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Reproduction Traits in the Korean Native Goat Doe

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ABSTRACT

The aim of this review is to give insight into the reproduction potential of the Korean native goat(KNG) doe. The mean age of the first estrus in the KNG doe is 141.24±18.17 days. The length of the estrous cycle was recorded as being 20.58±2.63 days, with the mean duration of estrous period being 17.8±7.3 to 32.9±1.2 h, and the duration of the post-partum anestrous period being 13.4(9 to 18) to 30.1±3.8 days in the KNG doe. The ages at first delivery are 10 to 12 months(56.3%) in the KNG doe. The KNG does are no restricted breeding season, because estrus and kiddings are observed throughout the year. The mean gestation period of the KNG doe is recorded as being 150.69±6.14 days with parities having no significant effect on gestation length. The mean interval between parturitions in the KNG doe is 207.78±1.72 days with parities and birth type having no significant effect on kidding intervals. The mean litter sizes at birth in the KNG doe are 1.69±0.03 heads, and litter size at birth was affected ($P<0.05$) by parity.

The mean birth weight of kid in the KNG is 2.04±0.30 kg with a variety as being 2.28±0.26, 2.11±0.30 and 1.64±0.19 kg for singles, twins and triplets over of birth type, respectively. The mean mortality of 635 kids in the KNG is 23±1 % with a variety as being 28±3, 21±2, 16±3 and 46±15 % for singles, twins, triplets and quadruplets of birth type, respectively.

(Key words : Estrus, Breeding season, Litter size, Kidding interval, Mortality)

Ⅰ. INTRODUCTION

Korean native goat(*Capra hircus coreanae*, KNG), the black goat, is the only indigenous breed in Korea and the population is about 500,000 in about 50,000 farms, and comprises the majority of small ruminant herd of the country(the Ministry of Agriculture and Forestry, 2003).

Reproduction is a major contributing factor to efficiency of meat production and makes an important contribution by a) influencing the number of surplus animals which may be utilized for meat and b) contributing to current and future production through culling (Shelton, 1978).

The level of reproductive performance is dependent on the interaction of genetic and environmental factors, but this performance is particularly susceptible to the latter, for example, the seasonal availability of nutrients can affect reproduction considerably(Riera, 1982). Although indigenous goat breeds have an excellent ability to accommodate and adapt to fluctuation in environment, this often involves some degree of reproductive failure(De-

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vendra and Burns, 1983).

Reproduction efficiency in female goat is determined by many different processes. These processes include, for example, the lenght of the breeding season, cyclic activity, ovulation rate, fertilization rate, the post-partum anestrous period and the growth and viability of the offspring. Reproductive efficiency as such can be measured and expressed as the kidding rate, weaning rate, kidding interval, live weight of kids born or weaned and the length of the reproductive cycle(Greyling, 1988; 2000). The KNG is the most prolific of all domestic ruminant in Korea and are able to breed throughout the year(Kang, 1975 ; Kim and Chung, 1979 ; Song et al., 2000a).

One of the most favourable attributes of the KNG as a meat producing animal, is its high rate of reproduction and the fact that it has an extended breeding, especially as reproduction is a major contributing factor to the efficiency of meat production(Naude and Hofmeyr, 1981). However, in order to determine the reproductive and productive potential of the KNG, a through knowledge of the reproduction physiology is essential. This review thus concentrates on reproductive aspects relevant to the KNG doe.

Ⅱ. PUBERTY

Puberty can be defined in several ways. For the purpose of the present review, it is considered as the age of the female at which estrus, pregnancy and delivery is first detected. The age of the first estrus in the KNG doe is 141.24±18.17 days with a short (<121 days) and long(≥176 days) ages (Song et al., 2000a) and 5 to 6 months(Kang, 1975). The age of the first pregnancy in the KNG doe is 8.0±2.7 months with a short(<6 months) and long(>12 months) ages(Kim and Chung, 1979). The age of the first delivery in the KNG doe is 10 to 12 months with a short(<8 months) and long(>18 months) ages(Song et al., 2000a; Song, 2002).

This age at puberty is somewhat earlier than in the Saanen(217.9 days), Angora(240 days), Black Bengal(196.5 days), Barbari nannis(213 days) and Boer goat(157.2~191.1 days) (Riera, 1982 ; Amoah and Bryant, 1984 ; Bhattacharyya et al., 1984 ; Greyling, 1988). Most goats reach puberty at a relatively young age(Shelton, 1978). Although there are considerable differences between genotypes, the sexes should be separated by or before 5 months of age. Puberty of goat is very dependent upon the season of birth and nutrition(Foote et al., 1970 ; Delgadillo and Malpaux, 1996 ; Walkden Brown and Restall, 1996; Walkden-Brown and Bocquier, 2000).

Ⅲ. THE ESTROUS CYCLE AND ESTROUS PERIOD

Few data on the length of the estrous cycles, the duration of the estrous period and return to first estrus in the KNG doe summalized in Table 1.

The duration of the estrous cycle in the mature KNG doe is 20.58±2.63 days with a high incidence of short(<17 days) and long(>25 days) cycles. The frequency of short(<17 days) and long (>25 days) cycles in KNG doe has been recorded as being 31.0 and 19.0%, respectively (Song et al., 1984b; Park, 1986). Many workers have observed cycles which differ significantly form this but generally have considered these abnormal and exprainable on some basis other than genetic variance in cycle length (Shelton, 1978). This variation in estrous cycle length could be related to the season of the year, breeds, nutritions and stage post-partum (Greyling, 2000).

The mean duration of the natural estrous period in the mature KNG doe is 17.83±7.34 h, with a variation 10 to 32 h between individuals(Song et

Table 1. Length of estrous cycle, duration of estrous period and return to first estrus in the KNG doe

	Period	Reference
Length of estrous cycle (day)	21.2±1.4 short(<18) : 30.6% normal(19~24) : 50% long(>25) : 19.4	Song et al., 1984b
	20.58±6.3 short(<17) : 5% normal(18~24) : 90% long(>25) : 5%	Song et al., 2000a
Duration of estrous period (hours)	21.6±4.2	Song et al., 1984a
	32.9±1.2	Song et al., 1984b
	32.5±3.3	Park et al., 1991
	17.83±7.34	Song et al., 2000a
Return to first estrus (days)	13.4(9~18)	Kang, 1975
	30.1±3.8	Song et al., 1984a
	24.9±3.1	Park et al., 1991

al., 2000a). Song et al. (1984a) found that the estrous period of the KNG doe is 32.9±1.2 h. The duration of the estrous period in the KNG doe appears to be variable in length, but in line with the common duration of estrus reported in goats of 36 h(Pillips et al., 1943 ; Bliss, 1980), with a variation of between 22 and 60 h(Riera, 1982), and 10 h(Gonzalez and Madrid, 1982) and 192 h (Simplicio et al., 1982). The length of estrous period appears to be highly variable, but this may more nearly represent interpretational differences since estrus is not easily defined (Shelton, 1978). This variation in estrous cycle length could be related to the season of the year, breeds, nutritions and stage post-partum(Chiboka et al., 1988 ; Greyling, 2000).

The interval between parturition and the first post-partum estrus is an important trait which contributes to the productive efficiency. The mean duration of post-partum anestrous period in the KNG doe is quoted as being 13.4(9 to 18) days(Kang, 1975), 30.1±3.8 days(Song et al., 1984b) and 24.9 ±3.1 days(Park et al., 1991). This duration of return to first estrus is somewhat earlier than in the Creole goats(70 days) and Boar goats (55.5±24.9 days) (Chemineau, 1983 ; Greyling, 1988). According to Riera(1982), this interval varies among goat breeders, lactational status and nutrition. Resumption of cyclic activity in the goat is very susceptible to external factors, such as season, suckling and a factor that also has a role to play, is the presence of the male.

Ⅳ. AGE AT FIRST KIDDING

While puberty in the KNG doe begins at about 5 months of age, pregnancies at such an early age would affect growth and irreversibly impair future performance(Song et al., 2000b). This is of particular importance with goats of autochthonous breeds of Korea raised under extensive range conditions and which have very low weight first estrus. Some observation on age at first breeding is compiled in Table 2. The ages of first delivery in the KNG doe are 10 to 12 months(56.3%) with a

Table 2. Ages of first delivery in the KNG doe

Age groups (month)	No (%) of goat observed		
	Song et al. (2000a)	Song (2002)	Total
8 below	5	1	6 (1.9)
8	9	4	13 (4.8)
9	8	17	25 (7.7)
10	16	25	41 (12.7)
11	15	61	76 (23.5)
12	20	45	65 (20.1)
13	8	28	36 (11.1)
14	9	23	32 (9.9)
15	3	9	12 (3.7)
16	1	6	7 (2.2)
17	2	2	4 (1.2)
18 over	2	5	7 (2.2)
Total	98	225	324(100)

short(<8 months; 14.4%) and long(>18 months; 30.3%) ages. Kim and Chung(1979) reported that the age for first breeding is 8.0±2.7 months with a short (<6 months) and long (>12 months) ages.

Ribeiro et al. (2000) reported that the mean age at first kidding was 402.28±19.14 days(13.4 months) with the youngest doe(252 days) and the oldest (732 days), and similar to values reported by Galina et al. (1995). However, it was lower than that obtained for the majority of the references consulted, which estimate means around 20 months of age (Wilson et al., 1989). This may be due to lower growth rate, as doe which were born as twins, with lighter birth weights and slower growth rate, kidded about 1 month later than their single born sisters (Ali et al., 1975 ; Vohradsky and Sada, 1978).

V. SEASONALITY OF REPRODUCTION

Seasonal fluctuations in daylight length and temperature are important factors affecting the length of the breeding season (Chemineau, 1983). The goat, like many other animals, shows a seasonal cycle in reproductive activity generally relating to the length of the photoperiod (Bissonnate, 1941 ; Phillips et al., 1943). In goats, breeding season usually commences as the days become shorter. There is evidence to indicate that the pineal gland, through its secretion of melatonin is involved in mediating the effects of photoperiod on gonadal function (Hafez, 1974). One characteristic often recorded and which is a good index of seasonal reproductive activity, is the interval between kidding rate and the latitude of the area where the goats are raised (Delgadillo and Malpaux, 1996). Reproductive efficiency in the female is thus greatly determined by this seasonality (length of the breeding season).

Indeed in Korea, estrus and kiddings are observed throughout the year (Table 3). In the KNG does, the sexual activity for all the months of the year were significantly higher than that observed in January observed by estrus, with these months not being significantly different from one another(Kim and Chung, 1979 ; Song et al., 1984a). In the KNG does, the parturition for all the months of the year were significantly higher than that observed in August and September observed by kidding, with these months not being significantly different from one another(Kim and Chung, 1979 ; Song et al., 2000a). KNG does may tend to show estrus and kiddings the year i.e., there is no restricted breeding season. Natural breeding programs with the KNG does must be executed taking into account the peak natural sexual activity of the animals for optimal reproductive performance.

VI. THE GESTATION PERIOD

The gestation periods for the KNG doe is record as being 148.5 days(Lee et al., 1973), 146.0 days

Table 3. Monthly distribution of estrus and parturition in the KNG doe

Month	Estrus head (%)		Parturition head (%)	
	Kim and Chung (1979)	Song et al. (1984a)	Kim and Chung (1979)	Song et al. (2000a)
January	7 (1.8)	15/ 15 (100)	20 (7.4)	32 (9.8)
February	12 (3.0)	16/ 17 (94)	43 (15.8)	30 (9.2)
March	11 (2.8)	10/ 14 (71)	61 (22.5)	17 (5.2)
April	34 (8.6)	9/ 14 (64)	46 (17.0)	35 (10.8)
May	47 (11.9)	11/ 19 (58)	28 (10.3)	46 (14.2)
June	38 (9.6)	12/ 18 (67)	11 (4.1)	24 (7.4)
July	62 (15.7)	4/ 18 (22)	15 (5.5)	24 (7.4)
August	73 (18.4)	3/ 18 (17)	4 (1.5)	8 (2.5)
September	51 (12.9)	13/ 17 (76)	6 (2.2)	4 (1.5)
October	31 (7.8)	15/ 15 (100)	3 (1.1)	42 (12.9)
November	14 (3.5)	15/ 15 (100)	14 (5.2)	39 (12.0)
December	14 (4.0)	16/ 16 (100)	20 (7.4)	24 (7.4)
Total	396 (100)	139/196 (70.9)	271 (100)	325 (100)

(Kang, 1975) and 153.0(145 to 158) days(Na et al., 1987). The mean gestation period for the KNG doe is recorded as being 150.69 ±6.14 days, with the duration being 152.90±10.0, 148.11±4.35, 151.4 ±5.7, 150.33±4.27, 150.15±5.94, 151.13±3.14, 150.88±3.14 and 150.20±2.95 days for does bearing 1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th parities, respectively(Song et al., 2000a). The gestation period for the first delivery is 152.9±10.0 days and its was significantly longer than that observed in all parity.

Asdell(1926) reported that the gestation period of goat is 150.8(147 to 155) days and the large breeders are higher than small breeders of goats. The gestation period normally is 149 days (Shelton, 1961). Ricordeau (1981) reported that the gestation period of goat is 143 to 153 days with a variation by breeds. This appears to be standard throughout most breeds, but Ali et al. (1975) reported that the mean gestation length in the Black Bengal breed was 143 days. The Black Bengal is one of the smaller breeds of goats, and it is not clear if this shorter gestation is common to all breeds. There was no significant difference in the gestation length between does bearing parity and the season of mating had no significant effect in the gestation length(Greyling, 1988). The influence of nutrition on fetal development during certain months of pregnancy does tend to shorten or lengthen the gestation period, but the variation due to this factor was only 1.5 days(Riera, 1982).

Ⅶ. INTERVAL BETWEEN PARTURITIONS

The number of parturition during the lifetime of a goat determined by longevity and the interval between kiddings is of great importance for the economics of production.

Song et al.(1998) reported that the kidding intervals ranged from 162 to 354 days and its mean is 207.78±1.72 days with parities and birth types

having no significant effect on kidding intervals in the KNG does(Table 4). Mean kidding interval of 207.78±1.72 days was considerably lower than 8.7 ±2.5, 9.9±3.3 and 10.7±3.2 months in parities of the 1st to 2nd, 2nd to 3rd and 3rd to 4th in the KNG does, respectively (Kim and Chung, 1979), and all estimates in literature for the other breeders(Ricodeau, 1981; Odubote, 1992, 1996; De Lucas et al., 1996a,b; Silva et al., 1998; Ebozoje and Ikeobi, 1998; Ribeiro et al., 2000).

Low kidding intervals has been associated with a free mating system. KNG doe is maintained under free ranging conditions in which controlled mating are not possible. Thus, the mating system may approach random mating. However, to the extent that only one breed is prevalent in a general area, it also might be considered as purebreeding. KNG does may tend to show estrus throughout the year. i.e., there is no restricted breeding season (Kim and Chung, 1979). Some cases of repeat breeders and abortions were observed in the flock.

The effect($p<0.05$) of season of birth could be attributed to the sexual activity of the does which tends to be highest in the autumn and winter of the days become shorter, and often declines in spring and summer of the days become longer(Na, 1987). Significant differences of kidding intervals by season could be explained from lactation length, which determined month of parturition, because weak or strong ovarian activity was determined in the beginning of the year(Galina et al., 1995; Walkden Brown and Restall., 1996; Silva et al., 1998). There was a significant increase in the kidding intervals from 1995 to 1997. It could, however, be observed that kidding intervals between 1993 and 1994 were lower($p<0.05$) than for 1995(Table 4). This may be traced to changes in management practices such as, culling of does for poor litter size. Efforts should be made to increase kidding intervals by changes in management restrictions, especially re-breeding intervals (Odubote, 1996). The trend of the effect of parity of birth and type of birth on kidding intervals is not clear.

Ⅶ. NUMBER OF KIDDING

Song et al.(1998) reported that the birth ratio of the KNG does was 102(2.4%) : 277(63.5%) : 21 (11.7%) : 6(1.4%) for singles, twin, triplets and quadruplets, respectively (Table 4) and compared favorably with reports which it was 132(35.3%), 173(46.3%), 58(15.5%), and 11(2.9%) for the single, twins, triplets and quadruplets, respectively (Kim and Chung, 1979). The percentage of singletons, twins, triplets and quadruplets born in Boer goat are reported as being 24.5, 59.2, 15.3 and 1%, respectively(Campbell, 1994). Nevertheless, Boer goat does can be considered as being one of the more prolific goat breed in the world.

Mean litter size at birth of 1.69 heads (Table 4) compared favorably with reports of other workers for the KNG does (Kim and Chung, 1979) and for the other breeders(Ricordeau, 1981; Odubote, 1996). In general, except for the Angora, kidding rates are reasonably high for most breeds in good condition with the Anglo Nubian having one of the highest kidding rates of the breeds which are distributed widely (Shelton, 1978). Litter size at birth was affected($p<0.05$) by year of birth and parity, first kidding being the smallest(Song et al, 1998).

The trend of the effect of season on litter size at birth is not clear. These results were similar to those published by other workers(Galina et al., 1995; Odubote, 1996; Silva et al., 1998). There seems to be a general increase in litter size at birth as parity progresses up till the eighth parity. This may be due to improved efficiency of reproduction and rearing as the doe matures(Lavasseur and Thibault, 1980). Secondly, since 1992, the management system permitted culling of does with small litters

Table 4. Least squares means for kidding interval, and littrer size at birth and weaning in the KNG doe

Variable	N	Kidding interval (days)	Litter size (heads) at		
			N	Birth	Weaning
Overall mean	436	207.78 ± 1.75	635	1.69 ± 0.03	1.31 ± 0.03
Season of birth					
Spring	113	192.12 ± 2.86 [b]	181	1.66 ± 0.05	1.29 ± 0.06
Summer	91	197.12 ± 3.41 [b]	107	1.76 ± 0.06	1.39 ± 0.08
Autumn	9	218.03 ± 3.47 [a]	148	1.66 ± 0.05	1.26 ± 0.06
Winter	139	220.63 ± 3.12 [a]	199	1.71 ± 0.05	1.33 ± 0.06
Year of birth					
91			14	1.21 ± 0.11 [b]	0.93 ± 0.16
92	29	204.24 ± 7.22 [ac]	46	1.74 ± 0.09 [a]	1.36 ± 0.10
93	45	196.96 ± 5.10 [b]	78	1.59 ± 0.06 [ab]	1.15 ± 0.08
94	87	199.63 ± 3.18 [b]	115	1.83 ± 0.07 [a]	1.33 ± 0.08
95	103	220.05 ± 4.08 [a]	160	1.65 ± 0.05 [a]	1.13 ± 0.06
96	141	206.56 ± 2.78 [ab]	176	1.75 ± 0.05 [a]	1.59 ± 0.05
97	31	214.45 ± 6.06 [ab]	46	1.57 ± 0.08 [ab]	1.20 ± 0.09
Parity					
1			199	1.22 ± 0.03 [b]	0.79 ± 0.04 [b]
2	151	214.9 ± 3.39	151	1.63 ± 0.05 [ab]	1.31 ± 0.05 [ab]
3	111	203.26 ± 2.87	111	1.96 ± 0.05 [a]	1.60 ± 0.06 [a]
4	66	206.59 ± 5.10	66	1.08 ± 0.08 [a]	1.62 ± 0.10 [a]
5	45	207.29 ± 4.55	45	2.20 ± 0.11 [a]	1.82 ± 0.13 [a]
6	26	202.88 ± 5.34	26	2.15 ± 0.12 [a]	1.77 ± 0.12 [a]
7	18	194.28 ± 3.17	18	2.22 ± 0.13 [a]	1.83 ± 0.19 [a]
8	8	196.88 ± 7.09	8	2.25 ± 0.16 [a]	1.75 ± 0.25 [a]
9	7	210.57 ± 11.09	7	1.86 ± 0.34 [a]	1.86 ± 0.34 [a]
10	4	198.25 ± 8.98	4	1.75 ± 0.25 [a]	1.75 ± 0.25 [a]
Litter size at birth					
1	102	212.10 ± 3.92			
2	277	206.58 ± 2.10			
3	51	205.12 ± 4.69			
4	6	212.17 ± 10.77			

N, Number of goat observed.

[a,b] Mean with superscripts that do not have a common superscript latter differ($P<0.05$).

(Song et al. , 1998).

which may partially account for the significant increase in litter size. It must be stressed that litter size is not directly influenced by management but both genetic and environmental factors(Wilson et al., 1989).

Ⅸ. BIRTH WEIGHT

Kid birth weights of the KNG are varied 1.83 kg (Lee et al., 1973), 1.6 to 1.7 kg(Kang, 1975) and 1.21 kg(Kim et al., 1987). Song et al. (2000a) reported that the mean birth weight of kid is 2.04± 0.34 kg with a variety as being 2.28±0.26, 2.11± 0.30 and 1.64±0.19 kg for singles, twins and triplets over of birth type, respectively (Table 5). Silva et al. (1998) reported that kid birth weight of the Alpine dairy goats is varied from 2.5 to 4.5 kg with a males 3.3 to 4.5kg and females, 2.5 to 3.7kg, and singles being 15% heavier. These results were in general agreement with those reported by Nawarz and Khalil Ahmad(1998) for ewes. Singles and twins born kids have higher than birth weight than triplets ; hence, a better chance for survival. Triplets on the other hand, had lighter average birth weight and were more subject to physiological starvation(Nawarz and Khalil Ahmad, 1998). Mourad and Anous(1998) reported that the birth weights of kids in Common African and Alpine crossbred goats are 3.1±0.1, 2.8±0.1, 2.3±0.2 and 2.3± 0.2kg for singles, twins, triplets and quadruplets, respectively.

Table 5. Birth weight of kid in the KNG

(unit : kg)

Birth type	No. of goats examined	Birth weight (mean ± s.e.)
Singles	26	2.28±0.26
Twins	62	2.11±0.30
Triplets over	26	1.64±0.19
Total	114	2.04±0.34

(Song et al., 2000a)

Ⅹ. KIDS MORTALITY

It is common experience that multiple birth in goats are associated with a high mortality rate (Devendra and Burns, 1983). There seems to be however, no biological reason why mortality should be high, provided nutrition and management is adequate. It should just be pointed out that the full meat production potential of the KNG could only be utilized by exploiting their prolificacy. To this end, intensive management and high nutritional levels might be economically worthwhile. Under intensive conditions, KNG does successfully raise twins and triplets. It is, however, necessary to pay special attention to triplets during the first few days after birth (Naude and Hofmeyr, 1981).

Kid mortality in Korea is one of the main factors adversely affecting goat production. While it is difficult to assess exactly the extent of these losses because producers tend to give very subjective information, it is beyond doubt that losses are high and may occasionally take 50% of the kid crop. The causes are closely related to the system of production and therefore difficult to control. They include birth weight, milk production of dam, predators, disease and accidents. There are only report on kid mortality in Korea, and those published are mainly on experimental stations where there is the possibility of registering data (Song et al, 1998). Mean litter size at weaning of 1.31 heads (Table 4) compared favorably with reports of other workers (ILCA, 1982 ; Ebozoje and Ikeobi, 1998). Litter size at weaning was affected ($p<0.05$) by parity. The trend of effect of season and year of birth on litter size at weaning is not clear. These seems to be a general increase in litter size at weaning as parity progress up till the eight parity.

This may be due to improved efficiency of reproduction and rearing as the doe matures (Levasseur and Thibault, 1980).

The mean mortality of 635 kids in the KNG is 23±1% with a variety as being 28±3, 21±2, 16±3 and 46±15% for singles, twins, triplets and quadruplets of birth type, respectively(Song et al, 1998). For goats raised under extensive conditions, a primary concern of management during kidding is death of kids due to predation, cold stress, or abandonment by does (Shelton, 1978). Any attempt to interfere under extensive conditions usually will increase kid losses. These problem can be overcome by intensification of management, but this often is contraindicated for economy.

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