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EFFECTS OF DIETARY PROTEIN CONCENTRATION AND FEEDING LEVEL ON GROWTH AND CARCASS CHARACTERISTICS OF BLACK BENGAL GOATS

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ABSTRACT

Twelve castrated male Black Bengal goats of 10.3 kg live-weight (8 months old) were used in a 2x2 factorial arrangement to study the effects of dietary crude protein concentration [20.3% (HP) and 16.9% (LP)] and feeding level [(*ad libitum* and 85% *ad libitum* (restricted)] on growth and carcass characteristics. *Ad libitum* feeding, on average, significantly (P<.05 to P<.01) increased daily live weight (6.27 *v.* - 5.87 g), dry matter intake (409 *v.* 351 g/d), estimated gain in carcass (0.195 *v.* - 0.20 kg) and empty body weight (0.387 *v.* - 0.353 kg), chemically extracted fat in meat sample (6.89 *v.* 6.48%), depth of *m. longissimus dorsi* (22.1 *v.* 18.3 mm) and gut and caul fat (170 *v.* 125 g) compared with restricted feeding regime. The greater intake of dietary protein from the HP diet resulted in significantly (P<.05 to P<.01) greater values for depth (20.9 *v.* 19.5 mm) and width (32.4 *v.* 27.9 mm) of *m. longissimus dorsi*, gut and caul fat (188 *v.* 107 g) and also perirenal and retroperitoneal fat (84.8 *v.* 50.3 g) than those that received the LP diet. Similarly, the HP diet had significantly (P<.05 to P<.01) higher values for CP digestibility and DCP concentration than those of the LP diet. The results indicated that growth rate and carcass gain were highest in goats fed the HP diet *ad libitum* and therefore, diet containing 20.3% CP may be suggested for feeding growing goats.

Key words : Goats, Growth, Carcass, Protein, Feeding level

INTRODUCTION

Bangladesh has 22 million goats (FAO, 1992) of which 98% is distributed in the rural areas of the country (BBS, 1986) and are traditionally raised by poverty-stricken village people in a sedentary system of grazing on harvested or fallow land, along roads and canal sides. They are also maintained by feeding tree leaves and by-products of human food. This system of feeding can not satisfy their nutrient requirement for maintaining proper growth and productivity, resulting in severe economic losses. Therefore, priority has to be given to optimize the productivity of goats utilizing available feed resources in the country. Dietary nutrients, especially energy and protein, are the major important environmental factors affecting meat production in goats (Ash and Norton, 1987b; Devendra, 1988; Shahjalal *et al.*, 1992). Reports on the nutrient requirements of Bangladeshi Black Bengal goats are scanty and little information is available particularly on the contribution of dietary energy and protein to the quality and quantity of meat produced by these animals under Bangladesh condition. The work reported here was therefore undertaken to investigate the effects of dietary protein concentration and feeding level on growth and carcass characteristics of Black Bengal goats.

MATERIALS AND METHODS

Location

The experiment was conducted at the Bangladesh Agricultural University Animal Nutrition Field Laboratory, Mymensingh for a period of 77 days.

Animals, diets and experimental design.

Twelve castrated male Black Bengal goats approximately 8 months of age and

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weighing, on average, 10.3 kg were purchased from the local market for this experiment. The goats were kept in individual pens in an animal house subjected to natural light and ventilation and allowed 15 days to adapt to the experimental conditions and feeds prior to the commencement of the study. During this period all the goats were dewormed with an anthelmentic drug. The animals were blocked into four groups according to live weight and the blocked groups were assigned at random to four dietary treatments. Each treatment consisted of either low or high level of protein (LP or HP) each at either *ad libitum* or restricted feeding regime. Two iso-energetic loose mix diets (9.65 MJME/kg DM) differing in protein concentrations of 20.3% (HP) or 16.9% (LP) were formulated with green grass, *Sesbania* leaves, wheat bran, soybean meal and sesame oil cake. The two diets were offered at two feeding levels in a 2X2 factorial experiment with three goats per treatment. The two feeding levels were achieved by offering the diets either *ad libitum* or 85% of *ad libitum* (restricted).A measured quantity of the diet was fed twice daily at 8.00 and 16.00 hours and refusals were collected in the next day before morning feeding. Roughage and concentrate fractions of the diets were fed separately. Water was made available at all times. Daily food intake and weekly change in live weight for individual animals were recorded. A digestibility trial was conducted towards the end of growth trial to assess the utilization of dietary nutrients by the goats. Feeds, faeces and refusals were analyzed for proximate components (AOAC, 1980).

Carcass characteristics

Two goats from each dietary group were slaughtered unfasted 77 days after commencing the study and the method and procedures for slaughter and measurements made on carcass were similar to those described by Shahjalal *et al.* (1997). About 250g of meat sample was taken from shoulder, thigh, best end, loin and flank regions of each carcass. These were chopped, mixed and minced and then analysed for DM, CP, EE and ash.

Statistical analysis

The data were analysed using the "MSTAT" statistical program to compute analysis of variance (ANOVA). In the ANOVA, appropriate for a 2x2 factorial experiment, the treatment sum of squares were partitioned into three components each with one degree of freedom and the results presented for main effects and interactions are as follows:P= main effect of dietary protein level (LP vs HP); E= main effect of feeding level (*ad libitum* vs restricted); I= interaction between the dietary protein and feeding level.

RESULTS AND DISCUSSION

Growth performance

The average growth performance of goats fed different diets is shown in Table 1. *Ad libitum* feeding of goats significantly ($P<.01$) increased average daily dry matter (408.9 vs 350.6 g), estimated metabolizable energy (4.0 vs. 3.4 MJ) and crude protein (64.0 vs. 54.9 g) intake compared with those of restricted feeding regime(85% of *ad libitum*).The higher intake of energy and protein given *ad libitum* diet resulted, on average, significantly ($P<.05$) superior values for daily live weight change (6.29 vs. -5.86 g) and feed conversion efficiency (0.015 vs. -0.018 gLWG/gDMI) than those received restricted diet. However, growth rate recorded in the present experiment was much lower than those cited in the previous studies with Cashmere goats (Ash and Norton, 1987a). They have reported that growing goats received *ad libitum* diet gained 85.8 g while goats on restricted diet gained 57.8 g daily.

The daily energy requirement for the maintenance of 10.3 kg LW goats were estimated as 2.44 MJME (NRC, 1981) which indicated 1.62 and 1.39 times more energy intake in goats from diets fed *ad libitum* and at restricted level, respectively. The results of the current studies, therefore, indicated that either energy was not utilized properly for maintaining the growth rate or Black Bengal goats may have required more energy for their maintenance than that was recommended for different breeds of goats by

Table 1. Effect of protein concentration and feeding level on growth performance of goats

Parameter	*Ad libitum*	Restricted (85% of *ad libitum*)				SEM	Significance of contrast #	
		HP	LP	HP	LP	P	E	I
Initial live weight (Kg)	10.27	10.30	10.33	10.13	0.52	NS	NS	NS
Final live weight (kg)	11.40	10.13	9.67	9.90	0.86	NS	NS	NS
Live weight change (g/d)	14.71	-2.17	-8.67	-3.04	5.32	NS	*	*
Dry matter intake (g/d)	409.7	407.8	352.3	349.0	11.68	NS	*	NS
Feed conversion efficiency (LWG/DMI)	0.035	-0.006	-0.025	-0.011	0.02	NS	*	NS
Crude protein intake (g/d)	73.34	54.64	63.06	46.76	1.88	**	**	NS
Protein conversion efficiency (CPI/LWG)	6.23	0.84	-9.28	5.02	2.81	NS	NS	**
ME intake (MJ/d)	3.97	3.92	3.42	3.35	0.11	NS	**	NS
Energetic efficiency (MEI/LWG)	0.340	0.064	-0.500	0.363	0.18	NS	NS	**
CPI: MEI (g/MJ)	23.75	16.87	23.52	16.88	0.21	**	NS	NS

#Contrast P= (*ad libitum*-HP+restricted-HP) vs (*ad libitum*-LP+restricted-LP)
E= (*ad libitum*-HP+*ad libitum*-LP) vs (restricted-HP+restricted-LP)
I= interactions between main effects.

the NRC (1981). Moreover, energy requirement for activity was not considered in this study although goats were seen to expend energy in exercising and jumping which may have reduced the availability of energy for growth.

Goats fed the high protein (HP) diet significantly (P<.01) increased crude protein (CP) intake (68.1 vs. 50.7 g/d) but not of ME (3.70 vs. 3.64 MJ/d) or DM (381.0 vs. 378.1 g/d) intake. The higher amount of protein intake from the HP diet did not significantly (P>.05) improve growth rate (3.02 vs. -2.61 g/d) and also feed conversion efficiency (.005

Table 2. Effect of feeding level and dietary protein concentration on digestibility and nutritive value

Parameter	*Ad libitum*	Restricted (85% of *ad libitum*)				SEM	Significance of contrast #	
		HP	LP	HP	LP	P	E	I
Apparent digestibility (g/100g):								
Crude protein (CP)	79.04	72.68	78.79	75.61	2.09	*	NS	NS
Crude fibre (CF)	58.35	68.13	68.14	67.65	2.81	NS	NS	NS
Ether extract (EE)	68.37	54.49	71.37	42.55	5.68	**	NS	NS
Nitrogen free extract (NFE)	61.35	71.64	68.32	80.14	3.84	**	NS	NS
Organic matter (OM)	67.31	69.69	70.55	72.68	2.51	NS	NS	NS
Nutritive value (g/100g DM):								
DCP	17.11	12.20	17.06	12.57	0.39	**	NS	NS
DCF	9.92	11.6	11.56	11.52	0.48	NS	NS	NS
DEE	4.05	2.24	4.23	1.76	0.28	**	NS	NS
DNFE	27.42	38.44	30.54	42.94	1.81	**	NS	NS
TDN	63.57	67.30	68.68	71.04	2.30	NS	NS	NS
DOM ("D" value)	58.50	64.51	63.38	68.84	2.22	*	NS	NS

#Contrast P= (*ad libitum*-HP+restricted-HP) vs (*ad libitum*-LP+restricted-LP)
E= (*ad libitum*-HP+*ad libitum*-LP) vs (restricted-HP+restricted-LP)
I= interactions between main effects.

Table 3. Selected carcass characteristics of goats given diets differing in protein concentration and feeding level

Parameter	*Ad libitum*	Restricted (85% of *ad libitum*)				SEM	Significance of contrast #		
		HP	LP	HP	LP		P	E	I
Slaughter weight (SW, kg)	11.40	10.13	9.63	9.87	0.86		NS	NS	NS
Warm carcass weight (WCW, kg)	4.65	3.98	3.90	4.01	0.37		NS	NS	NS
Estimated carcass gain(Kg)	0.460	-0.070	-0.280	-0.120	0.17		NS	*	NS
Gut fill (kg)	2.33	2.26	1.94	2.00	0.20		NS	NS	NS
Empty body weight (EBW,g)	9.07	7.87	7.70	7.87	0.70		NS	NS	NS
Estimated EBW gain (kg)	0.903	-0.130	-0.553	-0.153	0.34		NS	*	*
Gut and caul fat (kg)	0.250	0.089	0.125	0.125	0.02		**	*	**
Perirenal and retroperitoneal fat (kg)	0.086	0.054	0.083	0.047	0.01		**	NS	NS
Killing out proportion:									
WCW/SW	0.403	0.393	0.403	0.403	0.01		NS	NS	NS
WCW/EBW	0.513	0.507	0.507	0.510	0.01		NS	NS	NS
M. longissimus dorsi:									
Area (cm^2)	3.44	1.53	3.22	2.03	0.40		NS	NS	NS
Depth (mm)	23.60	20.50	18.10	18.47	0.63		**	**	**
Width (mm)	32.40	29.50	32.43	26.23	1.01		**	NS	NS
Chemical composition (g/100g meat sample):									
Dry matter	32.60	28.20	28.27	33.58	1.11		NS	NS	NS
Crude protein	21.93	21.00	22.84	22.48	0.60		NS	NS	NS
Ether extract	6.89	6.92	6.87	6.09	0.17		NS	**	**
Ash	0.49	0.45	0.46	0.45	0.25		NS	NS	NS

#Contrast P= (*ad libitum*-HP+restricted-HP) vs (*ad libitum*-LP+restricted-LP)
E= (*ad libitum*-HP+*ad libitum*-LP) vs (restricted-HP+restricted-LP)
I= interactions between main effects.

vs. -.009 gLWG/gDMI). However, there are evidence that DM intake and growth rate in Alpine and Nubian goats increased linearly as the level of protein concentration in the diet increased (Lu and Potchoiba, 1990). Lack of significant effect on growth rate due to high protein treatment in the present investigation may be attributed to the similar amount of protein available from both protein levels at the small intestine although there were great differences in crude protein intakes between the HP and LP diets. The major proportion of the dietary protein in goats fed the HP diet was probably degraded in the rumen with the production of ammonia and may have resulted in greater urinary losses of nitrogen. This may be the reason for similar growth rate of goats fed the HP and LP diets. Previous studies with goats given the high protein diet (20.9% CP) indicated that 28 percent of the dietary nitrogen was apparently lost across the stomach (Ash and Norton, 1987a).

Growth rate of goats fed the HP diet ad libitum was 14.71 g/day. This group only gained live weight but goats on other dietary groups lost their live weight. This lower growth rate recorded in this study may be explained by the fact that Black Bengal goats are mainly habituated to pasturing/grazing and not accustomed to stall feeding. Furthermore, intake of protein as a ratio of energy (gCP/MJME) in the HP and LP diets were 23.6 and 16.9, respectively. However, protein to energy ratio for optimum growth was recommended as 9.38 gCP per MJME (NRC, 1981). Therefore, excess protein was wasted and excreted from the body as proposed above and resulted in poor growth rate in goats.

Significant (P<.05 to P<.01) interactions between protein and feeding levels were recorded for live weight gain and efficiency of conversion of protein and energy into live weight gain. These results suggested that the effect of increasing feeding level on the HP diet was greater than on the LP diet and that of increasing protein on the ad libitum feeding group was greater than on the restricted feeding regime.

Digestibility and nutritive value

The apparent digestibilities of dietary crude protein (CP, 75.86 vs. 77.20%), crude fiber (CF, 63.24 vs. 67.90%), ether extract (EE, 61.43 vs. 56.96%), nitrogen free extract (NFE, 64.50 vs. 72.23%) and organic matter (OM, 68.50 vs. 71.62%) were almost similar (P>.05) in both the *ad libitum* and restricted fed animals. Here the results indicated that the level of feeding had no effect on nutrient digestibility. Ash and Norton (1987a) also reported that the digestibility of OM or N was not altered in Cashmere goats due to change of feeding level from restricted to *ad libitum*. Similar to nutrient digestibility, "D" value (61.51 vs. 66.11%) and DCP (14.66 vs. 14.87%) and TDN (65.44 vs. 69.89%) concentrations were almost similar in both the feeding regimes although higher values tended to be recorded for these parameters in goats fed on restricted diet.

Goats that received the HP diet had significantly (P<.05 to P<.01) higher values for the digestibility of CP (78.92 vs. 74.15 %) and EE (69.87 vs. 48.52 %) compared with those given the LP diet. Ash and Norton (1987a) also reported that the feeding of high protein diet significantly improved nitrogen digestibility in goats compared with the low protein diet (77.7 vs. 67.3%). In contrast, feeding the LP diet significantly (P<.05) increased NFE digestibility (75.89% vs. 64.84%) than that of feeding the HP diet. However, dietary protein concentration had no effect on the digestibility of CF (63.2 vs. 67.9%) or OM (68.9 vs. 71.2%). High protein diet had significantly (P<.01) greater value for DCP (17.1 vs. 12.4%) concentration but lower (P<.05) "D" value (60.9 vs 66.7%) compared with the LP diet.

Carcass characteristics

Feeding level (*ad libitum* vs restricted), on average, had no effect on slaughter weight (SW, 10.77 vs. 9.75 kg), empty body weight (EBW, 6.47 vs 7.79 kg), warm carcass weight (WCW, 4.32 vs. 3.96 kg) and killing out proportion expressed as WCW/SW (0.398 vs 0.403) or WCW/EBW (0.51 vs. 0.51) although larger values for SW and EBW were recorded in goats given diet *ad libitum*. Goats fed on *ad libitum* diet had significantly (P<.05) higher values for estimated gain in carcass weight (0.195 vs - 0.20 kg) and EBW (0.387 vs - 0.353 kg) compared with those on restricted feeding regime. These parameters ran in parallel to live weight gain of goats given diet *ad libitum*. High level of feeding (*ad libitum*) significantly (P<.01) increased the depth (22.05 vs 18.29 mm) of m. longissimus dorsi than those of low level of feeding (restricted). But there was no difference in the width (30.95 vs 29.33 mm) and area (2.49 vs 2.63 cm^2) of m. longissimus dorsi between the levels of feeding (*ad libitum* vs restricted).

High protein diet significantly (P<.05 to P<.01) increased depth (20.9 vs 19.5 mm) and width (32.4 vs 27.9 mm) of m. longissimus dorsi compared with the low protein diet. However, concentration of dietary protein, on average, had no effect on SW (10.52 vs 10.0 kg), WCW (4.28 vs 4.00 kg), estimated carcass gain (0.09 vs -0.10 kg), EBW gain (0.18 vs -0.14g), killing out proportion (0.403 vs 0.398 or 0.51 vs 0.51) and area of m. longissimus dorsi. (3.33 vs 1.78 cm^2). The lack of significant effect on carcass characteristics due to protein treatments indicated that the availability of protein at the tissue level was considered to be similar despite large differences in dietary protein intake. Feeding levels and dietary protein concentrations had no effect on the weight of gut fill. The average weight of gut fill recorded as 21.4 and 20.2% of live weight of goats fed *ad libitum* and restricted diets, respectively. Fehr *et al.* (1976) observed that gut fill varies from 12% of live weight in milk fed kids (57 days old) to 25% of live weight in weaned kids (133 days old). In the present experiment, the average gut fill ranged from 20.1 to 22.3 percent of live weight in different dietary groups which

correspond to the above findings.

Goats fed *ad libitum* contained significantly (P<.05) more ether extract (6.89 vs 6.48%) in their meat sample compared with the restricted fed goats. The results are in accordance with those reported by Ash and Norton (1987b). They have indicated that *ad libitum* feeding resulted in more fat in the body compared with the restricted feeding regime. Level of feeding had no effect on DM, CP or ash content of meat sample. Likewise, high protein diet did not significantly (P>.05) increase the concentrations of ether extract, dry matter, crude protein and ash in the meat sample of goats compared with those on the low protein diet. Ash and Norton (1987b) also reported that the dietary protein concentration had no effect on the composition of the empty body weight of goats.

Significant interactions (P>.05 to P>.01) between feeding level and protein concentration were recorded for estimated EBW gain, depth of eye muscle, gut and caul fat and also for ether extract content of meat sample. The results indicated that increasing feeding level generally produced positive effect on the above parameters with the HP diet (except for ether extract which was greater with the LP diet) and negative effect with the LP diet. Similarly, increasing dietary protein level resulted in positive effect on the *ad libitum* fed goats and negative effect on the restricted fed group.

CONCLUSION

The results showed that growing goats given the high protein diet *ad libitum* gained live weight, on the other hand goats that received the low protein diet lost their live weight. Therefore, diet containing 20.3% may be recommended for feeding *ad libitum* basis to growing Black Bengal goats.

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