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Intake and Growth Performance of Female Goats and Sheep Given Concentrate Supplement under Grazing Condition

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Abstract: Six females each of sheep and goats aged about 6 mo and weighing, on average, 9.8 and 9.77 kg, respectively were used to investigate the effect of concentrate supplementation on intake and growth performance under grazing condition. A grazing land was developed and all the goats and sheep were allowed to graze for 7 h daily with or without supplementary concentrate feeding in a 2 x 2 factorial experiment. Herbage yield and composition during experimental period were determined in this study. The average herbage yield recorded in the month of September was significantly ($P<0.01$) higher than that harvested either in June or December. Major grass species identified in the grazing land were *A. compressus* (39%), *I. cylindrica* (24%), *P. repens* (18%), *C. dactylon* (13%) and *C. rotundus* (6%). The highest CP content was observed in *C. rotundus* (12.27%) and lowest was recorded in. *I. cylindrica* (9.8%). Grazing intake estimate by either grass harvesting method (0.41 vs 0.28 kg) or animal weight gain method (0.26 vs 0.23 kg) indicated that sheep consumed significantly ($p<0.05$) higher amount of herbage DM than goats. However, apparent digestibility of all proximate components of herbage did not differ significantly between sheep and goats. Significantly ($p<0.05$ to $p<0.01$) higher live weight gain (16.59 vs 3.94 g d^{-1}) and total DM intake (457.7 vs 253.0 g d^{-1}) were observed in supplemented group than those of control group but there were no differences between sheep and goats for live weight gain (8.59 vs 11.80 g d^{-1}) and DM intake (371.0 vs 339.7 g d^{-1}). The results showed that concentrate supplementation improved growth rate and therefore, feeding of grazing goats and sheep with concentrate supplement may be suggested to optimize growth performance. Moreover, supplementation may be necessary to maintain body condition during the winter season particularly between December and January when the pasture quantity is inadequate in the grazing land.

Key words: Sheep, goat, grazing, supplementation, intake, growth

Introduction

Small ruminants, goats and sheep, contribute a significant role in the subsistence economy of small landholders and landless farmers in Bangladesh. Black Bengal goats are highly prolific and reputed for high quality meat and skin production. Goat production in many traditional village systems in tropical countries is often characterized by poor growth rates and high mortality (Devendra and Burns, 1983). However, goat productivity in village environments may be increased mainly by improving nutrition by either concentrate feeding (Parawan and Ovalo, 1985; Parthasarathy, 1986) or provision of additional forage (Parthasarathy *et al*., 1984). Sheep grow at a much higher rate on the feeding of energy rich high concentrate diet than the grazing alone and supplementation of grazing by concentrate feeding is more economical than the intensive fattening (Schiere and Ibrahim, 1986).

In Bangladesh, goats and sheep are mainly kept by the poor farmers and distressed women in extensive system under ranged condition without any supplementation. This system of production causes reduced growth rate which in turn results in severe economic losses. Previous studies (Mahajan *et al*., 1976; Kochapakdee *et al.,* 1994) have reflected the importance of concentrate supplementation on growth and productivity of sheep and goats in pasture based grazing system. They also reported that grazing alone may not be sufficient for optimizing live weight gain and wool production. The estimation of nutrient availability by goats and sheep under grazing condition was of particular interest in order to determine the need for supplementing concentrate to sustain productivity. Moreover, no comparative study has yet been done on the production characteristics of goats and sheep under Bangladesh condition. The present experiment was therefore, designed to study the

effect of supplementing concentrate on intake and growth response of female goats and sheep raised under grazing condition.

Materials and Methods

Location and time: The experiment was conducted at the Bangladesh Agricultural University Animal Nutrition Field Laboratory, Mymensingh during 16 September 1999 to 29 April 2000. During this period, generally temperature varies from 12 to 33^0 C with relative humidity between 71 and 90%.

Pasture establishment, yield and chemical composition: A grazing land of 0.3 ha was developed and natural pasture was allowed to establish before the onset of the experiment. Naturally grown grasses were collected and identified as *Axonopus compressus* (Carpet grass), *Panicum repens* (Banchina grass), *Imperate cylindrica* (Ulu grass), *Cynodon dactylon* (Durba grass) and *Cyperus rotundus* (Mutha grass). Irrigation was given when necessary and Urea at the rate of 50 kg per ha was applied. Herbage yield in the grazing land were estimated in three occasions (June, September and December, 1999). In every case, three patches (1x 1 meter) were made randomly and grasses in each patch were harvested and weighed. The mixed grasses were then separated and weighed individually to estimate yield and proportion of grasses available in the grazing land. Grass samples collected in different occasions were subjected to chemical analysis following the methods of AOAC (1980).

Animals, experimental design and method of feeding: Six females each of sheep and goats aged about 6 months and weighting, on average, 9.80 and 9.77 kg, respectively were used in a 224 day study. Animals (sheep and goats) were blocked into three groups according to live weight and then assigned at random to two feeding regimes (control and supplemented group). Goats and sheep were allowed to graze a newly established grazing land for 7 h daily (08:00 to 12:00 h and 14:00 to 17:00 h) and were housed overnight in individual pens in a well ventilated house. A skilled shepherd was engaged to rear the animals. In addition to grazing, the animals (sheep or goats) in supplemented group received a measured quantity of concentrate mixture consisting of wheat bran, rice polish and soybean meal. The supplemental diet was formulated to contain an estimated ME concentration of 10.8 MJ and CP content of 17%. Concentrate mixture was fed daily at night and water was made available to all animals. Live weight of sheep and goats was recorded initially and thereafter at 14 d intervals throughout the experimental period at 07:30 h prior to access to the grazing land.

Grazing intake: Two methods were applied for estimating nutrient intakes. In the first method (grass harvesting method), the grazing land was divided into four paddocks (12.5x3.5 meter) and in each paddock three patches (1x1meter) were made randomly and grasses were harvested prior to grazing and then estimated the amount of grass available in each paddock. Then the goats and sheep were allowed to graze separately in each paddock for 7 h daily. After grazing, each of the paddock was harvested and the quantitative difference before and after grazing was recorded as the amount of grass consumed by each species of animal.

In the second method (animal weight gain method), animal of each species were weighed individually before access to grazing land. The animals were then allowed for grazing and weighed at 2 h intervals from 08:00 to 16:00 h and average weight of each animal was recorded after grazing. The difference between two weights before and after grazing (i.e. weight gain) was estimated as the amount of herbage consumed by individual animals of each species (control or supplemented group).

Digestibility of herbage: A conventional digestion trial was conducted for 7d (97 to 104 day of the experiment) to assess the utilization of herbage nutrients by goats and sheep. Daily feed supplied, refused and feces voided by each goat and sheep were collected and weighed. Representative feed, refusal and feces samples were processed and analyzed.

Statistical analysis: The experimental data related to growth performance were analyzed using ``MSTAT@ statistical program to compute analysis of variance (ANOVA) for a 2 x 2 factorial experiment. Data for herbage yield and chemical composition of grasses were processed in a Randomized Block Design (RBD) and Duncan=s New Multiple Range Test (DMRT) was done to identify significant difference among the treatment means. Data for herbage intake and digestibility between sheep and goats were also analyzed using t-test

Results and Discussion

Herbage yield and composition: The average yields of fresh herbage, Dry Matter (DM) and Crude Protein (CP) in the grazing land during the experimental periods (June, September and December 1999) are shown in Table 1. The results showed that the yields of fresh and DM at the middle of the experiment (September) were significantly

Table 1: Average herbage yield and chemical composition of mixed grasses during the experimental period

	Months				
Parameter	June, 99	Sept, 99	Dec, 99	SEM	Level of significance
Herbage yield (g sqm^{-1}):					
Fresh grass (g sqm^{-1})	1040.0a	2690.0b	1520.0a	12 0.00	**
Dry matter (g sqm^{-1})	280.0a	460.0b	280.0a	30.00	**
Crude protein (g sqm^{-1})	28.0	38.3	34.4	2.74	NS
Chemical composition(g/100gDM):					
CP	11.15a	7.95b	2.93a	0.44	**
CF	25.77	26.67	24.94	0.84	NS
EE	1.53	1.68	1.91	0.39	NS
NFE	52.00b	55.07a	48.94c	0.89	**
OM	91.30a	91.32a	88.65b	0.34	**
Ash	8.70b	8.69b	11.36a	0.31	**

a,b,c Data having dissimilar superscripts differ significantly ($p<0.01$)

Table 2: Intake, digestibility and nutritive value of herbage in sheep and goats

	Animal			
Parameter	Sheep	Goats	SEM	Level of significance
Measurement of intake:				
Grass harvesting method (kg d^{-1})	0.41±0.05	0.28±0.02	0.017	*
Animal weight gain method (kg d^{-1})	0.26±0.04	0.23±0.02	0.015	*
Apparent digestibility (g g^{-1}):				
DM	0.56	0.61	0.04	NS
CP	0.64	0.66	0.04	NS
CF	0.78	0.82	0.02	NS
EE	0.51	0.44	0.04	NS
NFE	0.67	0.68	0.03	NS
OM	0.70	0.71	0.03	NS
Nutritive value (g/100g DM):				
DCP	8.33	8.42	0.47	NS
DCF	20.34	21.45	0.40	NS
DEE	0.73	0.62	0.05	NS
DNFE	31.61	31.77	1.46	NS
"D" value	61.01	62.26	2.33	NS
ME (MJ kg^{-1} DM)[#]	9.76	9.96	0.37	NS

[#]ME value was estimated from digestible organic matter ('D' value) as ME (MJ kg^{-1} DM) = 0.16 × 'D' value (MAFF, 1984)

Table 3: Effect of concentrate supplementation on live weight gain of sheep and goats under grazing condition

	Sheep		Goats			Significance of contrast[#]		
Parameter	Control group	Supplemented group	Control group	Supplemented group	SEM	S	C	SC
Initial live weight (kg)	9.93	9.67	9.77	9.77	0.49	NS	NS	NS
Final live weight (kg)	9.97	13.48	11.5	13.3	0.98	NS	*	NS
Total live weight gain (kg)	0.03	3.82	1.73	3.55	0.85	NS	*	NS
Average live weight gain (g d^{-1})	0.15	17.03	7.72	15.87	3.78	NS	*	NS
Total dry matter (DM) intake (kg)	64.40	101.8	48.91	103.3	3.06	NS	**	*
DM intake (g d^{-1})	287.7	454.3	218.3	461.0	13.5	NS	**	*
DM intake from concentrate (g d^{-1})	-	227.0	-	225.0	-	-	-	-
DM intake (% live weight)	2.97	3.93	2.09	4.01	0.21	NS	**	NS
DM intake (g/kg$^{0.75}$/d)	52.27	72.27	37.47	73.77	3.06	NS	**	*
Feed conversion efficiency (LWG d^{-1}MI)	0.00	0.03	0.03	0.03	0.02	NS	NS	NS
Crude protein intake (g d^{-1})	29.97	63.40	22.93	64.03	1.46	NS	**	*
Protein conversion efficiency (LWG/CPI)	0.01	0.27	0.35	0.24	0.17	NS	NS	NS
ME intake (MJ/d)	2.83	4.77	2.21	4.91	0.14	NS	**	*
Energetic efficiency (LWG/ MEI)	0.12	3.60	3.65	3.22	1.72	NS	NS	NS

[#]Contrast S= Main effects between sheep and goats C = Main effects between control and supplemented group SC= Interaction between main effects

($p<0.01$) higher than those recorded at the beginning (June) or at the end of the experiment (December). However, no difference was observed between the yields of grasses (fresh grass or DM) harvested during the months of June and December. The probable reason for higher yield at the middle of the experiment (September) indicated optimum nutrient availability and suitable environment required for proper meristematic growth of herbage in the grazing land. Tareque and Saadullah (1988) reported that the yield of grasses was observed to vary in

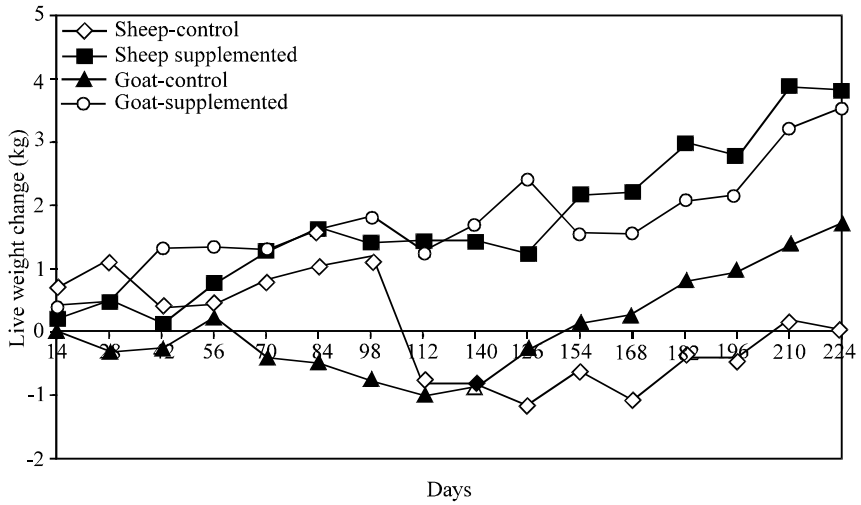

Fig. 1: Cumulative live weight change of goats and sheep

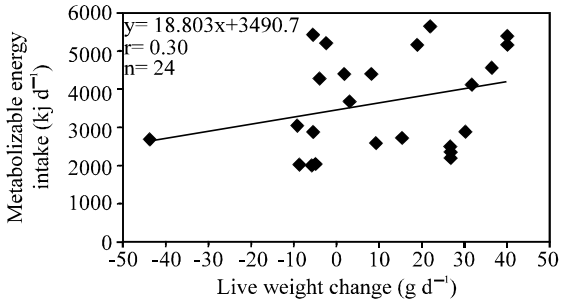

Fig. 2: The relationship between ME intake (42-day interval) and live weight change of goats and sheep

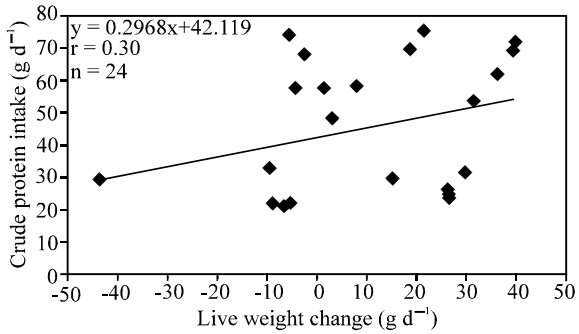

Fig. 3: The relationship between CP intake (42-day interval) and live weight change of goats and sheep

different seasons and their availability was not uniform all over the year. The proportion (weight/weight of DM) of different grass species available in the grazing land were *Axonopus compressus* (39%), *Imperata cylindrica* (24%), *Panicum repens*(18%), *Cynodon dactylon*(13%) and *Cyperus rotundus* (6%).

Chemical composition of grasses: The chemical composition in relation to CP, NFE, on and ash contents of herbage in different months of the experimental period varied significantly ($P<0.01$). The results revealed that CP contents of grass harvested in June (11.5%) and in December (12.93%) were significantly ($p<0.01$) higher than those harvested in September (7.95%). This variation might be due to the fact that N fertilizer was applied 15 d before collecting grass sample during June and December 1999. Wilson (1981) reported increased crude protein content of grass with the application of N fertilizer in the field. This was brought about by stimulating new growth of tissue and by accumulation of NPN compounds in the tender region of the plant. In contrast, DM content of grasses ranged from 21.48-24.83% during the period mentioned above. This might be due to variation in soil moisture content during different seasons of the year. Tareque and Huque (1985) observed lower dry matter content in grasses during dry season. In previous studies (Norton, 1984) it was reported that as with pasture, the nutritive value of browse varied considerably, not so much with season, mainly with species.

Intake under grazing condition: Grazing intake and digestibility of herbage in sheep and goats are shown in Table 2. DM intake, estimated by either grass harvesting method or animal weight gain method, was significantly ($p<0.05$) higher in sheep than that in goats. The results also indicated that animals consumed higher amount of DM in grass harvesting method than that in animal weight gain method. However, intake estimated by grass harvesting method would be appropriate under homogeneous distribution of herbage/grasses and at equal height of sward throughout the grazing land. In fact,

large variations in yield and proportion of different grasses were observed at different locations of the grazing land.

The average daily ME and CP intakes estimated by grass harvesting method for goats were 0.504 MJ and 6.7g kg^{-1} $w^{0.75}$, respectively. In contrast, ME and CP intakes by animal weight gain method were 0.414 MJ and 5.5 g kg^{-1} $w^{0.75}$, respectively. The average ME and CP requirements for the maintenance of goats as recommended by the NRC (1981) are 0.424 MJ and 5.6 g kg^{-1} $w^{0.75}$, respectively. Based on nutrients requirements and performance of goats in control group (goats) during growth trial, ME and CP intakes estimated by animal weight gain method would be reasonable and this method would be appropriate for estimating grazing intake of goats and sheep under the prevailing conditions of the grazing land.

The digestibilities of all proximate components of herbage were almost similar ($p>0.05$) in goats and sheep. Nutritionally, goats are usually treated as being the same as sheep, on the assumption that the digestion of herbage diets is similar in both species (Doyle *et al*., 1984). The average CF digestibility in goats and sheep was 0.82 and 0.78, respectively. Ali (1976) stated that average CF digestibility of native grasses collected from four different regions was 0.77. The results showed that CF digestibility tended to be higher in goats than sheep. This appears to be a general agreement that goats digest cellulose more efficiently than sheep and cattle, particularly when low quality diets are fed (Norton, 1984). Similar to digestibility, the nutritive value of herbage was almost similar in goats and sheep and there was no significant ($p>0.05$) difference between two species.

Growth performance of sheep and goats: The effect of concentrate supplementation on intake and growth performance of sheep and goats is shown in Table 3. Feeding of sheep and goats with concentrate supplement significantly ($p<0.01$) increased intakes of dry matter (DM) expressed either on absolute live weight (457.7 vs 253.0 g d^{-1} or on metabolic body size (73.02 vs 44.87 g kg^{-1} $w^{0.75}$ d^{-1}) of the animals, estimated Metabolizable Energy (ME, 4.84 vs 2.52 MJ d^{-1}) compared with those of control group (grazing without concentrate). The higher intake of dietary energy and protein, on average, resulted in significantly ($p<0.05$) superior values for daily live weight gain (16.59 vs 3.94 g) in sheep and goats given concentrate supplement to those on grazing only. Siviah and Mudalior(1977) reported that crossbred *Merino deccani* lambs received concentrate diet (200g/h/d) gained 44 g d^{-1} while lambs on control diet (100% roughage) gained only 13.5g d^{-1}. Similarly, Kochapakdee *et al*. (1994) reported that the Thai female growing goats received concentrate diet (0.75% BW) gained 36g d^{-1} while goats on control diet (grazing only) gained 14 g d^{-1}. The growth rate of goats and sheep recorded in the present experiment was much lower than those recorded in previous studies. The differences in live weight gains may be attributed to poor genetic potentiality of indigenous sheep and goats for converting dietary nutrients (energy and protein) into body tissues and growth compared with other breeds of goats or sheep mentioned above. No significant difference was observed between sheep and goats for the values of DM intake (371.0 vs 339.7 g d^{-1}) and live weight gain (8.59 vs 11.80g d^{-1}), conversion efficiencies of feed (0.020 vs 0.036 kg LWG kg^{-1} DMI), protein (0.141 vs 0.301 g LWG g^{-1} CPI) and energy (1.86 vs 3.44 g LWG/MJME).

The cumulative live weight gain throughout the experiment is shown in Fig. 1 which illustrates that animals of control group lost their body weight during certain growth interval of the experimental period (sheep lost body weight during 112 to 196 days and goats lost body weight during 28 to 126 days). In fact, all the animals (supplemented or control group) lost their live weight between December and January. This could be explained by the fact that with the advancement of grazing period, quantity and quality of grasses available in the grazing land became inadequate to support the animals body condition. Mahajan *et al*. (1976) in his study reported that grazing alone was not sufficient for better live weight gain and supplementation of green oat or concentrate mixture showed better performance to grazing sheep.

When ME intake (42-day interval) was regressed on live weight gain, the slope was 18.8 kj g^{-1} of gain (Fig. 2). This value was similar to that recorded by Lu and Potchoiba (1990) in Alpine and Nubian goats but much lower than the recommended value (NRC, 1981). The recommended value, 30 kjME g^{-1} of gain is the mean of three separate observation, 42.5, 21.5 and 26.9kjME g^{-1} of gain, observed from indigenous Malaysian, West African Dwarf and various breeds of Indian goats. When CP intake (42-day interval) was regressed on live weight gain, the slope was 0.30g CP g^{-1} of gain (Fig. 3). The recommended value of 0.28 g CP per g of gain (NRC, 1981) recorded for non-dairy breeds similar to the present estimate of CP requirement for growth. The equation derived for the energy requirement is $y=580.9+3.13x$, where y is ME intake (kj kg^{-1} $w^{0.75}$ d^{-1}) and x is growth rate (g d^{-1}). The intercept, 580.9 kj kg^{-1} $w^{0.75}$ d^{-1}, is larger than 424 kj kg^{-1} $w^{0.75}d^{-1}$, which was used to calculate maintenance requirement (NRC, 1981). This implies that additional energy might have been needed for activity. The equation for protein requirement is $y=7.01+0.05x$, where y is CP intake (g kg^{-1} $w^{0.75}$ d^{-1}) and x is growth rate (g d^{-1}). Y intercept values, 3491 kjME and 42 g CP, were equivalent for medium activity recommended by NRC (1981). This implies that

goats used in this study required substantial amounts of ME and CP for activity. But in the present study, energy and protein requirements for activity were not considered, although goats were seen to expend energy in exercising, jumping and walking for searching food.

The results of the present study showed that concentrate supplementation improved growth rate of goats and sheep under grazing condition, however, animals lost live weight without supplementation under the same feeding regime. Therefore, feeding of grazing goats and sheep with concentrate supplement may be suggested to optimize growth performance. In addition, supplementation may be necessary to maintain body condition during the winter season particularly between December and January when pasture quantity is inadequate in the grazing field. Further studies with different levels of concentrate supplementation may be conducted using large number of animals for a longer period to get more detailed information.

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