ORIGINAL ARTICLE

Growth performance, body composition and feed efficiency of Alpine-beetal crossbred kids fed on various levels of energy and bypass protein

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ABSTRACT

Thirty Alpine-beetal crossbred male kids were grouped in to five of six each to study effects of energy and bypass proteins on growth performance, feed efficiency and body compositions. All groups received iso-nitrogenious (18% CP) concentrate but varied energy densities. Kids in group I and II were fed medium energy per NRC (1981) recommendation but varied by formaldehyde treatment of the protein in group II. Group III was fed with 25 % higher TDN, while groups IV and V were given 25% lower TDN than NRC level and protecting the protein in group V. The trial was conducted for a period of 20 weeks.The two lower energy groups (IV and V) had low nutrient intakes compared to the rest ($P<0.01$). Group III consumed about 150 gm more; while groups I and II consumed 90 gm more dry matter per day than the two low energy groups. Groups II and III had significantly higher ($P<0.05$) body weight, daily gain and body condition scores than the two low energy groups due to variation in feed intake. Body weight gain was higher by 10-15 g/d for groups II and III than IV and V. However, the body compositions and feed conversion efficiency (gain/nutrient intake) of the kids were not affected. Despite the relatively lower cost incurred to groups IV and V, the cost per gain in body weight remained similar for all due to proportionate growth rate and feed intake. However, kids in group II had the better return in terms of estimated sale price of meat.In conclusion, higher energy with low bypass protein and medium energy with bypass protein improved the feed intake and growth performance of the kids with better returns, while the body composition and the feed conversion efficiency were not affected.

Keywords: body composition, concentrate formaldehyde treatment, goats, growth

INTRODUCTION

The contribution to and population of goat is immensely increasing worldwide, especially in developing countries (Devendra, 2001; Oliver et al., 2004) due to their low initial cost, fast growth and prolificacy. In developing countries, however, problem of feed inadequacy (both in quantity and quality) is widely reported (Adugna et al., 2000; Walli, 2005). Poor nutrition results in low production and reproductive performances, loss of body condition and increased susceptibility to diseases and parasites (Singh and Sengar, 1970). In addition to supplementation of concentrates, protection of the protein concentrate mainly through optimum heating at 150 C for 2 hours (Walli, 2005) and formaldehyde treatments has been acknowledged in boosting the productivity of livestock (Clark, 1975; Chatterjee and Walli, 2003b; Walli, 2005).This approach can result in increased conversion efficiency of feeds within the animal system.

Due to higher effective protein degradability (84%) of mustard cake, physical and/or chemical treatment has been recommended to reduce its rumen degradability and enhance efficient utilization (Chatterjee and Walli, 2003a; Walli, 2005). Earlier works on formaldehyde treatment (at 1.2 g/100 g CP) of mustard cake highly improved its rumen undegradable protein (Sahoo and Walli, 2005; Walli, 2005). Similarly, protection of protein from ruminal degradation has resulted in faster body weight gain and feed conversion efficiency in calves (Spear et al., 1980), buffalo calves (Chatterjee and Walli, 2003b).

Positive responses in production and feed utilization have also been reported through supplementation of energy and/or protection of proteins from rumen degradation. Feeding goats at higher plane of energy was reported to improve the efficiency of feed utilization (Srivastava et al., 1994), the growth rate and carcass composition (Mahgoub et al., 2005) as well as milk yield (Taye etal., 2009).

The use of formaldehyde is not only effective in protecting protein degradation in the rumen but also is cheap and required in small doses (Walli, 2005), which can be applied in developing countries to improve the nutrient utilization. Sahoo and Walli (2005) reported net return per lactating goat per day was 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 on growth rate of lambs (Hadyipanyiotou, 1992).

Various levels of energy and the use of bypass protein technology have been worked out independently to increase the productivity of animals, information is lacking on relative comparison of the bypass protein at different energy densities on growth performance, body composition, economic and feed utilization efficiencies of kids. Therefore, the objectives of this study were to evaluate the influence of varying levels of energy and bypass protein supplementation on growth performances, body composition, feed utilization and economic efficiencies of crossbred kids.

MATERIALS AND METHODS

Animals, diets and production records

Thirty Alpine-Beetal crossbred male kids (average body weight of 13.6 kg) were randomly grouped in to five having six animals each to study the effect of energy and bypass protein on body weight, body measurements (heart girth, height at withers, and body length), body condition score, feed utilization and economic efficiencies. The experiment was carried out at National Dairy Research Institute, Karnal (India). National Dairy Research Institute, Karnal is situated in eastern zone of Haryana 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 kids were provided a concentrate mix consisting of maize grain, wheat bran, mustard cake, as well as mineral mix and salt while targeting the level of mix in each achieve the target energy level under each treatment group (Table 1). Green fodder was provided ad lib to all groups from Berseem (*Trifoliumalexadrium*). The ration has been changed every two weeks depending on change in body weight, and feed dry matter. Mustard cake 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 (2003a). The treated cake was mixed thoroughly and stored in tightly sealed plastic bags for at least four days before mixing with other concentrate ingredients during ration formulation.

All groups received iso-nitrogenious (18% CP) concentrate but varying energy densities. Groups I and II were offered medium energy according to NRC (1981) requirement but varied by protecting the protein (mustard cake) in group II with formaldehyde treatment. As shown in Table 1, kids in group III (high energy low bypass protein) were provided with 25% more TDN than NRC; while groups IV and V were given lower energy (25% less TDN than NRC) but varied in terms of protecting the protein (mustard cake) in group V.

Daily feed intake was recorded from measured quantity of feed offered and refusal over twenty four hours. The feed conversion efficiency was calculated as the amount of nutrient consumed per gram weight gain, while cost of the ingredients in each group and labour cost were used for the cost comparison in relation to growth and feed intake. For more informative cost estimates, the dressing percentages from early works (Das and Singhal, 2005) as well as cost per kg of meat at the current market price (Rs 120/kg; where the current conversion rate of 1 USD =45 Rs) were used for comparison of cost effectiveness of each ration.

Data on weekly body weight and fortnight physical body measurements and body condition scores were recorded. The body compositions (body water, fat, protein and ash) were estimated indirectly by employing water dilution technique in which antipyrine or phenazone (1 phenyl 2,3- dimethyl pyrazolene-5-1) was used as an indicator for examining body water following the procedure given by Soberman (1949) and modified by Sahoo (1999). The body water data was finally used for the estimation of the body composition on the basis of the formula suggested by Panaretto and Tills (1963) for goats and sheep. The experiment was conducted for 150 days (twenty weeks).

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**
Berseem	11.30	88.70	14.87	2.65	30.40	21.84				
Concentrate										
I	10.20	89.80	19.79	3.58	10.20	53.22	366	2600	263.52	100
II	13.47	86.50	19.42	3.78	13.47	49.335	366	2600	263.52	100
III	10.60	89.40	17.50	1.76	10.60	61.22	439	2600	327.06	124.11
IV	11.57	88.43	18.90	2.97	11.57	55.67	283	2600	195.27	75.89
V	8.60	91.44	19.47	2.95	8.60	58.07	283	2600	195.27	75.89

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

Statistical Analysis

The effects of treatment and period of record (weekly or fortnightly as shown in section 2.1) on feed intake, growth rate, physical body measurements (heart girth, body length, height at withers), body condition scores, body composition and efficiency parameters were analyzed using Analysis of Variance (ANOVA) procedure of SYSTAT (SPSS, 1996). Means were separated using Tukey's HSD multiple comparison technique whenever ANOVA showed significant variation.

RESULTS AND DISCUSSION

Growth and body composition

The results of average body weight, body weight gain, physical body measurements and body condition scores are presented in Table 2. There was significant variation ($P<0.05$) in all growth parameters and body measurements (except heart girth) among the treatment groups. The two low energy groups (IV and V) had lower average body weight, body weight gain/d and body condition as compared to groups II and III. Hence, higher energy supplementation without bypass protein and medium energy with bypass protein improved the growth rate and body condition of the kids. The present study closely agrees with most of the earlier results (Sengar, 1979). Jones and Hogue (1960) found that lambs which received high protein and energy rations gained faster and were heavier at slaughter, yielding higher dressing percentage and graded better than the lambs on low protein and energy rations.However, Hadyipanyiotou (1992) reported that soybean meal treated with formaldehyde had no significant difference on weight gain in calves, kids and lambs; which might be due to lower level of formaldehyde used, resulting in insufficient protection of protein. Lack of variation in growth performance among groups I, II and III in this study reflects additional cost for energy in group III is not justifiable in terms of both economic and feed conversion efficiencies especially compared to group II (Table 5).

The results for body composition of kids are given in Table 3. The body water, fat, protein, energy and total ash compositions (as percentage of live weight)ranged from 61.99-66.08, 2.75-16.71, 15.13-19.06 and 3.81-4.82, respectively. The values for average body composition of kids under this experiment are similar to the standard components obtained by many investigators (Panaretto and Tills, 1963) for sheep and goat, (Panaretto, 1963a) for rabbits and (Panaretto, 1963b; Sengar, 1979) for goats. Panaretto and Tills (1963) found a range of 58-75% for body water, 15.4-19.7% for body protein and 0.5-22.8% for body fat contents of goats. However, Panaretto (1963b) found a wide range of values (2-52% fat) for sheep and goat through tritiated water space and direct slaughter methods.

The variations in overall body compositions (water, fat, protein and ash) among the treatment groups were not significant ($P>0.05$). Early work done on the effect of different feeding levels on body composition (percent water, protein, fat and ash) have shown lack of significant difference between the formaldehyde treated and control groups in goats (Prasad and Mudgal, 1979). On the other hand, an attempt made to attain faster and higher slaughter weights of lambs on high energy feedlot rations resulted in undesirable fat deposition in the carcass (Karim and Santra, 2000). This was also depicted by a study made by Gaffar and Biabani (1986) where they fed different combinations of DCP and TDN (80:80, 80:100, 80:120, 100:80, 100:100 and

100:120) of the recommended levels, and found that the high level of dietary energy increased the fat and gross energy but decreased the moisture content of the carcass.

Table 2. Least squares means ± standard errors of body weight, body measurements (cm) and condition scores (1-5 scale) of growing goats

Parameter*	Treatment group				
	I	II	III	IV	V
Initial weight (kg)	13.62±1.00	13.83±1.00	13.80±1.00	13.80±1.00	14.08±1.00
Final weight (kg)	22.58±1.30	24.08±1.30	24.67±1.30	21.17±1.30	21.14±1.42
Average weight (kg)	17.62^{ab}±0.33	18.04^{a}±0.33	18.73^{a}±0.33	17.36^{b}±0.33	17.35^{b}±0.36
Over all weight gain (kg)	8.96^{ab}±0.81	10.25^{a}±0.81	10.87^{a}±0.81	7.37^{b}±0.81	7.06^{b}±0.88
Gain (g/d)	59.78^{ab}±5.40	68.33^{a}±5.40	72.44^{a}±5.40	49.11^{b}±5.40	47.06^{b}±5.40
$BW^{0.75}$ (Kg)	8.57^{ab}±0.12	8.72^{ab}±0.12	8.96^{a}±0.12	8.47^{b}±0.12	8.47^{b}±0.13
Height at withers (cm)	62.14^{ab}±0.50	62.29^{ab}±0.50	62.92^{a}±0.50	60.89^{b}±0.50	60.77^{b}±0.56
Heart girth (cm)	59.92±0.50	59.39±0.50	60.89±0.50	59.46±0.50	59.28±0.56
Body length (cm)	41.88^{ab}±0.40	42.66^{a}±0.40	41.74^{ab}±0.40	40.92^{b}±0.40	41.31^{ab}±0.45
Body condition (scale of 1-5)	2.62^{b}±0.05	2.67^{ab}±0.05	2.82^{a} ±0.05	2.30^{c}±0.05	2.59^{b}±0.05

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

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

Table 3. Least squares means ± standard errors for body composition of crossbred kids

Composition	Treatment group				
	I	II	III	IV	V
Water (%)	63.88±0.26	64.12±0.27	64.05±0.26	64.28±0.27	64.06±0.26
Fat (%)	12.49±0.24	12.27±0.25	12.33±0.24	12.12±0.24	12.32±0.24
Protein (%)	16.34±0.05	16.37±0.06	16.34±0.05	16.39±0.05	16.32±0.05
Total ash (%)	4.11±0.02	4.13±0.02	4.13±0.02	4.14±0.02	4.13±0.02

Feed utilization and economic efficiencies

Feed treatment groups significantly ($P<0.01$) varied in daily feed intake (Table 4). The two low energy groups had lower intakes of dry matter, TDN and crude protein (all expressed as g/d, percentage of body weight and metabolic body size) than the medium and high energy groups regardless of bypass protein. Group III consumed about 150 gm more; while groups I and II consumed 90 gm more dry matter per day than the two low energy groups. Therefore, feed supplementation below the standard with or without bypass protein resulted in reduction of the overall nutrient intake which has contributed to low growth performances as discussed earlier (3.1). However, additional energy supplementation had no benefit in improving the overall dry matter and TDN intakes over the standard feeding of NRC with or without bypass protein.

These results agree with most of early findings (Chatterjee and Walli, 2003b, Sahoo and Walli, 2005). Studies have also indicated that increasing the concentrate level from 150g/d to 350 g/d to lambs improved DMI of corn stalk ($P<0.01$) but had no additional effect when the concentrate was increased to 450 g/d (Liu et al., 2005). Hence, additional nutrient would be beneficial only up to a certain limit. Housain et al. (2003) reported feeding of sheep with increased levels of dietary energy supplementation (10.02, and 11.98 MJ/kg DM) to grazing did not result in significant ($P>0.05$) difference for daily average dry matter and crude protein intakes. On the other hand, Singh et al. (2003) reported that the dry matter intake was significantly higher ($p<0.05$) on low energy ration (52% TDN).

The real benefit of various feeding levels can be revealed from comparison of feed conversion and economic efficiencies. The variation in terms of percentage gross efficiency of growth (% GEG) and intakes of dry matter per gram of body weight gains remained statistically similar ($P>0.05$) among all the groups due to the fact that those groups which had better performance of growth had more intake of nutrient so that the unit conversion remained unchanged (Table 5).

Many reports showed positive impact of feeding bypass protein on feed conversion efficiency (FCE) of growing animals (Spear et al., 1980; Tiwari and Yadav, 1994). Tiwari and Yadav (1994) reported that the body weight gain and FCE in growing male buffalo calves fed formaldehyde treated mustard cake at 1% of CP was significantly higher in 100% replaced by treated mustard cake group. However, it had no significant difference at 0.5 % of CP and 0.12% of DM in calves, kids and lambs; which might be due to lower level of formaldehyde used, resulting in insufficient protection of protein (Hadyipanyiotou, 1992). Supplementation of energy was also reported to improve the growth rate and/or feed efficiency of growing animals (Fimbres et al., 2002; Singh et al., 2003; Liu, et al., 2005). Generally, the results of the present study agreed in terms of improved growth rate of kids due to higher energy level as well as protection of protein at moderate energy, while the feed conversion efficiency was not statistically influenced.

Table 4. Least squares means ± standard errors of nutrient intakes of kids duringgrowth trial**Intake**	**Treatment group**				
	I	**II**	**III**	**IV**	**V**
DMI (g/d)**	886.12ᵃ±18.07	891.21 ᵃ±18.07	951.21 ᵃ±18.07	800.41ᵇ±18.07	798.08ᵇ±19.80
TDNI(g/d)**	573.66ᵃ±12.36	576.24 ᵃ±12.36	616.32 ᵃ±12.36	502.39ᵇ±12.36	500.85ᵇ±13.54
CPI(g/d)**	123.92 ᵇ±1.65	124.20 ᵇ±1.65	135.88ᵃ±1.65	115.87 ᶜ±1.65	114.83 ᶜ±1.80
DMI kg/100kg BW*	4.82ᵃ±0.07	4.77ᵃ±0.07	4.97ᵃ±0.07	4.47 ᵇ±0.07	4.46ᵇ±0.08
DMI kg/kg $BW^{0.75}$*	10.22 ᵃ±0.15	10.12ᵃ±0.15	10.57ᵃ±0.15	9.37 ᵇ±0.15	9.33ᵇ±0.17
TDNI kg/100kg BW*	3.12 ᵃ±0.05	3.08ᵃ±0.05	3.22 ᵃ±0.05	2.80ᵇ±0.05	2.80ᵇ±0.05
TDNI kg/kg $BW^{0.75}$*	6.61 ᵃ±0.11	6.53 ᵃ±0.11	6.84 ᵃ±0.11	5.88 ᵇ±0.11	5.85 ᵇ±0.12
CPI kg/100kg BW*	0.61ᵃᵇ±0.01	0.60ᵃᵇ±0.01	0.62 ᵃ±0.01	0.67 ᵇ±0.01	0.67ᵇ±0.02
CPI kg/kg $BW^{0.75}$*	1.44 ᵇ±0.01	1.43ᵇᶜ±0.01	1.53 ᵃ±0.01	1.38 ᶜ±0.01	1.36ᶜ±0.01

DMI = Dry matter intake, TDNI = Total digestible nutrient intake, CPI = Crude protein intake, BW = body weight,
$BW^{0.75}$ = Metabolic body weight; g/d = gram per day
*Means in a row having different superscript are statistically different;** P<0.01; * p<0.05*

The total feed cost and therefore overall cost per day per kid was significantly highest (P<0.01) for group III followed by groups II, I, V in that order and lowest cost was seen in group IV (Table 4). Because of higher energy supplementation to group III and additional cost of formaldehyde in group II, their relative cost appeared to be higher than those of lower energy groups (IV and V). However, the additional cost of formaldehyde treatment in group II compared to group I was only 27 paisa/kid/day, where as the variation in daily body weight gain between the two groups was 59.78 vs 68.33 g/d, respectively. Due to these reasons, there was no variation (P>0.05) in cost per gain between the treated and non-treated groups at medium energy levels. The results for both estimated dressing percentages and income from sale of meat were statistically significant (P<0.01), where groups II and III had higher values than the two low energy groups corresponding to their growth rate (Table 3). Despite the higher cost incurred on formaldehyde in group II and on concentrate in group III; kids fed on medium energy high bypass protein had net return of about Rs 23, 43, 47 and 90/kid higher than that of groups III, I, IV and V, respectively.

The fact that results of the net return had high standard errors might have caused non significance in net profit for the otherwise large variation. However, such huge difference in net income coupled with better body condition scores (which is important parameter in live sale of the kids) can be considered as encouraging superiority of the medium energy high bypass protein supplementation followed by high energy without bypass protein. The relative lower return of group III compared to II was due to higher cost of feed, whereas the additional cost of formaldehyde with lower growth performance of group V has resulted in economic losses.

There are little reports available on economics of feeding bypass protein and/or different energy levels on growing animals. Chatterjee and Walli (2003b) found thatsimilar result to the present study in buffalo calves the total cost of feeding per animal per day was higher for formaldehyde treated group than the control (Rs 13.45 vs 12.09). However, the cost of feeding per kg live weight gain was much lower for formaldehyde treated group (Rs 22.42) as compared to the untreated group (Rs 31.32). Similarly, Sahoo and Walli (2005) reported better returns from growing goats fed bypass protein due to higher growth. Even though statistically no variation was obtained for cost per gain in the present study, the differences in values of the cost/kg gain is wider and this might have great impact for the farmer's decision to choose the ration.

CONCLUSION

Provision of higher energy than NRC without bypass protein and bypass protein supplementation at NRC energy level improved the daily feed intake, growth in body weight, body measurements and body conditions of crossbred kids than the two low energy groups regardless of bypass protein, while body composition and feed conversion efficiency remained similar among the groups. Bypass protein supplementation at standard NRC energy level provided good returns from the estimated sale of meat than the remaining four treatment groups. Therefore, it is suggested that further work should be carried out on using the bypass protein technology in finishing animals.

Table 5. Feed conversion andeconomic efficiencies of feeding the different treatments groups to crossbred kids

Parameter**	**Treatment group**				
	I	**II**	**III**	**IV**	**V**
DMI g/g gain	5.79±8.54	9.53±8.35	17.03±8.52	-5.07±8.48	15.16±9.27
TDNI (g/ g gain)	4.01±5.49	6.36±5.36	11.10±5.41	-3.17±5.39	9.51±5.89
CPI (g/g gain)	0.83±1.09	1.29±1.07	2.38±1.08	-0.44±1.07	2.05±1.17
GEG (%)	4.16±0.80	4.08±0.80	4. 87±0.80	3.68±0.80	3.71±0.88
Feed cost (Rs/150days)	363.24[c]±0.01	397.40[b]±0.01	457.76 [a]±0.01	271.10 [e]±0.01	297.29[d]±0.01
Labour cost (Rs/150 days)	150.00±0.00	150.00±0.00	150.00±0.00	150.00±0.00	150.00±0.00
Total cost	513.24 [c]±0.01	547.40 [b]±0.01	607.76 [a]±0.01	421.10 [e]±0.01	447.29 [d]±0.01
Dressable carcass from wt gain(kg)	4.48 [ab]±0.40	5.13 [a]±0.40	5.43 [a]±0.40	3.68 [b]±0.40	3.53 [b]±0.44
Income from meat sale (@Rs120/kg)	538.00[ab]±48.65	615.00[a]±48.65	652.00[a]±48.65	442.00[b]±48.65	423.60[b]±53.65
Net return (Rs)	24.76±48.66	67.60±48.66	44.24±48.66	20.90±48.66	-23.69±53.30
Cost/kg gain	61.29±7.48	54.74±7.48	56.15±7.48	65.62±7.48	65.67±8.19

** Means in a row having different superscript are statistically different at P<0.01
DMI = Dry matter intake, TDNI = Total dry matter intake; CPI = crude protein intake; g/d = gram per day, wt = weigh ;kg = , kilo gram; $BW^{0.75}$ = *metabolic body size, GEG = gross energetic gain; Rs = Rupees (1US $ = Rs 45.00 during the study period of 2005/06)*

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