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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Effect of Dietary Energy Supplementation on Feed Intake, Growth and Reproductive Performance of Goats under Grazing Condition

M. E. Hossain, M. Shahjalal, M. J. Khan and M. S. Hasanat
Department of Animal Nutrition, Bangladesh Agricultural University,
Mymensingh, Bangladesh
E-mail: emran2136@yahoo.com

Abstract: Twelve female goats were used in a 90 day trial to study the effects of dietary energy supplementation to grazing on feed intake, growth and reproductive performance of female goats. Animals were blocked according to live weight and blocked groups were assigned at random into three feeding regimes i.e. low, medium and high energy (10.02, 11.06 and 11.98 MJ ME/kg DM). Each goat received 250 grams of supplemental diet in addition to grazing. Results showed that, daily average dry matter and crude protein intake significantly ($P<0.05$) decreased from 406.1 to 362.4 g/d and 47.7 to 40.4 g/d when supplemental energy level increased from 10.02 to 11.98 MJ ME/kg DM. Energy supplementation had positive effect on energy intake. ME intake significantly ($P<0.05$) increased from 3.75 to 4.25 MJ/d as well as the digestibility of OM and CF significantly ($P<0.05$) increased from 62.25 to 73.68% and 43.80 to 53.21% respectively as the level of supplemental energy increased from 10.02 to 11.98 MJ ME/kg DM. However, the digestibility of DM, CP, NFE and EE was similar ($P>0.05$) irrespective of level of energy supplementation. Average daily live weight gain increased ($P>0.05$) in a linear fashion and the mean values were 37.7, 44.4 and 52.9 g/d for low, medium and high energy supplemented diets respectively. Birth weight of kids was highest i.e. 0.75 kg fed high energy diet and lowest i.e. 0.55 kg fed low energy diet. These results indicate that, increasing levels of supplemental energy improved live weight gain and reproductive performance of female goats. Therefore, supplementation of higher level of dietary energy (11.98 MJ ME/kg DM) may be suggested for optimizing growth and reproductive performance of female goats under grazing condition.

Key words: Goat, energy supplementation, intake, digestibility, live weight gain, reproductive performance

Introduction

Goats play a potential role in the subsistence economy of Bangladesh where they are generally raised by poor farmers and distressed women with very little capital investment (FAO, 1991). Goats are numerically and economically very important and promising animal resource in the developing countries especially in Asia and Africa (Husain, 1993). According to BBS (1990) goats in Bangladesh are reared by small, marginal and landless farmers (55%) followed by medium (35%) and large farmers (10%). The country has 34.6 million goats and sheep representing 58.8% (96.8% goat alone) of total livestock population and yielding 129 thousand metric tons (97.7% goat meat) of meat annually, which accounts for 43.9% of total livestock meat (FAO, 1999). The importance of goat is strongly emphasized for their versatile production profile and valuable contribution like meat and milk, industrial raw products as skin, fibers and manure; socioeconomic relevance as security by income generation and human nutrition. Most of the farmers in Bangladesh rear goats with tethering as well as traditional system of grazing without any supplementation. This system of production causes reduced growth and poor reproductive performance. Studies conducted by various authors reflect the facts that, grazing alone may not be sufficient for optimizing live weight gain of goats. Therefore, if scavenging type of rearing can be supplemented with minimum level of concentrate as an additional source of dietary energy then the level of production can be increased at minimum cost. Limited works have been done for overall improvement of goats. Therefore, present investigation was aimed at predicting the effect of dietary energy supplementation on feed intake, growth and reproductive performance of female goats under grazing condition.

Materials and Methods

Location and climatic condition: The experiment was conducted at Bangladesh Agricultural University Animal Nutrition Field Laboratory, Mymensingh during the period from April 2001 to June 2001 for a period of 90 days. This region has a subtropical humid climate with an average annual rainfall of 210.3 cm having dry period extending from November to March with marked incidence of rainfall during May to October. Ambient temperature varies from 21.52 to 30.55 ^{0}C with an average relative humidity of 80.72%.

Establishment of pasture and management: An estimated area of approximately 0.12 ha. was surrounded by protective fancy materials to establish

pasture in the grazing land. After completing establishment of the pasture, it was allowed for the animals to graze during day. Naturally grown grasses available in the grazing land were identified as *Axonopus compressus*, *Panicum repens*, *Imperata cylindrica, Cynodon dactylon* and *Cyperus roturdus*. Intercultural operations like proper irrigation, removal of undesirable plants and toxic weeds had been accomplished to make the land ready for grazing goats. Urea (45 kg/ha.) was applied in two weeks interval to accelerate proper growth potentials of the grasses.

Animals and their housing: Twelve female goats aged about 10-months and weighing, on average 8.85 kg were used for the trial. The animals were ear tagged and allowed for 10 days to adapt to the experimental conditions prior to onset of the study. Faeces of animals were examined initially for checking internal parasitic infestation and all animals were dewormed with suitable anthelmintic drugs immediately before starting the experiment. Following adaptation, goats were housed in individual pen in an animal house subjected to adequate natural ventilation and sunlight. The animals were allowed to graze for a particular period of 6 hours daily during day while at night they were individually penned.

Experimental design: Animals were blocked according to live weight (Table 1) and the blocked groups were assigned at random to supplemental diets having three different levels of energy i.e. low (10.02 MJ ME/kg DM), medium (11.06 MJ ME/kg DM) and high energy (11.98 MJ ME/kg DM). All animal groups were allowed to graze the newly established grazing land and supplemented with one of the three diets in addition to grazing.

Table 1: Experimental design and dietary treatments

Block	Goats		
	Low energy	Medium energy	High energy
I	9.26	10.6	14.2
II	9.10	9.0	7.5
III	8.50	8.6	7.9
IV	8.9	7.2	5.83
Mean±sd	8.85±0.32	8.85±13.9	8.85±3.67

Diet and method of feeding: Animals were grazed for 6.0 hours daily (08:00 to 12:00 and 15.00 to 17:00 hours) in the newly established pasture and supplemented with 250 g of concentrate mixture consisting of maize, wheat bran, rice polish and soybean meal. The chemical composition and ME content of the ingredients used in formulating supplemental diets are given in Table 2. The supplemental diets were fed daily at night when the animals were kept in individual pen. The increment of supplemental diets was based on live weight gain and daily feed consumption. Free access of drinking water was carefully ensured for all animals.

Digestibility of energy supplemented diet: A conventional digestion trial was conducted for 10 days at the end of the experiment to assess the utilization of different dietary nutrients. During this period, animals were kept in individual pen and were fed with a measured quantity of grass every morning collected from the grazing land in which animals were raised during growth trial. In addition, supplemental diets (250 g/animal/day) of different energy level (low, medium and high energy) were fed to animals. Representative feed, refusal and faeces samples collected over the period of 10 days were subjected to chemical analysis (AOAC, 1980).

Measurements and procedure

Grazing intake: Dry matter (DM) and other nutrient intake were estimated by animal weight gain method. Animals were weighed individually before access to the grazing land. The animals were allowed to graze and weighed at 2 hour interval from 08.00 to 16.00 hours. Average weight of each animal was recorded. The difference between two weights before and after grazing was considered as the amount of herbage consumed by individual animal of each group.

Live weight gain: Animals were weighed initially and then at 15 day interval throughout the experimental period. After completion of 90-day experimental period, final live weight of each animal was recorded in three consecutive days and the average weight was calculated. The animals were weighed at 07.30 hour prior to grazing.

Reproductive performance: The estrus symptoms of female goats were identified by visual observation method and animals in oestrum were mated by Black Bengal buck. Special attention was given to pregnant animals and their gestation gain was recorded. Age at puberty, date of service, gestation period, litter size, sex, birth weight of kids and dams were also recorded after parturition.

Statistical analyses: The experimental data related to chemical composition of mixed grass, dry matter intake, digestive efficiency and growth performance were analyzed by using "MSTAT" statistical program to compute analysis of variance for a randomized block design (RBD).

Results and Discussion

Chemical composition of mixed grass: The chemical composition of mixed grasses at fortnight interval has been shown in the Table 3. The table showed that, dry matter (DM), ether extract (EE) and crude fibre (CF)

Table 2: Chemical composition and ME contents of ingredients used for energy supplemented diet

Ingredients	Amount (g/100 g)			Chemical composition (g/100 g DM)						*ME (MJ/kg DM)
	Low energy	Medium energy	High energy	CP	CF	EE	Ash	NFE	OM	
Maize	18	37	60	8.50	10.02	2.50	2.12	76.76	97.88	13.0
Wheat bran	60	10	12	10.2	15.88	2.24	8.23	63.65	91.77	11.3
Rice polish	10	40	15	12.4	16.00	7.15	12.9	51.52	87.01	9.90
Soybean meal	12	13	13	26.5	11.02	5.40	10.3	46.85	89.70	12.3

* ME values of feed ingredients were taken from Ranjhan (1980), Banerjee (1998) and McDonald *et al.* (1988).

Table 3: Chemical composition of mixed grass (g/100 g DM)

Parameters	Time of harvest							Level of significance
	7 April	22 April	7 May	22 May	6 June	21 June	SEM	
Dry matter (DM)	20.32	20.40	20.95	21.25	22.50	22.50	0.15	*
Organic matter (OM)	87.10	89.50	89.20	89.05	87.95	87.85	0.84	NS
Crude protein (CP)	9.25	9.06	8.95	9.15	10.05	9.20	0.75	NS
Crude fibre (CF)	25.04	25.50	24.90	26.10	26.04	25.38	0.24	*
Ether extract (EE)	2.50	2.40	2.30	2.45	2.25	2.15	0.02	*
Nitrogen free extract (NFE)	50.31	51.54	53.05	50.35	49.6	51.12	0.86	NS
Ash	12.90	11.50	10.80	11.95	12.05	12.15	0.96	NS

content of green grasses differed significantly ($P<0.05$) with harvest time. No marked ($P>0.05$) differences were observed in organic matter (OM), nitrogen free extract (NFE) and ash content. This observation clearly indicates that, the proximate components of green grasses are affected at fortnight intervals. Various factors may affect the chemical composition of green grass. Tareque (1987) observed that, dry matter content of plant materials tend to decline during dry season. Similarly, Norton (1984) demonstrated that, NFE content of plant materials may be affected markedly by grass species, environmental condition, stage of maturity, region of the world and leaf stem ratio. Other factors may also affect the chemical composition of plant i.e. soil fertility, stage of maturity, light intensity, season and other macro and micro environmental factors (Ranjhan, 1980). Singh *et al.* (1988) reported that, stage of maturity put a vital impact in changing the chemical composition of plants. Similarly, Rahman *et al.* (1991) and Tareque (1987) reported that, season may alter the production and chemical composition of green grasses. Wilson (1960) remarked that, crude protein content of forage materials can be drastically changed with the application of N fertilizer in the soil. This is due to the reason that, nitrogenous materials stimulate growth and multiplication of new tissues and tend to accumulate NPN components in different soft regions of the plants.

Digestibility and nutritive value of energy supplemented diets: The digestibility of dry matter (DM), crude protein (CP), nitrogen free extract (NFE) and ether extract (EE) was similar ($P>0.05$) in goats for all dietary energy regimes with trends to increase these parameters with the increased levels of dietary energy supplementation (Table 4). However, the digestibility of organic matter (OM) and crude fibre (CF) increased significantly ($P<0.05$) as the levels of dietary energy supplementation was increased. The digestibility of CP, CF and EE was 65.12, 43.80 and 68.14%. These results of the present study may be compared with the previous report of Huston *et al.* (1988) who reported that, goats digest and utilize low quality diets with better efficiency. In present study, the average value for digestibility of CP was 68.00% in goats irrespective of level of energy supplementation. Alam and Akbar (1989) found similar report for digestibility of CP. They mentioned that, CP digestibility of native grasses was 64.00% in goats. Similar to digestibility, nutritive value of different diets was almost similar ($P>0.05$) for goats (Table 4). The digestible organic matter ('D' value) of low, medium and high energy supplemented diets was 66.06, 69.78 and 70.56% respectively. ME content (MJ ME/kg DM) of low, medium and high energy supplemented diets was 9.25, 10.42 and 11.73 respectively. These results are similar with those reported by Salim (1999) who found that, ME content of grass was 9.96 and 9.76 for goats. Similarly, Shahjalal (1997) also reported that, ME concentration of roadside grasses was 8.9 MJ/kg DM.

Energy supplementation, intake and growth performance of goats: Feeding of grazing goats with increased levels (10.02, 11.06 and 11.98 MJ ME/kg DM) of dietary energy supplementation significantly decreased ($P<0.05$) intake of green grass dry matter (222.9, 191.7 and 179.7 g/d) and daily average dry matter (406.1, 374.3 and 362.4 g/d) (Table 5). Dry matter intake expressed as per cent live weight, significantly ($P<0.05$) decreased in goats (3.44, 3.13, 2.84 kg/d respectively) with increased levels of dietary energy supplementation (low, medium and high energy). This result is in well agreement with that, of Devendra and McLeory (1982) who observed that, dry matter intake in meat type goat hardly exceed the level of 3% of live

Table 4: Effect of energy supplementation on digestibility and nutritive value in goats

Parameter	Goats			SEM	Level of significance
	Low energy	Medium energy	High energy		
Apparent digestibility (g/100 g):					
DM	51.22	61.24	63.17	3.76	NS
OM	62.25	67.23	73.68	2.79	*
CP	65.12	67.07	71.72	3.66	NS
CF	43.80	49.21	53.21	1.68	*
NFE	72.06	74.30	78.83	3.67	NS
EE	68.14	73.21	79.20	3.47	NS
Nutritive value (g/100 g DM):					
DCP	7.59	7.60	8.35	0.87	NS
DCF	6.81	8.06	9.69	0.83	NS
DEE	2.75	2.95	3.19	0.71	NS
DNFE	42.26	43.96	46.64	0.95	NS
"D" value	66.06	69.78	70.56	0.87	NS
ME (MJ/kg DM)[#]	9.25	10.42	11.73	0.80	NS

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

Table 5: Effect of energy supplementation on growth performance of female goats

Parameter	Goats			SEM	Level of significance
	Low energy	Medium energy	High energy		
Initial live weight (kg)	8.86	8.85	8.85	0.88	NS
Final live weight (kg)	12.30	12.85	14.63	0.93	NS
Average live weight gain (g/d)	37.77	44.43	52.96	4.90	NS
DM intake from grass (g/d)	222.90	191.70	179.70	7.33	*
DM intake from concentrate (g/d)	183.30	182.50	182.80	0.75	NS
Total DM intake (g/d)	406.10	374.30	362.40	8.93	*
DM intake (% live weight)	3.44	3.13	2.84	0.12	*
DM intake (g/kg0.75/d)	69.18	62.98	57.89	3.64	NS
Crude protein intake (g/d)	47.73	43.30	40.44	0.17	*
ME intake (MJ/d)	3.75	3.89	4.25	0.11	*
Feed conversion efficiency (DMI/LWG)	10.84	8.37	6.84	0.73	*
Protein conversion efficiency (CPI/LWG)	1.26	0.97	0.76	0.08	**
Energetic efficiency (MEI/LWG kJME/g LWG)	99.30	87.60	80.20	0.35	**

Table 6: Effect of energy supplementation on reproductive performance of female goats

Parameter	Goats		
	Low energy	Medium energy	High energy
No. of pregnant animals	1	1	2
Litter size	1	1	3
Percentage born alive	100	100	100
Birth weight (kg)	0.55	0.63	0.75
Sex of kids	Female	Male	2 Male 1 Female

weight. Ranjhan (1980) also reported that, dry matter intake in goats varied from 1.47 to 3.65% of live weight. Daily average dry matter intake expressed as metabolic body size (g/kg$^{0.75}$/d) was similar (P>0.05) in goats (69.18, 62.98 and 57.89 g for low, medium and high energy supplemented diets respectively). The average daily ME intake in goats was 3.75, 3.89 and 4.25/d MJ for low, medium and high energy supplemented groups respectively. Crude protein intake in goats decreased significantly (P<0.05) due to increased levels of dietary energy supplementation and the mean values were 47.73, 43.30 and 40.44 g/d for low, medium and high energy supplemented diets respectively. Average daily live weight gain was highest (52.96 g) in goats fed high energy diet and lowest (37.77 g) in goats fed low energy diet (Table 5), but the difference was non significant (P>0.05). This result is similar with that, reported by Shahjalal *et al.* (1992). They observed a relationship between growth rate of Angora goats and dietary energy concentration. Growth rate of goats increased from 64.0 to 103.5 g/d when dietary energy concentration was increased from 10.2 to 11.9 MJ ME/kg DM. In contrast, Lu and Potchoiba (1990) observed that, increasing dietary energy concentration from 10.3 to 12.8 MJ ME/kg DM decreased average daily live weight gain from 115.0 to 99 g/d in Alpine and Nubian growing goats. They further observed that, growth rate was relevant mainly with the increased relationship between dry matter intake and dietary ME concentration. Feed required per kg live weight gain in goats was 10.84, 8.37 and 6.84 kg for low, medium and high energy regimes. The efficiency of utilization of ME for growth (kJ ME/g LWG) was 99.3, 87.6 and 80.2 for low, medium and high energy supplemented diets and the difference among energy levels was significant (P<0.01). The efficiency of utilization of protein (CPI/LWG) improved significantly (P<0.01) with increased levels of dietary energy supplementation and the mean values were 1.26, 0.97 and 0.76 for low, medium and high energy supplemented diets respectively.

Reproductive performance of goats: Certain reproductive traits of female goats raised under three feeding regimes i.e. low, medium and high energy supplementation (10.02, 11.06, 11.98MJ ME/kg DM) in addition to grazing have been shown in Table 6 .The number of pregnant does were higher in high energy supplemented group compared with other two groups. Birth weight of kids increased as the levels of dietary energy supplementation was increased and the mean values were 0.55, 0.63 and 0.75 kg for low, medium and high energy supplemented diets respectively. It is speculated that, increased levels of dietary energy supplementation along with other nutrients from the concentrate mixture might increased the availability and proper balance of nutrients to the host animal. This in turn resulted in higher supply of nutrients to the fetus and reflected higher birth weight. However, size, weight and health status of doe may be another important factors, which may affect birth weight of kids. Kochapakdee *et al.* (1994b) reported that, better supplementary feeding did not always play potential role in attainment of birth weight or post weaning rate of gain of kid. So, it is too difficult to draw a precise conclusion regarding why birth weight of kids markedly increased with increased levels of dietary energy supplementation.

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