Feeding Black Bengal Goat under Intensive Management : Milk Feeding in Pre-weaned Kids

S. A. Chowdhury* and S. Faruque
Bangladesh Livestock Research Institute, Savar, Dhaka 1341, Bangladesh

ABSTRACT : Despite higher fecundity, Black Bengal goat generally has lower milk production, which is often insufficient for their multiple kids. However, milk requirement of Black Bengal kids is poorly defined. Present trial was thus designed to determine the requirement and intake of milk of pre-weaned Black Bengal kids in relation to their growth rate age and sex. Thirty, one month old Black Bengal kids of either sex divided into two groups were allocated to two groups, suckling alone (T1) or suckling along with teat-bottle feeding of milk (T2). Ten kids were allocated for the T1 and 20 kids were allocated for the T2. Digestibility of milk was also determined in T2 animals. Average daily consumption of milk, milk energy and milk N were 773 and 722 g, 1,170 and 1,093 kJ/kg $W^{0.75}$/d and 1,552 and 1,462 mg N/kg $W^{0.75}$/d, respectively. During 9 weeks trial period, male kids had significantly higher live weight (4.32 vs. 4.20 kg; $p<0.01$) and intake of milk (773 vs. 722 g/d; $p<0.05$), energy (117 vs. 1,093 kJ/kg $W^{0.75}$/d; $p<0.01$) and N (1,552 vs. 1,462 mg/k $W^{0.75}$/d; $p<0.01$) than the female. Milk consumption and the corresponding milk energy and milk N intake increased linearly up to 5th week of the trial, which, then decreased quadratically up to 9th week i.e., up to the weaning. Overall milk DM intake during this period was 2.58% (range 1.5-3.0%) of live weight or about 36 g/kg $W^{0.75}$/d (range 29-45 g/kg $W^{0.75}$/d). Pre-weaned Black Bengal kids of about 4.5 kg weight, growing at the rate of 60 g weight daily requires at least 750 g milk daily. Daily live weight gain, estimated as the regression between the live weights over time, was 60 g ($r^2=0.99$) and 55 g ($r^2=0.99$), respectively, for the male and female kids. Efficiency of milk energy utilization for weight gain ranged from 0.67 to 0.84 (mean 0.81) for the male kid and 0.75 to 0.91 (mean 0.82) for the female kids. Efficiency of milk protein utilization for weight gain ranged from 0.46 to 0.70 (mean 0.61) for the male kid and 0.51 to 0.81 (mean 0.64) for the female kids. Additional teat-bottle feeding of suckling kids had no significant effect on their growth rate (54 vs. 57 g/d). Average digestibility of milk DM, OM and N was 98.85, 98.99 and 98.69%, respectively and they were slightly ($p>0.05$) higher in the male than the female kids. Results suggest that the requirement of energy and protein and their utilization efficiency in Black Bengal kids is not different from that of the other breeds of goat. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 1 : 39-45)***

Key Words : Black Bengal Goat, Pre-weaned Kids, Milk Feeding

INTRODUCTION

Black Bengal goat is highly prolific, having multiple births in 70% cases (Devendra and Burns, 1983). Generally, they are poor milk producer 108-135 g/d (Husain, 1999). However, selected Black Bengal doe under improved feeding is found to yield 556 g milk daily in a 72 d lactation period (Chowdhury and Faruque, 2001). Dam's milk production has its obvious effect on kid survivability. Chowdhury et al. (2002) showed that the survivability of Black Bengal kid increased from 60% at 150-250 g milk yield daily to 94% at 451-550 g milk yield daily, but it declined again to about 70% at 551-651 g milk yield daily. The later decrease was attributed to overfeeding related diarrhea. It has been suggested that at 2 kg live weight, it requires 200 g milk/kid daily, while at 6-7 kg live weight; it requires 700 g milk daily (Devendra and Burns, 1983). Singh and Sengar (1979) showed that the milk intake of Black Bengal kid during their 1st (1.7 kg), 2nd (2.67 kg) and 3rd (4.13 kg) month of life was 293 (100% milk in diet), 400 (87% milk in diet) and 82 g (19% milk in diet) and the corresponding growth rate was 34, 33 and 38 g/d, respectively. Considering maintenance energy and maintenance protein requirement of 438 kJ metabolizable energy (ME_m) and 2.19 g metabolizable protein (MP_m) per kg $W^{0.75}$/d (AFRC, 1998), 2 kg kids requires 0.921 MJ ME and 3.683 g MP daily at the maintenance level. While 200 g milk can only provide 0.9 MJ 4.31g MP, and ME which can apparently meet the MP_m requirement but not the ME_m requirement. Thus, either assumed AFRC (1998) maintenance requirement values are high or suggested milk requirements are low or both. This uncertainty as far as the concern on milk requirement for pre-weaned kids, especially for Black Bengal kids, needs to be resolved. The present study was thus designed to determine the -

- milk requirement of pre-weaned Black Bengal kids
- effect of additional milk supplementation to suckling;
- apparent digestibility of goat-milk in pre-weaned Black Bengal kids.

MATERIALS AND METHODS

Experimental animals and their management

Dams of the experimental kids were reared under semi-intensive management in the Bangladesh Livestock

* Corresponding Author: S. A. Chowdhury. Tel: +88-2-7708320, Fax: +88-2-7708325, E-mail: aprdblri@accesstel.net
Received September 17, 2002; Accepted September 25, 2003

Table 1. Composition of kid starter used for feeding kids

Ingredient	%
Maize crush	30
Lathyrus sativa crush	16
Wheat bran	25
Soyabean meal	20
Soyabean oil	1
Molasses	5
Dicalcium phosphate	1
Salt	1.5
Vitamin mineral pre-mix	0.5
Total crude protein	20.25
Metabolizable energy (MJ/kg DM)	10.87

Research Institute Goat farm. They were fed according to NRC (1981) and were kept in a wooden-slated floor house. After birth, kids were allowed to stay with their dam for one month and had free access to suckle their dam throughout the day except during the grazing period (9.00 to 12.00 h and 14.00 to 17.00 h). After one month, ten of the thirty kids were allowed to stay with their dam as they used to, while the rest 20 kids were kept separately in individual pen. Dams of the later group of kids were kept in the same house but in separate enclosure. The two groups of kids were then allocated to two different treatments i.e., suckling alone (T1) or suckling along with teat-bottle feeding of milk (T2). Ten kids were allocated for the T1 and 20 kids were allocated for the T2. Kids from T1 were allowed to suckle their dam freely through out the day. It was not possible to quantify the amount of milk suckled by these kids, but live weight was recorded daily. On the other hand, T2 kids were allowed to suckle their dam only at 6:30, 13:00 and 19:00 h of the day and had additional goat milk free of choice through teat-bottle at 11:00 and 16:00 h of the day. Individual kid of T2 group was weighed prior to and immediately after suckling. Difference in weight was taken as the amount of milk suckled. Total milk intake was the sum of suckled milk from dam and that of the teat-bottle. Kids from both groups had free access to a kid starter (Table 1), *Leucaena leucocephela* and *Artocarpus hetrophyllus* leaves and fresh drinking water were offered free of choice. Intake of the solid feed was negligible and was not included here.

Table 2. Average (SE) weekly live weight, intake of milk energy, milk N and live weight gain of black bengal kids of two months old

Parameter	Sex	Weeks on trial									Overall mean
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	
Live weight (kg)	Male	3.13 (0.092)	3.46 (0.090)	3.46 (0.078)	3.76 (0.078)	4.08 (0.078)	4.53 (0.078)	5.01 (0.078)	5.47 (0.078)	5.95 (0.084)	4.32 (0.02)
	Female	2.87 (0.111)	3.28 (0.11)	3.52 (0.102)	3.80 (0.102)	4.08 (0.102)	4.47 (0.102)	4.90 (0.102)	5.18 (0.102)	5.64 (0.110)	4.20 (0.03)
	Significance										p<0.01
Total milk intake (g/d)	Male	592 (23.9)	723 (23.9)	701 (20.7)	818 (20.7)	936 (0.7)	913 (20.7)	884 (20.7)	754 (20.7)	639 (22.4)	773 (7.21)
	Female	514 (29.7)	630 (29.3)	664 (27.1)	820 (27.1)	868 (27.1)	835 (27.1)	790 (27.1)	717 (27.1)	663 (29.3)	722 (9.28)
	Significance										p<0.05
Suckled milk (g/d)	Male	392 (16.6)	485 (16.6)	466 (14.4)	533 (14.4)	549 (14.4)	549 (14.4)	552 (14.4)	498 (14.4)	379 (15.6)	489 (5.02)
	Female	404 (20.4)	460 (20.4)	466 (18.9)	594 (18.9)	571 (18.9)	576 (18.9)	557 (18.9)	514 (18.9)	452 (18.9)	510 (6.45)
	Significance										p<0.01
Milk energy intake (kJ/kg $W^{0.75}$/d)	Male	1,109 (38.9)	1,206 (38.0)	1,239 (32.9)	1,375 (32.9)	1,447 (32.9)	1,296 (32.9)	1,164 (32.9)	942 (32.9)	755 (35.56)	1.170 (11.5)
	Female	1,026 (47.1)	1,097 (46.6)	1,141 (43.1)	1,318 (43.1)	1,309 (43.1)	1,180 (43.1)	1,050 (43.1)	915 (43.1)	803 (46.6)	1.093 (14.8)
	Significance										p<0.01
Milk N intake (mg/kg $W^{0.75}$/d)	Male	1,534 (46.6)	1,654 (45.5)	1,632 (39.37)	1,797 (39.37)	1,904 (39.37)	1,705 (39.37)	1,532 (39.37)	1,232 (39.37)	981 (42.53)	1.552 (13.8)
	Female	1,401 (56.4)	1,495 (55.7)	1,515 (51.6)	1,753 (51.6)	1,743 (51.6)	1,575 (51.6)	1,396 (51.6)	1,215 (55.7)	1,065 (55.7)	1.462 (17.7)
	Significance										p<0.01
Live weight gain (g/d)	Male	45	51	35	39	52	56	52	62	68	51 (4.84)
	Female	44	65	45	42	29	53	73	40	14	45 (4.84)
	Significance										NS

NS: not significant.

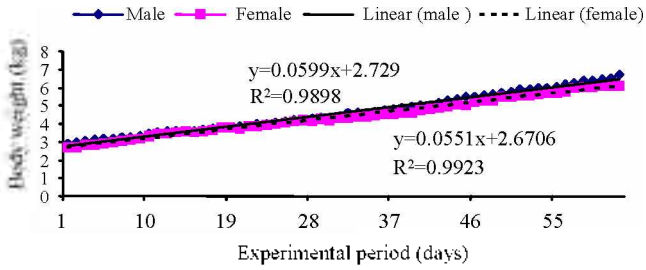

Figure 1. Regression between the live weights vs. time of male and female Black Bengal kids during 2nd-3rd months of their life, maintained on suckling and additional teat-bottle feeding of milk. Each point represents the mean of 12 (male) or 7 (female) kids.

Digestibility of milk diet

Digestibility of milk diet was determined by measuring the total daily faecal nutrient excretion and intake for seven consecutive days in T2 animals. During this time they only had access to milk. Faecal material from 7 d collection and the corresponding milk sample was analyzed for dry matter, organic matter and N according to AOAC (1984).

Estimation of nutrient intake

The net energy (NE) content of milk was estimated according to Tyrrell and Reid (1965) as :

Milk NE (kcal/lb)=41.63×(%fat)+22.29×(%protein)+21.60×(%lactose)-11.72.

The value was then expressed as NE MJ/kg milk. The ME and MP requirement for live weight gain was estimated (AFRC, 1998) as follows :

ME MJ/kg gain=4.972+0.3274W;
Protein (g/kg)=157.22-0.694W

Where, W is the live weight of the animal. The efficiency of ME and MP utilization for live weight gain on milk diet assumed to be 0.7 and 0.59, respectively (AFRC, 1998).

Statistical analysis

Data were analyzed using 'SPSS 9.05 for Windows' statistical package. The effect of sex and age of kids on intake of milk, milk-energy, milk-protein and growth rate was determined by using the following model:

$$Y_{ij}=\mu+\alpha_i+\beta_j+\alpha\beta_{ij}+e_{ij}$$

where, Y_{ij} is the effect of i^{th} sex at j^{th} week on parameter in question, μ is the general mean, α_i is the effect of i^{th} (i=1 (male), 2 (female)) sex of kid, β_j is the effect of j^{th} (j=1, 2, ... 9) week, $\alpha\beta_{ij}$ is the effect of i^{th} sex at j^{th} week and e_{ij} is the random error.

Similar model ($Y_{ij}=\mu+\alpha_i+\beta_j+\alpha\beta_{ij}+e_{ij}$) was also used for

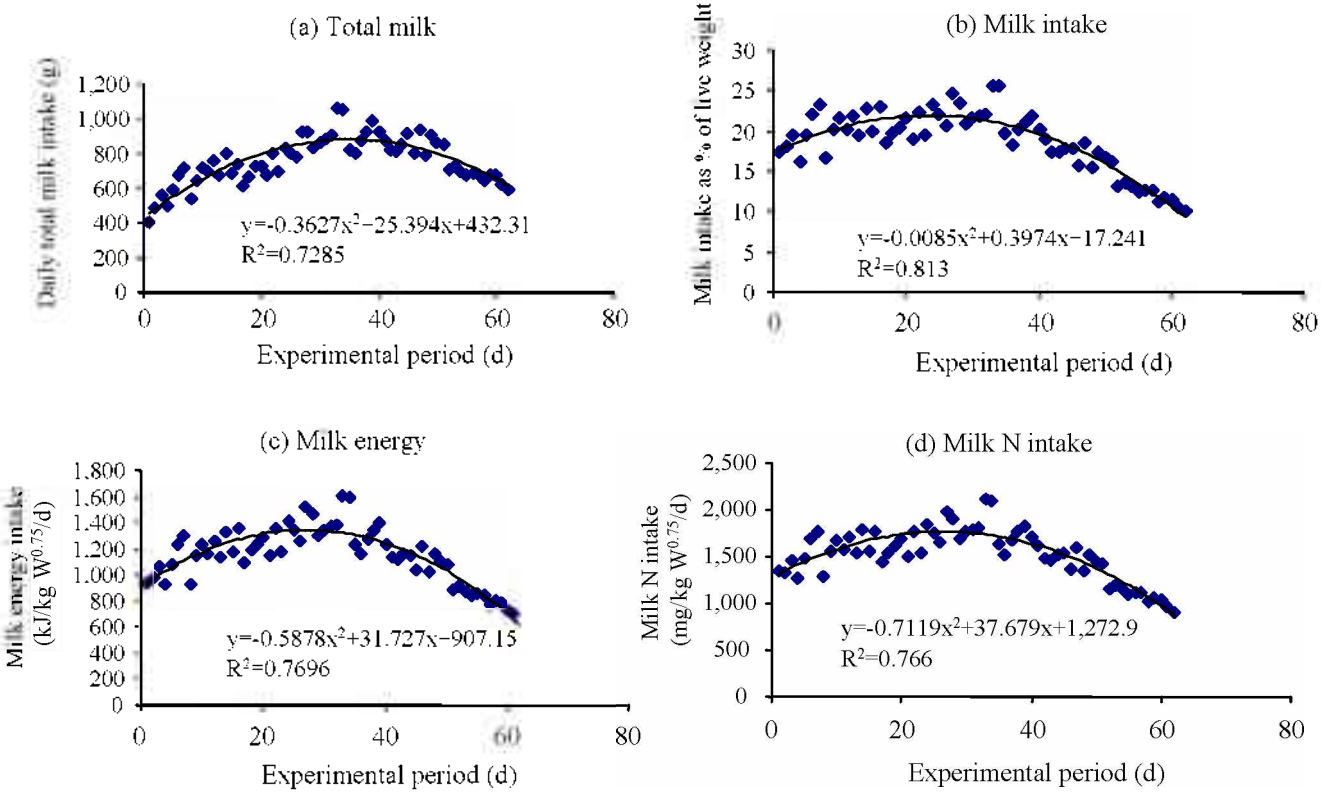

Figure 2. Average (of 19 kids) daily milk (a), milk intake as % of live weight (b), milk energy (c) and milk N (d) intake Black Bengal kids during 2nd to 3rd month of age.

Table 3. Estimated average (SE) maintenance energy requirement and available milk energy for live weight gain for pre-weaned Black Bengal kids of either sex at different weeks

Parameter	Sex	Weeks on trial									Overall mean
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	
ME for maintenance (MJ/d)	Male	1.045 (0.023)	1.185 (0.023)	1.184 (0.020)	1.263 (0.020)	1.345 (0.020)	1.456 (0.020)	1.572 (0.020)	1.679 (0.020)	1.788 (0.022)	1.391 (0.007)
	Female	1.010 (0.029)	1.144 (0.029)	1.207 (0.027)	1.278 (0.027)	1.347 (0.027)	1.441 (0.027)	1.544 (0.027)	1.611 (0.027)	1.716 (0.029)	1.367 (0.009)
	Significance										$p<0.05$
Milk energy available for live weight gain (MJ/d)	Male	1.407 (0.102)	1.839 (0.102)	1.886 (0.088)	2.338 (0.088)	2.754 (0.088)	2.544 (0.088)	2.302 (0.088)	1.646 (0.088)	1.049 (0.095)	1.972 (0.031)
	Female	1.165 (0.125)	1.533 (0.125)	1.684 (0.116)	2.292 (0.116)	2.434 (0.116)	2.185 (0.116)	1.899 (0.116)	1.520 (0.116)	1.185 (0.125)	1.766 (0.040)
	Significance										$p<0.01$
Available milk energy kJ/g of gain	Male	31 (0.51)	36 (0.45)	54 (2.51)	60 (2.26)	53 (1.69)	45 (1.57)	44 (1.69)	27 (1.42)	15 (1.39)	41 (6.36)
	Female	26 (2.84)	28 (1.92)	40 (2.58)	54 (2.76)	83 (4.00)	41 (3.22)	26 (1.59)	38 (3.13)	84 (8.93)	47 (6.36)
	Significance										NS
Efficiency of utilization of milk energy for live weight gain (kJME/kJ gain)	Male	0.78	0.81	0.86	0.87	0.86	0.84	0.84	0.76	0.64	0.81
	Female	0.76	0.73	0.81	0.86	0.90	0.83	0.75	0.82	0.91	0.82
	Significance										NS

Values in the parenthesis indicate SE. [a,b] Values in the same column with different superscripts differ significantly. NS: not significant.

Table 4. Estimated average (SE) maintenance protein requirement and available milk protein for live weight gain for pre-weaned Black Bengal kids of either sex at different weeks

Parameter	Sex	Weeks on trial									Overall mean
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	
MP for maintenance (g/d)	Male	4.87 (0.109)	5.52 (0.109)	5.52 (0.095)	5.89 (0.095)	6.27 (0.095)	6.79 (0.095)	7.32 (0.095)	7.82 (0.095)	8.33 (0.102)	6.48 (0.033)
	Female	4.71 (0.134)	5.33 (0.134)	5.62 (0.124)	5.96 (0.124)	6.28 (0.124)	6.72 (0.124)	7.19 (0.124)	7.51 (0.124)	8.00 (0.134)	6.37 (0.042)
	Significance										$p<0.05$
Milk protein available for growth (g/d)	Male	16.61 (0.825)	20.68 (0.825)	19.89 (0.715)	23.78 (0.715)	27.67 (0.715)	26.32 (0.715)	24.72 (0.715)	19.50 (0.715)	14.82 (0.772)	21.55 (0.249)
	Female	13.93 (1.01)	17.51 (1.01)	18.45 (0.936)	23.77 (0.936)	25.21 (0.936)	23.55 (0.936)	21.43 (0.936)	18.47 (0.936)	16.05 (1.01)	19.82 (0.320)
	Significance										$p<0.01$
Milk protein available mg/g of gain	Male	369 (18.3)	405 (16.2)	568 (20.4)	609 (18.3)	532 (13.8)	470 (12.8)	475 (13.8)	314 (11.5)	218 (11.4)	440 (75.09)
	Female	317 (22.95)	269 (15.54)	442 (20.8)	566 (22.3)	869 (32.3)	444 (17.7)	293 (12.8)	462 (23.4)	1.146 (72.1)	535 (75.09)
	Significance										NS
Efficiency of utilization of milk protein for weight gain (g MP/g gain)	Male	0.59	0.61	0.69	0.70	0.67	0.64	0.65	0.55	0.46	0.61
	Female	0.55	0.51	0.61	0.68	0.77	0.62	0.53	0.64	0.81	0.64
	Significance										NS

Values in the parenthesis indicate SE. [a,b] Values in the same column with different superscripts differ significantly. NS: not significant.

determining the effect of rearing system and age on growth rate of goat. Where, Y_{ij} is the growth rate at i^{th} rearing system at j^{th} month, μ is the general mean, α_i is the effect of i^{th} rearing system (i=1: suckling alone, 2: suckling plus supplemental teat-bottle feeding) of kid, β_j is the effect of j^{th} month (j=1, 2 and 3), $\alpha\beta_{ij}$ is the effect of i^{th} rearing system at j^{th} month and e_{ij} is the random error.

The effect of sex on digestibility of milk following was determined by using the following linear model.

$$Y_i=\mu+\alpha_i+e_i$$

where, Y_i is the parameter in question, μ is the general mean, α_i is the effect of i^{th} sex (i=1 (male), 2 (female)) of kid and e_i is the random error.

Besides, linear or quadratic models were used for expressing the relationship between two variables where appropriate.

RESULTS AND DISCUSSION

Intake of milk

Average (SE) weekly live weight, milk intake and live weight gain of Black Bengal kids are shown in Table 2. During the 1st week male and female kids weighed 3.13 and 2.87 kg and the corresponding daily milk consumption was 592 and 514 g, which were 18.9 and 17.9% of live weight, respectively. At that time, the estimated milk energy intakes of male and female kids were 1,109 kJ/kg $W^{0.75}$/d and 1,026 kJ/kg $W^{0.75}$/d and the corresponding milk N intakes were 1,534 mg/kg $W^{0.75}$/d and 1,401 mg/kg $W^{0.75}$/d, respectively. Live weight of male and female (Figure 1) kids increased linearly with time, but the intake of total milk (Figure 2a), milk energy (Figure 2b) and milk N (Figure 2c) increased quadratically. Up to 5th week (i.e., up to 2nd months of the life), total milk, energy and N intake increased linearly, which then decreased quadirtically towards the end (i.e. in 3rd months of life) of the trial. At 5th week, daily milk consumption were 936 and 868 g, which were 22.9% (3.19% on DM basis) and 21.3% (2.6% on DM basis) of live weight, respectively for the male and female kids. At that time, corresponding milk energy intake was 1,447 kJ/kg $W^{0.75}$/d and 1,309 kJ/kg $W^{0.75}$/d and the milk N intake were 1,904 mg/kg $W^{0.75}$/d and 1,743 mg/kg $W^{0.75}$/d, respectively for the male and female. Overall milk DM intake during this period was 2.58% (range 1.5-3.0%) of live weight or about 36 g/kg $W^{0.75}$/d (range 29-45 g/kg $W^{0.75}$/d). Intake was much higher in this trial than that observed in one and two months old Black Bengal kids of 2.31% of live weight or 26 g/kg $W^{0.75}$/d and 1.66% of live weight or 23 g/kg $W^{0.75}$/d, respectively (Singh and Senger, 1979). However, same authors (Singh and Senger, 1979) reported higher DM intake for the Beetal (2.69% of live weight) and the Barbari (2.76% of live weight) kids at one month of age. As a result, live weight gain, estimated as the regression between the live weight over time, of male 60 g (r^2=0.99; Figure 1) and female 55 g (r^2=0.99; Figure 1) kids was much higher in the present trial than that observed in Black Bengal goat of 33 g/d by Singh and Senger (1979).

Milk nutrient available for maintenance and growth

Milk energy and protein available for maintenance and live weight gain is shown in Table 3 and 4, respectively. Relatively higher live weight of male kids resulted in higher maintenance energy (1.391 MJ/d) and protein (6.48 g/d) requirement for the male than the female (1.367 MJ/d; and 6.37 g/d). However, higher milk intake ensured significantly higher ($p<0.01$) available milk energy and protein for live weight gain in the male (1.972 MJ and 21.55 g) than the female (1.766 MJ and 19.82 g) kids. For each gram of live weight gain, there was 41 and 47 kJ milk energy and 0.44 and 0.54 g milk protein available in the male and female kids, respectively.

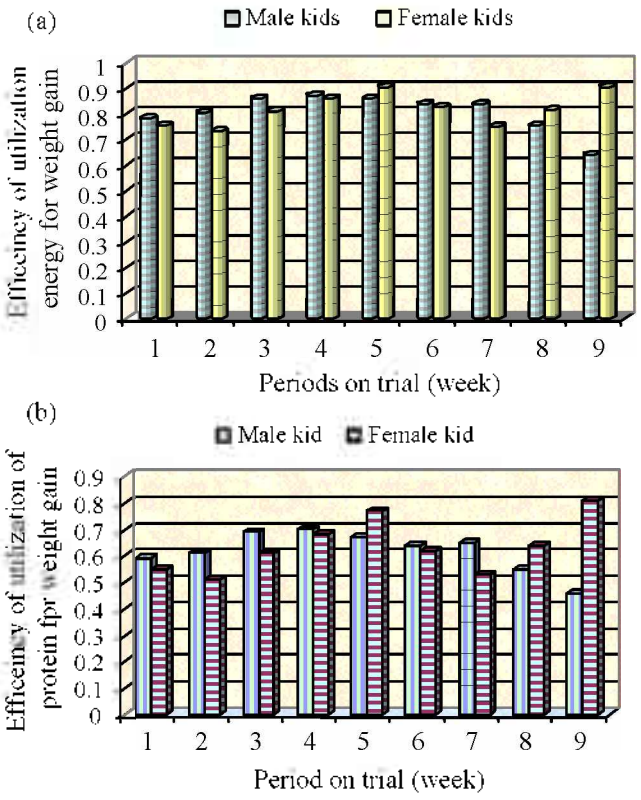

Figure 3. Efficiency of utilization of milk energy (Figure a) and protein (Figure b) for deposition as body tissue of milk-fed pre-weaned Black Bengal kids of either sex.

Assuming maintenance ME requirement of goat-milk fed kids of 470 kJ/kg $W^{0.75}$/d (Jagusch et al., 1983), efficiency of utilization of ME for maintenance of 0.8 (AFRC, 1998), ME cost of each gram of live weight gain of 5.997 kJ (AFRC, 1998) and efficiency of utilization of ME for live weight gain of 0.70 (Jagusch et al., 1983), it can be calculated that a 4.5 kg kid growing at the rate of 60 g/d requires 2.327 MJ milk ME or 517 g milk (4.5 MJ ME/kg milk, AFRC, 1998) daily. Assuming maintenance MP requirement of 2.19 g/kg $W^{0.75}$/d, efficiency of utilization of MP for maintenance of 1.0 (AFRC, 1998), MP requirement for each gram of live weight gain of 0.154g (AFRC, 1998) and efficiency of utilization of MP for live weight gain of 0.59 (AFRC, 1998), it can be calculated that a 4.5 kg kid growing at the rate of 60 g/d requires 22.43 g milk MP or 606 g milk (assuming 3.7% CP in milk) daily.

In the present trial, on an average, kids suckled approximately 750 g (range 514-936 g) milk daily, which is probably enough to support at least 60 g live weight gain daily. Thus, pre-weaned Black Bengal kids of about 4.5 kg weight, growing at the rate of 60 g weight daily require at least 750 g milk daily. This is similar to the suggested milk requirement of 750 g/d for a 6 weeks old Saanen kids

Table 5. Effect of supplemental bottle-feeding on growth rate of pre-weaned kids

Month	Suckling alone		Suckling along with bottle feeding		Significance
	Mean	SE	Mean	SE	
1	58	6.10	64	6.43	NS
2	52	6.1	48	6.43	NS
3	48	6.10	68	6.43	NS
Overall	52	3.52	60	3.71	NS

NS: not significant.

Table 6. Digestibility coefficient of goat milk in pre-weaned black bengal kids

Parameter	Male		Female		Significance
	Mean	SE	Mean	SE	
Dry matter digestibility (%)	98.98	0.122	98.72	0.166	NS
Organic matter digestibility (%)	99.13	0.107	98.86	0.146	NS
N digestibility (%)	98.77	0.130	98.62	0.130	NS
Digestible DM intake (g/d)	128.75	7.846	121.93	10.692	NS
Digestible OM intake (g/d)	121.76	7.408	115.30	10.096	NS
Digestible N intake (g/d)	18.39	1.121	17.42	1.527	NS

NS: not significant.

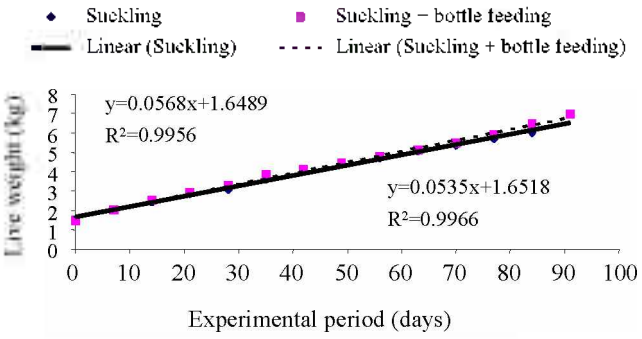

Figure 4. Regression between the live weights vs. time of Black Bengal kids maintained either on suckling alone or suckling along with additional teat-bottle feeding of milk. Each point represents the mean of at least 10 kids.

(Wilkinson and Stark, 1987). This may suggest that nutrient requirement of a pre-weaned Black Bengal kid is not different from that of a Saanen kid although the former is a sub-tropical dwarf type meat breed while the later is a temperate milk breed.

Efficiency of milk energy utilization for live weight gain

Efficiency of utilization of milk energy for live weight gain is shown in Table 3 and Figure 3a. The efficiency was then calculated as (1/(1+X)). Here, X is the proportion of milk energy stored as tissue energy. Efficiency of milk energy utilization for live weight ranged from 0.67 to 0.84 (mean 0.81) for the male kid and 0.75 to 0.91 (mean 0.82) for the female kids. These efficiency values are close to the maximum theoretical energetic efficiency of protein deposition of 0.89 (Chowdhury, 1992). Goat kids either on milk or milk substitute reported to have much lower efficiency of energy utilization ranging from 0.45 (Jagusch et al., 1983) to 0.73 (Sanz Sampelayo et el., 1988). AFRC (1998) adopted a value of 0.70. Prieto et al. (1993) showed that the efficiency of conversion of milk substitute by kids fed *ad libitum* from birth to two-months age were 0.52, 0.66 and 0.76 g of gain per g of milk substitute DM at ambient temperatures of 12, 20 and 30°C, respectively. Within the physiological limit, high ambient temperature apparently has higher efficiency of energy utilization. Experiment reported here was conducted during the dry hot months having average temperature of about 32°C. Higher efficiency observed in the present trial may be related this higher temperature.

Efficiency of milk protein utilization for live weight gain

Efficiency of utilization of milk protein for live weight gain is shown in Table 3 and Figure 3b. The efficiency was calculated as (1/(1+X)). Here, X is the proportion of milk protein stored as body protein. Efficiency of milk protein utilization for live weight ranged from 0.46 to 0.70 (mean 0.61) for the male kid and 0.51 to 0.81 (mean 0.64) for the female kids. Comparable data on efficiency of utilization of milk protein for growth in goat kid is not available. Based on the values for cattle, Morand-Fehr et al. (1987) suggested efficiency of utilization of truly absorbed amino acid-N in young kids of 0.65. However, AFRC (1998) adopted an efficiency value of 0.59, which, is close to the present observation.

Effect of supplemental teat-bottle feeding on growth rate

Growth rate of kids suckling alone or suckling with additional milk from teat-bottle feeding is given in Table 5. Growth rate was non-significantly ($p>0.05$) higher in the supplemental teat-bottle feeding kids than those had suckling alone. Slope of the regression of live weight versus time of kids form suckling alone and those of additional

milk from teat-bottle-feeding were 54 g/d (r^2=0.99; Figure 4) and 57 g/d (r^2=0.99 Figure 4), respectively. Slope of the two regression lines are statistically non-significant ($p<0.05$). Additional milk through bottle-feeding had only marginal effect on the growth rate of kids. This may suggest that, at least under the present experimental conditions, dam had sufficient milk to support the milk requirement of their kid. Average daily milk production of dams of both suckling alone or suckling with additional milk from teat-bottle fed kids was 845 g/d for 96 days of lactation. As mentioned earlier, dams were fed according to NRC (1981) during their pregnancy and lactation, which probably ensured the expression of their milk production potentiality. Teat-bottle feeding under such condition, may result over feeding which may leads to scouring. Genetically Black Bengal goat is a dwarf goat with low growth potentiality (Devendra and Burns, 1983). Consumption of excess milk probably results higher circulating plasma amino acids concentration in kids. In human subject, elevated plasma amino acids concentration inhibit pancreatic secretion (DiMagno et al., 1973; Solomon, 1987). Similar phenomenon might also happen for kids. As a result, large amount of undigested or partially digested casein may escape enzymatic fermentation which may cause scouring due to hind gut fermentation. The requirement of supplemental milk for pre-weaned suckling kids will probably depends on maternal milk production ability, litters size, weight of kid, expected growth rate and ambient temperature.

Digestibility

Digestibility of milk DM, OM and N of male and female kids are shown in Table 6. Digestibilities were slightly ($p>0.05$) higher in the male than the female kids. On an average, digestibility of milk DM, OM and N was 98.85, 98.99 and 98.69%. Singh and Sengar (1979) showed that milk DM digestibility of one-month old pre-weaned black Bengal kids is 93%. Milk DM intake in the former (present trial) and the later was about 27 and 45 g/kg $W^{0.75}$/d, respectively. Digestible nutrient intake is much higher in the present trial than that reported by Singh and Sengar (1979).

Conclusion

Results suggest that the requirement of energy and protein and their utilization efficiency in Black Bengal kids is not different from that of the other breeds of goat. Thus, AFRC (1998) recommended energy and protein requirement could also be used for the Black Bengal kids. Provided, milk availability per kid from suckling is about 750 g/d, additional teat-bottle-feeding is not necessary.

REFERENCES

Agricultural and Food Research Council (AFRC), 1998. The Nutrition of Goats, CAB International, Wallingford, UK.

AOAC. 1984. Official Method of Analysis. Centennial Edition. Association of Official Analytical Chemist, Washington DC.

Chowdhury, S. A. 1992. Protein utilization during energy undernutrition in sheep. Ph.D. Thesis, University of Aberdeen, Aberdeen,UK.

Chowdhury, S. A. and S. Faruque. 2001. Improvement of Black Bengal goat through selective breeding. Research Report Bangladesh Livestock Research Institute, Saver, Dhaka 1341.

Chowdhury, S. A., M. S. A. Bhuiyan and S. Faruk. 2002. Rearing Black Bengal goat under semi-intensive management 1. Physiological and reproductive performances. Asian-Aust J. Anim. Sci. 15(2):477-484.

Devendra, C. and M. Burns. 1983. Goat Production in the Tropics. Commonwealth Agricultural Bureaux, Franham House, Franham Royal, Slough SL2 3BN. UK.

DiMagno, E. P., V. L. W. Go and W. H. J. Summerskill. 1973. Intraluminal and postabsorptive effect of amino acids on pancreatic enzyme secretion. J. Lab. Cli. Med. 82:241-248.

Husain, S. S. 1999. Sustainable genetic improvement of economic traits of Black Bengal goats through selective and cross breeding. Bangla. Agric. Univ. Res. Prog. 10:72-80.

Jagusch, K. T., D. M. Duganzich, G. T. Kidd and S. M. Church. 1983. Efficiency of goat milk utilization by milk-fed kids. New Zealand J. Agric. Res. 26:443-445.

Morand-Fehr, P., D. Sauvant and J. Brun-Bellut. 1987. Recommendations alimentaires pour les caprins. Bulletin Technique, C.R.J.V. Theix, 70:213-222.

NRC. 1981. Nutrient Requirements of Goats: Angora, Dairy and Meat Goats in Temperate and Tropical Countries. National Research Council, No. 15:1-12.

Prieto, C., M. R. Sanz Sampelayo, F. Gil Extremera, J. F. and J. Boza. 1993. Feed intake and performance of pre-ruminant kid goats and lambs at different environmental temperature. In: FAO-CIHEAM-EC meeting on sheep and goat nutrition. Thessalonica, Greece; Aristotle University of Thessaloniki, p. 21.

Sanz Sampelayo, M. R., F. J. Munoz, J. E. Guerrero, F. Gil Extremera and J. Boza. 1988. Energy metabolism of Granadina breed goat kid. Use of milk and milk replacer. J. Anim. Phy. and Anim. Nutrn. 59:1-9.

Singh, S. N. and O. P. S. Sengar. 1979. Studies on combining ability of desirable characteristics of important goat breeds for meat and milk separately and in combination. RBS. Collage, Bichpuri (Agra), UP. India.

Solomon, T. E. 1987. Control of exocrine pancreatic secretion. In: Physiology of Gastrointestinal tract (Second Edition), Raven Press, pp. 1173-1209.

Tyrrell, H. F. and J. T. Reid. 1965. Prediction of the energy value of cow's milk. J. Dairy Sci. 48:1215-1223.

Wilkinson, J. M. and B. A. Stark. 1987. Commercial Goat Production. BSP Professional Books, Oxford, London, UK.