Genetic and Non-genetic Causes of Variation in Gestation Length, Litter Size and Litter Weight in Goats

M. A. Hoque*, M. R. Amin and D. H. Baik[1]

Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

ABSTRACT : This study was made with 631 does of 3 genetic groups and 1,112 of their kids allocated into 3 different locations to examine gestation length, litter size and litter weight in goats. Attributes studied were genetic group, parity, age of dam at kidding, weight of dam at breeding, season and location. Genetic group of dam affected significantly ($p<0.01$) size of litter but not gestation length and weight of litter. Selected Black Bengal (SBB) genetic group performed better in litter size and litter weight than random bred Black Bengal (RBB) and its crossbreds with Jamunapari ♂ (JBB). Litter size and weight were significantly affected by age of dam at kidding ($p<0.01$), weight of dam at service ($p<0.001$) and parity ($p<0001$). Size and weight of litter were found highest in SBB does, or does having 35-40 months of age at kidding, or does with 19-20 kg live weight at service, or at 4th parity. Season, location and parity also affected significantly ($p<0.05$) gestation length. Shortest gestation length was found in 5th parity or in summer season, whereas the longest was in 2nd parity or in winter season. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 6 : 772-776)***

Key Words : Genetic Group, Parity, Litter Biomass, Season, Gestation Length

INTRODUCTION

It is well known that reproductive efficiency is one of the important pre-conditions for increasing production potential in any given environment. In order to evaluate the productive ability of goats, prolificacy and birth weight are considered the most important and economic criteria. Birth weight is strongly correlated with subsequent growth rate and body size and also with kid viability (Morand-Fehr, 1981), and birth weight depends mainly on genotype. Within breeds, kid birth weight is determined by the weight of the dam, sire effect, sex and birth type of kid. Male kids are, generally, 5 to 15% heavier then female kids, while the average birth weight of twins is less then that of single kids (Angelika, 1991). The number of young born alive per kidding is an important factor in increasing productivity as it contributes more to the total weight weaned per dam than the growth rate of the kid (Bradford, 1985). Litter size in goat is affected by parity (Wilson and Light, 1986) and season of birth (Karua, 1989).

Hafez (1993) considered that the genotype of the fetus accounts for almost two thirds of the variations in gestation length of sheep; male lambs are carried longer than female lambs, spring-born lambs longer than fall-born lambs, and singles longer than twins. The gestation length for sheep and goats varies between breeds and individuals. In sheep, the early maturing breeds and the highly prolific breeds have shorter gestation periods than the slow maturing wool breeds. Husain et al. (1995) demonstrated that poor pre-weaning kid survivability could be improved by increasing birth weight of kids. A similar observation was made by Singh et al. (1991) with the conclusion that goats could be selected for higher weaning weight on the basis of their birth weight.

Keeping the above points in mind, this experiment was undertaken to investigate the genetic and non-genetic factors affecting gestation length, litter size and litter weight at birth in goats.

MATERIALS AND METHODS

The experiment was conducted at village goateries replicated at three different locations viz. i) Bangladesh Agricultural University Artificial Insemination (AI) Center (BAU), ii) Dauhakhola AI sub-center (DHK), and Shimla AI sub-center (SHM) in the Mymensingh district during the period from 1997 to 1999. Goats of this experiment were produced from three of parent genetic groups viz. Jamunapari ♂× Black Bengal ♀, selected Black Bengal ♂× selected Black Bengal ♀and random Black Bengal ♂× random Black Bengal ♀. The offspring were designated as JBB, SBB and RBB respectively. Details of the breeding design and selection program can be obtained from Amin et al. (2001). Animals were born, grown and maintained under the typical goat husbandry system prevailing in the country (Husain et al., 1998). They were fed solely on grazing/browsing and managed almost identically. All the does under study were served by the bucks kept in the Breeding Center. Records were kept on gestation period, litter size and weight (bio-mass) at birth, dam's age at kidding and weight at breeding, season of

* Address reprint request to M. A. Hoque. E-mail: azharhoque @hotmail.com

[1] Department of Animal Resources and Biotechnology, Chonbuk National University, Chonju 561-756, Korea.

Received June 5, 2001; Accepted January 14, 2002

mating and parity.

Reproductive records were partitioned according to 3 seasons of the year viz. winter (November-February), summer (March-June) and monsoon (July-October). Birth weights of kids were taken within 6 h after birth. The data of the experimental animals were grouped on the basis of dam's age at kidding viz. A (10-16 months), B (17-22 months), C (23-28 months), D (29-34 months), E (35-40 months), F (41-46 months) and G (47-52 months) and dam's weight at breeding viz. A (9-10 kg), B (11-12 kg), C (13-14 kg), D (15-16 kg), E (17-18 kg), F (19-20 kg) and G (21-22 kg) to see the effect on gestation length, litter size and weight.

Data were analyzed by 'Least Squares Mixed Model and Maximum Likelihood Computer Program' (Harvey, 1990). The analyses of variance were made for all the traits studied to have the variabilities of those parameters in different genetic groups. The general statistical model was:

$$Y_{ijklmno}=\mu+G_i+A_j+W_k+P_l+S_m+L_n+e_{ijklmno}$$

Where, $Y_{ijklmno}$=individual record

μ=general mean

G_i=effect of i-th genetic group (i=1,2,3)

A_j=effect of dam's age at kidding

W_k=effect of dam's weight at breeding

P_l=effect of parity of dam

S_m=effect of season of breeding

L_n=effect of location

$e_{ijklmno}$=residual error

Least Significant Difference (LSD) test was performed to separate means in groups of significant difference according to the method described by Shil and Debnath (1995).

RESULTS AND DISCUSSION

Effect of dam's age at kidding

The means and their standard errors for gestation period, litter size and litter weight according to dam's age group are presented in table 1. Dam's age group had a significant effect on litter size ($p<0.001$) and litter weight ($p<0.01$) but had no significant effect on gestation period. Among the different age groups of dam, the highest litter size (2.20) and litter weight (2.39 kg) were observed in E (35-40 months of age) group. In contrast, Hafez (1993) reported that gestation length of goats increases with age of dam.

Effect of genetic group

Litter size increased ($p<0.01$) when Black Bengal was selected within breed for heavier live weight but decreased when crossed in random bred Black Bengal and with Jamunapari, but dam's genetic group had no significant effect on gestation period and litter weight (table 2). Dickson et al. (2000) observed gestation length to be affected ($p<0.01$) by breed type among Alpine and Nubian, while Mourad (1996) found that gestation length did not differ between dam genotypes in Egypt local and Alpine. Average litter size in Black Bengal does of this study appears to be smaller than those (2.09 in India and 2.31 in Bangladesh) cited by Devendra (1985), larger than the report (1.4) of Devendra and Burns (1983) and close to Husain (1993). Selection for heavier live weight increased litter size in the present study and this may be due to positive heterosis and maternal effect. Results of the present experiment, indicate that selection within Black Bengal goats augmented litter size and weight but did not affect gestation length.

Effect of dam's weight at breeding

Table 3 shows that the weight group of dam at breeding did not have a significant effect on gestation period and litter weight but affected ($p<0.01$) litter size and litter weight. Size (2.24) and weight (2.89 kg) of litter was found highest in does having 19-20 kg and 21-22 kg weight at breeding, respectively. Saithanoo et al. (1988) found that reproductive rate, particularly multiple births, was moderately heritable and genetically correlated with dam's live weight.

Effect of parity

Gestation period ($p<0.05$) of dam, litter size ($p<0.001$) and litter weight ($p<0.001$) of kids were significantly affected by different parity (table 4). As regards to parity, maximum and minimum litter size and weight were found in kids of 4th parity and 1st parity, respectively. Second parity required longest gestation period followed by 1st, 3rd, 4th, 5th and 6th parity. Husain et al. (1996) noticed that of the four parities, kid's birth weight was lower in 1st parity does compared to 2nd, 3rd and 4th parity. Similarly it was concluded that parity significantly ($p<0.01$) affected litter size (Kale and Tomer, 1999 and Mourad, 1996) and litter weight (Garci et al., 1996). Abdelsalam et al. (1997) also noticed that 4th parity does gave birth to the heaviest litters out of 5 parities, which supports the present findings. Litter weight of does increased with increasing parity, which might cause an increase in the birth weight of their kids in 3rd, 4th and 5th parity.

Effect of season

Season of breeding influenced ($p<0.05$) gestation period but did not affect litter size and litter weight (table 5). Does inseminated in winter and summer showed longest (145.7 and 146.1 days, respectively) gestation period followed by monsoon (145.0 days). Dickson et al. (2000) conducted an experiment with Alpine and Nubian goat for the period of 1989 to 1994 and found that litter size was affected ($p<0.01$) by breed and year of kidding. Ageeb (1992) reported that there was a significant correlation between

Table 1. Effect of dam's age on gestation period, litter size and litter weight

Dam's age (months)	No. of observations	Parameter		
		Gestation period (days)	Litter size	Litter weight (kg)
10-16	232	145.2	1.64^{b}	1.82^{b}
17-22	105	145.4	1.67^{b}	1.78^{b}
23-28	97	145.8	1.78^{ab}	2.04^{ab}
29-34	68	145.1	1.96^{ab}	2.11^{ab}
35-40	30	145.3	2.20^{a}	2.39^{a}
41-46	32	145.7	1.90^{ab}	2.15^{a}
47-52	28	145.0	1.86^{ab}	2.12^{ab}
Level of significance		NS	***	**

Means with different superscript (s) in the column differ significantly.
NS, **, *** Means non-significant, $p<0.01$, $p<0.001$, respectively.

Table 2. Effect of dam's genotype on gestation period, litter size and litter weight

Genotype	No. of observations	Parameter		
		Gestation period (days)	Litter size	Litter weight (kg)
RBB	192	145.6	1.80^{a}	2.05
SBB	288	145.4	1.83^{a}	2.16
JBB	241	145.3	1.62^{b}	2.04
Level of significance		NS	**	NS

Means with different superscript (s) in the column differ significantly.
NS, ** Means non-significant and $p<0.01$, respectively.

Table 3. Effect of dam's weight on gestation period, litter size and litter weight

Dam's weight (kg)	No. of observations	Parameter		
		Gestation period (days)	Litter size	Litter weight (kg)
9-10	145	145.4	1.57^{b}	1.59^{b}
11-12	122	145.3	1.68^{b}	1.77^{b}
13-14	119	145.2	1.71^{b}	1.97^{ab}
15-16	83	145.6	1.87^{ab}	2.14^{ab}
17-18	58	145.3	1.95^{ab}	2.02^{ab}
19-20	34	145.5	2.24^{a}	2.42^{a}
21-22	14	145.0	1.93^{ab}	2.89^{a}
Level of significance		NS	**	**

Means with different superscript (s) in the column differ significantly.
NS, ** Means non-significant and $p<0.01$, respectively.

Table 4. Effect of parity on gestation period, litter size and litter weight

Parity order	No. of observations	Parameter		
		Gestation period (days)	Litter size	Litter weight (kg)
1	329	145.2^{a}	1.64^{b}	1.84^{b}
2	155	148.0^{b}	1.74^{b}	1.96^{b}
3	95	145.4^{a}	2.03^{a}	2.01^{ab}
4	25	145.5^{a}	2.28^{a}	2.40^{a}
5	17	144.9^{a}	2.00^{a}	2.34^{a}
6	10	145.5^{ab}	1.80^{ab}	2.28^{a}
Level of significance		*	***	***

Means with different superscript (s) in the column differ significantly.
NS, * , *** Means non-significant, $p<0.05$, $p<0.001$, respectively.

Table 5. Effect of season on gestation period, litter size and litter weight

Season of mating	No. of observations	Parameter		
		Gestation period (days)	Litter size	Litter weight (kg)
Winter	302	145.7[b]	1.76	1.90
Summer	217	146.1[b]	1.75	2.01
Monsoon	112	144.0[a]	1.78	2.01
Level of significance		*	NS	NS

Means with different superscript (s) in the column differ significantly.
NS, * Means non-significant p<0.05, respectively.

Table 6. Effect of location on gestation period. litter size and litter weight

Location	No. of observations	Parameter		
		Gestation period (days)	Litter size	Litter weight (kg)
BAU	444	145.0[a]	1.77	2.10[a]
DHK	90	145.4[ab]	1.66	1.67[b]
SHM	97	147.0[b]	1.79	1.61[b]
Level of significance		*	NS	**

Means with different superscript (s) in the column differ significantly.
NS, *, ** Means non-significant, significant p<0.05, p<0.01, respectively.

litter size and season of birth and also noted that litter weight was significantly affected (p<0.05) by year and litter size. Garci et al. (1996) reported that season of birth had a significant effect on litter weight of kids. Amoah et al. (1996) mentioned that December and January matings of goats of 7 breeds in USA had the shortest gestation length compared to other months of the year.

Effect of location

In the present study location effect on gestation period (p<0.05) and litter weight (p<0.01) was significant but non-significant on litter size (table 5). From table 5, it has been observed that shortest gestation length (145 days) and highest litter weight were found in BAU. However. Horst and Husian (1991) noted that meat type goats have the highest litter size (>2.0) and that most of the dual type goats varied between 1.5 to 2.5 in tropical dry and humid areas.

CONCLUSION

Superiority in litter size and weight of SBB to JBB and RBB signifies that within breed selection for heavier mature weight resulted in larger and heavier litters. Gestation period in goats is very consistent in different genetic groups but is slightly varied by the effects of parity of dam, season of mating and location. Attempts should be made to improve dam's body weight at breeding. which will certainly help to improve the prolifiacy and birth weight of kids.

REFERENCES

Abdelsalam, M. M., A. S. Heider, N. M. Abdelaziz and M. Eissa. 1997. Alexandria J. Agric. Res. 42(3):21-32.

Aegelika, S. 1991. Husbandry and kid raising methods. In: Goat Husbandry and Breeding in the Tropics. International Seminar carried out by German Foundation for International Development. University of Malaya, Kualalampur. pp. 151-161.

Ageeb, A. A. 1992. Production and reproduction characteristics of a flock of Baggara goats of South Kordofan, Sudan. Sudan J. Anim. Prod. 5:1-24.

Amin, M. R., S. S. Husain, A. B. M. M. Islam and M. Saadullah. 2001. Direct selection response to growth and correlated response to lactational traits in Black Bengal goats. Asian-Aust. J. Anim. Sci. 14:899-904.

Amoah, E. A., S. Gelaye, P. Guthrie and C. E. J. Rexroad. 1996. Breeding season and aspects of reproduction of female goats. J. Anim. Sci. 74:723-728.

Bradford, G. E. 1985. Selection for litter size. J. Anim. Sci. 49:66-74.

Devendra, C. 1985. Profilic breeds of goats. In: Genetics of Reproduction in Sheep (Ed. R. B. Land and D. W. Robinson). Butterworths, London. pp. 69-80.

Devenrda, C. and M. Burns. 1983. Goat production in the tropics. Commonwealth Agricultural Bureaux, Farnham Royal, UK.

Dickson, U. L., G. H. Torres, C. P. Becerril, F. C. Gonzalez, M. A. Osorio and O. B. Garcia. 2000. Comparison of Alpine and Nubian goats for some reproductive traits under dry tropical conditions. Small Rumin. Res. 36:91-95.

Garci, B. O., B. E. Garci, J. Bravo and B. Kennedy. 1996. Analysis of a crossbreeding trial with Criollo and imported goats. 2. Litter weight. Revista de la Facultad de Agronomia, Universidad del Zulia. 13:417-428.

Hafez, 1993. Reproduction in Farm Animals. 6th Edition. Lea and Febige. Philadelphia. USA. pp. 320-321.

Harvey, W. R. 1990. Mixed Model Least-Squares and Maximum Likelihood Computer Program PC-2 Version. Mimeograph. Ohio State University, Ohio, USA.

Horst, P. and S. S. Husain. 1991. Animal genetic resources. In: Goat Husbandry and Breeding in the Tropics. International Seminar carried out by German Foundation for International Development. University of Malaya, KualaLumpur. p. 141.

Husain, S. S. 1993. A study on the productive performance and genetic potentials of Black Bengal goats. Ph.D. thesis. Bangladesh Agricultural University, Mymensingh, Bangladesh.

Husain, S. S., P. Horst and A. B. M. M. Islam. 1995. Effect of different factors on pre-weaning survivability of Black Bengal kids. Small Rum. Res. 18:1-5.

Husain, S. S., P. Horst and A. B. M. M. Islam. 1996. Study on the growth performance of Black Bengal goats in different periods. Small Rumin. Res. 21:165-171.

Husain, S. S., M. R. Amin and A. B. M. M. Islam 1998. Goat production and its breeding strategy in Bangladesh. Proc. 1st National Workshop on Animal Breeding. Bangladesh Agricultural University, Mymensingh pp. 17-34.

Kale, M. M. and O. S. Tomer. 1999. Reproductive performance of crossbred goat flock under stall-fed conditions. Indian J. Small Rumin. Res. 5(1):20-24.

Karua, S. A. 1989. Some performance indicators os Malawi indigenous goats under village and ranch conditions. African Small Rumin. Res. Devel. 12:243-249.

Morand-Fehr, P. 1981. Goat Production, (Ed. C. Gall). Academic Press, London. p. 124.

Mourad, M. 1996. Estimation of repeatability of litter size of common African goats and crosses with Alpine in Rwanda. Small Rumin. Res. 19:263-266.

Saithanoo, S., B. J. Restall and W. A. Pallie. 1988. The relationships between reproduction rate and production traits of Australian Cashmere goats. Prodeedings of the Australian Association of Animal Breeding and Genetics. 7:528-531.

Shil, R. N. and S. C. Debnath. 1995. An introduction to the theory of statistics. Bangladesh Agricultural University, Mymensingh, Bangladesh. p. 286.

Singh, D. K., C. S. P. Singh and H. R. Misra. 1991. Factors affecting growth of Black Bengal and its crossbreds with Jamunapari and Beetal goats. Indian J. Anim. Sci. 61:1101-1105.

Wilson, R. T. and D. Light 1986. Livestock production in central traditionally managed goats and sheep. J. Anim. Sci. 62:557-567.