	226.46 b±5.90
DMI (kg/100kg W)	3.99±0.13	3.81±0.13	4.21±0.13	3.72±0.13	3.72±0.13
DMI (g/kg BW0.75)	98.44 ±4.44	95.13±4.44	95.91 ±4.44	92.01±4.44	91.38±4.44
Gross Energy of Lactation (%GEL)	22.94±1.36	23.57±1.36	25.53±1.36	25.53±1.36	26.03±1.36
Milk Yield (kg)/kg DMI*	0.78 b±0.01	0.81ab±0.01	0.85 a±0.01	0.83ab±0.01	0.85a±0.01
Total feed cost (Rs/d)**	5.10 c±0.01	5.65 b±0.01	5.91 a±0.01	4.60 d±0.01	5.07 c±0.01
Labour cost (Rs/d)	1.50±0.00	1.50±0.00	1.50±0.00	1.50±0.00	1.50±0.00
Overall cost (Rs/d)**	6.60 c±0.01	7.15 b±0.01	7.41 a±0.01	6.10 d±0.01	6.57 c±0.01
Gross income (Rs/d) from milk @10/kg*	11.63ab±0.47	12.39ab±0.47	13.29a±0.47	11.44b±0.47	11.45ab±0.47
Net return (Rs/d/ animal)	4.99±0.49	5.09±0.49	5.86±0.49	5.21±0.49	4.68±0.49

*Means in a row having different superscript are statistically different.; * P<0.05, ** P<0.01*

Earlier works by Clark *et al*. (1975) did not find significant variation in dry matter intake between sheep provided formaldehyde treated and untreated feed. However, Crawford and Hoover (1984) reported increased dry matter intake by lactating cows fed formaldehyde treated soybean meal. Similarly, Sahoo and Walli (2005) found that formaldehyde protected proteins resulted in increased dry matter and TDN intakes by lactating goats. Singh *et al*. (1986) reported increased dry matter and TDN intakes with increase in energy level to lactating goats. Similar report was given by Liu *et al.* (2005), where higher energy level improved dry matter intake of sheep. However, Hossain *et al.* (2003) didn't find any variation in dry matter and crude protein intake of grazing sheep by provision of additional energy density.

The trend in weekly nutrient intake of lactating goats (Fig. 1) showed a gradual increase up to the tenth fortnight and then declined thereafter perhaps due to change in climate, nature of feed and production level.

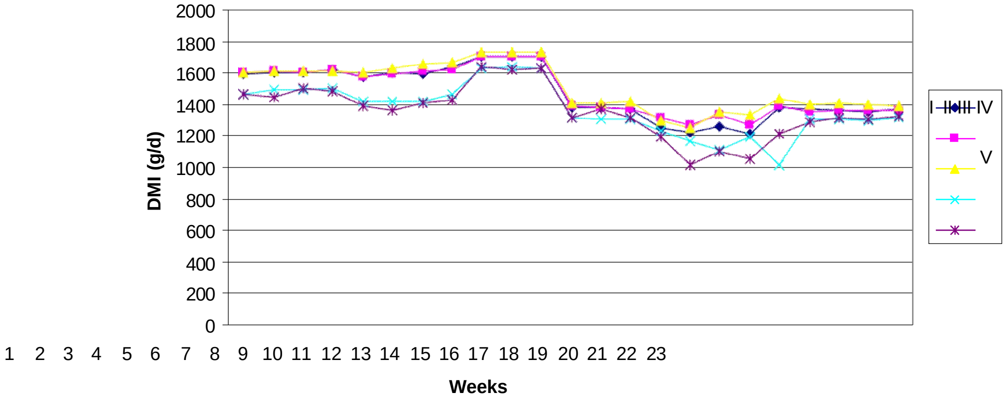

Figure 1: Weekly Dry matter intake (kg) of lactating goats

The feed conversion efficiency in terms of kg milk yield per kg dry matter intake showed significant variation (P<0.05). Groups III and V had higher milk yield (kg) per kg dry matter intake than all the rest (Table 2). While the better efficiency by group III could be due to increased milk yield; the lower feed intake in relation to milk production by group V compared to group I could be explained for the difference in their efficiency. On the other hand, the variation in gross energy of lactation among the groups was statistically non-significant (P>0.05) because the amount of energy (TDN) utilized was proportional to the level of milk/FCM produced in each group.

In agreement with the present study, Srivastava *et al*. (1994) reported feeding goats at higher plane of energy resulted in increased efficiency of feed utilization and production of milk. Such an increase did reflect that with higher levels of energy in the ration, more of it was available as a precursor of milk in the mammary gland. However, Karanjkar *et al.* (1993) indicated that the Sannen x Osmanabadi (F_1) goats couldn't utilize higher levels of TDN (120 or 140%) more efficiently for milk production. The same study suggested that the lower gross energy efficiency observed was attributed to lower milk yield by the goats, especially during the last weeks of lactation.

Due to differences in dry matter intake, the feed cost in rupees (Rs/d) was higher for the high energy group (III) followed by groups II, I and V in that order and the lowest cost was shown by group IV (Table 2). The variation in cost within the two medium energy as well as two low energy groups was due to cost of formaldehyde treatment rather than feed intake. The gross income (Rs/d) was higher for group III as compared to IV ($P<0.05$) due to better milk yield, while there was no significant variation among the rest of the treatment groups. When net return was considered, there was no variation ($P>0.05$) among the groups due the fact that group III which had better milk yield and sale, also had higher cost for the higher DMI than IV. However, some of these variations in net return could be crucial for a farm with large herd size so that the higher return from group III relative to the others could be considered. Hence, it is suggested that future study would be geared to large herd size, different species of lactating animals and varied production level to verify the economic benefits.

Little information is available to support economics of feeding bypass protein to lactating animals. Sahoo and Walli (2005) reported net return per lactating goat per day at Rs 7.30 in formaldehyde treated group compared to Rs 4.8 in the control. Garg *et al*. (2003) and Garg *et al*. (2005) also found formaldehyde treated bypass protein was economical for milk animals (local cows, crossbred cows and buffaloes) producing 5 to 8 liters of milk per day under farm condition. Similarly, Walli *et al*. (2004) found that the feed cost was reduced by Rs 0.60/day in lactating crossbred animals fed formaldehyde treated cake.

Milk yield and composition

The least squares means and standard errors for milk yield and composition of lactating goats is presented in Table 3. The results indicated that the groups significantly (P<0.05) varied in milk yield. Group III had significantly (P<0.05) higher milk yield (by about 15% per animal) than all the other groups, except group II. However, there was no variation (P>0.05) in fat corrected milk (FCM) and, all milk constituents studied. Though milk yield was variable, the statistically similar values obtained for the fat composition in this trial diluted the variation in FCM yield of the lactating goats.

The weekly milk yield (kg/d) in Fig 2 showed a similar and steady increase for all groups up to the 8th week and slowly declining there after, which is a typical lactation curve. The decline in milk yield could also be attributed to changes in climate (commencement of summer season at the end of April) leading to slight reduction in weekly dry matter intake (Fig 1).

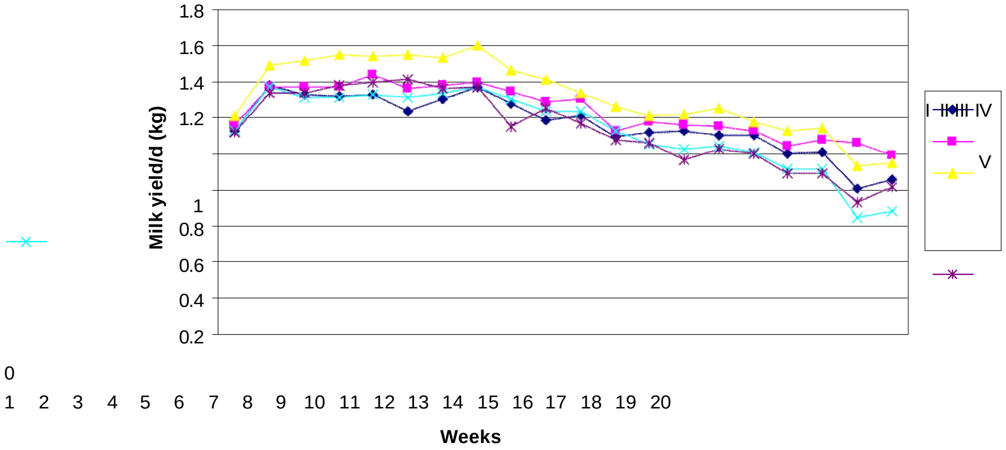

Figure 2: Weekly milk yield of lactating goats

Reports on the effect of formaldehyde treated cakes on milk production of lactating animals have shown variable effects, which may be due to several factors apart from the optimum level used for the treatment. Feeding of formaldehyde treated soyabean meal to cows had no significant effect on milk yield or milk protein synthesis at 0.9% (Clark *et al.*, 1975) and on milk yield of cows (Small and Gordon, 1990). Feeding of crossbred dairy cattle at 30% lower level of energy and/or protein than recommended was also found to be more economical, without influencing efficiency of milk production and its composition (Ashok and Singh, 1997).

However, positive result in milk yield was reported upon formaldehyde treatment of the oil seed cake fed to cows (Morgan, 1985; Kim *et al.,* 1992), buffaloes (Chatterjee and Walli, 1998) and goats (Sahoo and Walli, 2005). Sampath *et al.* (1997) reported higher FCM yield on lactating crossbred cows fed formaldehyde treated groundnut cake (9.4 kg/d) than the control group (7.8 kg/d). Walli et al. (2004) reported that the feeding of formaldehyde treated rape seed meal showed 15.13% increase in milk yield in crossbred cows over the untreated groups (from 18.9 kg/d to 10.35 kg/d).

Similarly, the positive influence of energy supplementation on milk yield has been reported in cows (Prasad, 1994) and lactating goats (Singh *et al*., 1986; Srivastava *et al*., 1994). Higher energy level improves the availability of nutrients for the mammary glands during milk synthesis.

Reports on the influence of energy level and/ or bypass protein supplementation on milk composition are also variable. Most of the researchers (Hadji-panayiotou, 1992; Sahoo and Walli, 2005) however, didn't report any variation in milk fat and protein while Crawford and Hoover (1984), Morgan (1985), Garg *et al*. (2003) reported increased fat content of milk due to supplementation of energy and/or bypass protein.

Lack of significant variation in milk formalin residue and its relatively lower concentration than the limits given by Liteplo *et al*. (2002) was another encouraging factor to be noted for those who are on the virtue of expanding the use of bypass technology in high and medium yielding dairy animals. According to Liteplo *et al*. (2002) for the general population, dermal exposure to concentrations of formaldehyde, in solution, in the vicinity of 1–2% (10 000–20 000 mg/ liter) is likely to cause skin irritation; however, in hypersensitive individuals, contact dermatitis can occur following exposure to formaldehyde at concentrations as low as 0.003% (30 mg/liter). Therefore, the range of milk formalin detected during this study (Table 3) is below the minimum risk level set for hypersensitive individuals. Moreover, study made by Mills *et al*. (1972) using C^{14} labeled formaldehyde, has shown that the chemical gets metabolized in the body of the animal especially liver to non-toxic forms, mainly carbon-dioxide and methane by the enzyme alcohol dehydrogenase. No detectable formalin was also recovered in milks of animals fed formaldehyde treated mustard cake and even the plasma urea concentration of the treated group was lower than animals fed on non treated feeds (Sahoo and Walli, 2005).

Table 3. Least squares means ± SE for milk yield and composition for lactating goats

Parameter	I	II	III	IV	V
Milk yield (kg/d)*	1.20 b±0.05	1.26ab±0.05	1.37 a±0.06	1.19b±0.06	1.18b±0.06
FCM (kg/d)	1.31±0.07	1.37±0.07	1.50±0.07	1.32±0.07	1.32±0.07
Fat (%)	4.20±0.06	4.20±0.06	4.19±0.06	4.19±0.06	4.25±0.06
Solids non-fat (%)	8.26±0.02	8.28±0.02	8.31±0.02	8.28±0.02	8.32±0.02
Protein (%)	3.50±0.11	3.68±0.11	3.64±0.11	3.513±0.11	3.37±0.11
Formalin (μg/ml)	1.43±0.35	1.14±0.35	1.19±0.35	1.29±0.35	1.22±0.35

* Means in a row having different superscript are statistically different at $P<0.05$

Conclusions

Energy densities at NRC recommendation as well as 20% higher concentrate supplementation than the control improved the nutrient intake and milk yield (15% per animal) but with higher production cost than the two low energy groups, regardless of bypass protein. The feed conversion in terms of milk yield per unit dry matter intake was improved either by provision of higher energy or bypass protein at low energy, while economic efficiencies didn't show conclusive trend to favor the levels of energy and/or bypass protein. Therefore, future works should be geared towards large herd size to confirm the results of small differences in return obtained under this trial regarding supplementation of energy concentrates and/or bypass protein.

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