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Study of morphometric and growth traits of Bakerwal (Kagni) goat at birth in an organized farm of Kashmir

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Abstract
Bakerwal (Kagni) are heavy goats reared in large flocks under extensive system for meat and household milk purpose by Bakerwal tribe of Jammu and Kashmir. A study was undertaken to study dam weight and effect of some non-genetic factors on birth weight and morphometric traits at birth of Bakerwal goats in organized farm. The data pertaining to dam weight at kidding (DW), birth weight (BW), Body length (BL), height at weathers (BH), Heart girth (HG), paunch girth (PG) were collected from history sheets of Bakerwal (Kagni) goats maintained at Mountain Sheep and Goat Research Station, SKUAST-K, Shuhama, Kashmir, India from 2016 to 2021. The effect of non-genetic factors on birth weight and morphometric traits was studied by least-squares analysis owing to non-orthogonal data using the technique developed by Harvey (1990) [8]. The coefficient of variation (CV %) of all the traits under study were low (7.37%) to medium (32.62%) indicating corresponding low to medium variability of these traits in Bakerwal kids. The overall estimates of 2.97±0.07 kg, 32.11±0.37 cm, 33.60±0.34 cm, 31.97±0.57 cm, 29.88±0.45 cm, 11.03±0.33 cm and11.15±0.50 cm for BW, BL, BH, HG, PG, CL and CC, respectively were obtained in the present study. The effect of period was significant (p<0.05) only on BL whereas the effects of sex of kid and dam weight were significant only (p<0.05) on the BW. The effect of birth type was significant (p<0.05) on the BW. The effect of period of birth was found to be significant (p<0.05) on BL and PG only in the present study. All the phenotypic correlation among all studied traits Bakerwal kids were positive (except between CL and BH) ranging from very low (-0.12) to high (0.54) between BG and BL. It is concluded that heavy goats produce heavy kids of larger size.

Keywords: Morphometric, growth traits, goat

Introduction
The Bakerwal tribe of Jammu and Kashmir rears a goat population commonly known as "Bakerwali" goat which is still not characterized as a distinct breed. This population in some areas is known as "Kaghani" goat. These goats are reared for meat and household milk purpose. These goats are maintained in large flocks under extensive system of rearing. The success of goat farming is also dependent on birth weight of goat as it influences the survival and sub sequent growth. Birth weight is an important economic trait as animals with better birth weight grows faster in the early growth period of life. The birth weight has definite economic importance as it also affects the overall growth of the body.

Materials and Methods
The data pertaining to dame weight at kidding (DW), birth weight (BW), Body length (BL): distance from point of shoulder to the point of tuber ischii); height at weathers (BH: distance from the base of hoof to the highest point of withers); Heart girth (HG): body circumference around the chest just behind the front legs and withers; Paunch girth (PG): circumference of body measured just before hind legs; CL (cm) and CC (cm) were collected from history sheets of Bakerwal (Kagni) goats maintained at Mountain Sheep and Goat Research Station, SKUAST-K, Shuhama, Kashmir, India from 2016 to 2021. The means, standard deviations and coefficient of variations dam weight, birth weight and morphometric traits were estimated by using standard statistical procedures (Snedecor and Cochran, 1994) [28]. The effect of non-genetic factors on birth weight and morphometric traits was studied by least-squares analysis owing to non-orthogonal data using the technique developed by Harvey (1990) [8]. The data were suitably classified to study the major effect of non-genetic factors like period of birth (2 levels; each level consists of 3 years), type of birth (2 levels single born and twin born), weight of dam at kidding (3 levels; 25-34 kg, 35-44 kg and 45-58 kg were considered level 1, 2 and 3,

respectively) and sex of kid (2 levels (Male and Female based on gender of kid). The modal used to serve the purpose to analyzing the data was:

$$Y_{ijklm} = \mu + P_i + G_j + T_k + W_l + e_{ijklm.}$$

Were, Y_{ijklm} performance of animal for a particular trait, μ is population mean. P_i, G_j, T_l and W_m are fixed effect of period of birth, gender of kid, birth type and weight of dam at kidding, respectively. Whereas, $_{eijklmn}$ is random residual error assumed to be NID (0, σ^2).

The statistical significance of various fixed effects in the least squares model was determined by 'F' test. For significant effects, the differences between pairs of levels of effects of weight of dam were tested by Duncan's multiple range test (DMRT). Pearson's correlation coefficient was estimated between birth weight and other body measurements and each other using the correlation procedures of SPSS (SPSS, 2020). The standard error of phenotypic correlations was obtained according to formula given by Panse and Sukhatme (1961) [29]. The statistical significance of correlations was tested by comparing t value (obtained by dividing correlation with standard error) with table given by Snedecor and Cochran (1967) [9].

Results and Discussion

The descriptive statistics including coefficient of variation (CV %) of birth weight and morphometric traits at birthof Bakerwal (Kagni) goat is presented in Table 1. The coefficient of variation (CV %) of all the traits under study were low (7.37%) to medium (32.62%) indicating corresponding low to medium variability of these traits in Bakerwal kids. However, higher average estimates of 3.28±0.05 kg, 30.00±0.42 cm, 42.22±0.42 cm and 41.12±0.43 cm with corresponding CV (%) of 11.28. 10.10, 7.01 and 6.03 for BW, BL, HW and CG, respectively in Bakerwali kids were observed by Zarger *et al*. (2017) [1]. An average body weight of 39.11±0.88 kg with range of 25 to 58 and CV (%) of 18.22 was observed in the present study. The average body weight observed for Bakerwal goats in present study is far less than the reported average of 60.14±1.22 kg (Anonymous. 2021). The difference may be attributed to the fact that the animals managed under farm conditions receive restricted feed and fodder whereas the animals reared by Bakerwal receive adlib grazing round the year. Adult body weight of 38.15±1.85 kg was reported by Rather *et al*. (2020) [35] in Kashmir goat.

Table 1: Descriptive statistics of different traits of Bakerwal dams and kids

Trait	N	Mean±S.E	Std. deviation	CV	Range
BW (kg)	65	3.00±0.07	0.60	20.11	1.9 to 4.5
DW (cm)	66	39.11±0.88	7.13	18.22	25 to 58
BL (cm)	65	31.83±0.36	2.88	9.05	25 to 40
BH (cm)	65	33.63±0.31	2.48	7.37	25 to 39
HG (cm)	65	31.43±0.53	4.30	13.67	3 to 38
PG (cm)	65	29.58±0.43	3.47	11.72	24 to 39
CL (cm)	65	11.18±0.29	2.38	21.26	4 to 18
CC (cm)	65	10.92±0.44	3.56	32.62	5 to 19

The least-squares means: The overall least-squares means for the birth weight and body measurements at birth are presented in Table 2. Comparable least square means for different traits at birth were also reported by Meel *et al*. (2010) [4] in Sirohi goats, Mandal *et al*. (2010) [7] and Bhusan*et al*. (2012) [6] in Jakhrana goats, Waiz *et al*. (2018) [5] in Sirohi Goat and Patil *et al*. (2013) [14] in Sangamneri goats. Patil *et al*. (2008) [17] in Osmanabadi goats also reported similar values for HG. Fahim *et al*. (2013) [15] reported similar value for BH in Rohilkhand local goats. Kharkar*et al*. (2014) [16] in Berari goats, Sharma *et al*. (2008) [11] and Dudhe *et al*. (2015 a; b) [12, 13] in Sirohi goats observed similar estimates for BH.

Effects of non-genetic factors: The effect of period was significant (p<0.05) only on BL whereas the effects of sex of kid and dam weight were significant only (p<0.05) on the BW. The effect of birth type was significant (p<0.05) on the BW. The effect of period of birth was found to be significant (p<0.05) on BL and PG only in the present study. Tomar *et al*. (2001) [19], Sharma *et al*. (2010) and Dudhe *et al*. (2015) [12, 13] in Sirohi goats also reported significant effect of year of birth on the BL. Contradictorily Tomar *et al*. (2001) [19], Sharma *et al*. (2010) and Dudhe *et al*. (2015) [12, 13] in Sirohi goats reported significant of year of birth on BW, CG and BH. The effect of sex was significant (p<0.05) only on BW in the present study. However, sexual dimorphism in favour of males was observed for all the traits of kids under study. The significant effect of sex on birth weight was also observed by Dudhe *et al*. (2015) [12, 13] and Pathodiya *et al*. (2004) in Sirohi kids and Waiz *et al*. (2018) [5] in Sirohi Goat. Kharker *et al*. (2014) also observed non-significant effect of sex on the HG, BH and BL at birth. Contradictory to the results of present study, Gohain *et al*. (2014) [18] Assam local goats, Dudhe *et al*. (2015) [12, 13] Sirohi goats and Waiz *et al*. (2018) [5] in Sirohi Goat observed highly significant (p≤0.01) effect of sex of kid on HG, BH and BL at birth. The sexual dimorphism in favour of males was in consonance with findings of Dudhe *et al*. (2015) [12, 13], Pathodiya *et al*. (2004), Gohain *et al*. (2014) [18] and Waiz *et al*. (2018) [5]. The sexual dimorphism in favour of male kids may be attributed to anabolic effect of androgen. The effect of birth type was significant (p≤0.05) on BW and BL only. However, single born lambs performed better than single born lambs with respect to all traits. These observations were in consonance with Tomar *et al*. (2001) [19], Sharma *et al*. (2010) and Dudhe *et al*. (2015) [12, 13] in Sirohi goats. The lighter birth weight and shorter size of twins as compared to single born kids may be attributed to the competition among twins for utrine space and nutrients during pre-natal life Hafiz, 1962) [21]. The effect of dam weight was significant on the BW only. However, the results suggested that heavy goats of body weight 45-58 kg produced heavy kids of larger size with respect to all traits except CL**.** Dudhe *et al*. (2015a) [12, 13] reported non-significant effect of dam on BW and significant effect on HG, whereas Dudhe *et al*. (2015b) [13] reported significant (p≤0.01) effect on BH and BL at birth and in Sirohi goat. Hence, Dudhe *et al*. (2015b) [13] observed significant (p≤0.05) effect for HG at birth. Kumar *et al*. (1992) reported significant effect of dam's weight at kidding on morphometric traits at birth in Jamunapari goats.

Table 2: The overall least-squares means for the birth weight and body measurements at birth

Effect	N	BW (kg)	BL (cm)	BH (cm)	HG (cm)	PG (cm)	CL (cm)	CC (cm)
Overall	65	2.97±0.07	32.11±0.37	33.60±0.34	31.97±0.57	29.88±0.45	11.03±0.33	11.15±0.50
Year		0.265	0.010*	0.760	0.063	0.020*	0.725	0.175
2016-18	23	2.90±0.10	33.05±0.58	33.50±0.53	33.00±0.89	30.89±0.70	11.14±0.51	11.80±0.78
2019-21	41	3.04±0.08	31.18±0.43	33.69±0.39	30.94±0.67	28.87±0.52	10.92±0.38	10.50±0.58
Sex		0.002**	0.714	0.477	0.619	0.019*	0.292	0.789
Female	32	2.78±0.09	31.99±0.52	33.37±0.47	32.23±0.80	28.88±0.63	10.71±0.46	11.27±0.70
Male	33	3.16±0.09	32.24±0.49	33.82±0.45	31.71±0.76	30.88±0.59	11.35±0.43	11.03±0.66
Birth type		0.000**	0.040*	0.083	0.104	0.596	0.668	0.859
Single	35	3.26±0.09	32.84±0.50	34.15±0.45	32.85±0.76	30.10±0.60	11.16±0.44	11.23±0.67
Twin	30	2.68±0.09	31.39±0.52	33.04±0.47	31.09±0.80	29.65±0.62	10.90±0.46	11.07±0.70
Dam weight		0.001**	0.444	0.204	0.199	0.694	0.288	0.787
25-34	19	2.63±0.11^{a}	31.60±0.64	32.77±0.58	31.95±0.90	29.42±0.77	11.12±0.57	10.76±0.86
35-44	32	3.00±0.09^{b}	31.91±0.49	33.69±0.44	30.77±0.75	29.79±0.59	11.61±0.43	11.03±0.65
45-58	14	3.29±0.13^{c}	32.82±0.75	34.33±0.68	33.19±1.15	30.43±0.90	10.37±0.66	11.66±1.00

**. Correlation is significant at the 0.01
*. Correlation is significant at the 0.05
N. Non-significant
The averages with different superscript differ significantly (p<0.05)

Phenotypic correlations: The phenotypic correlation among the studied traits is presented in Table 3. All the phenotypic correlation among all studied traits Bakerwal kids were positive (except between CL and BH) ranging from very low (-0.12) to high (0.54) between BG and BL. This indicated that longer lambs were taller also. The birth weight had moderate correlations with BL, BH and HG. The highest correlation of birth weight was observed with BL. Further, the phenotypic correlations of BW with BL, BH and HG are highly significant (p<0.01) indicating these traits can be define birth weight in absence of weighing balance. The correlations coefficients of birth weight with BL, BH, PG and CG observed in the present study were comparable to the reported values Das and Sharma (1994) [23] in Black Bengal goats, Topal *et al*. (2003) [25] in Morkaraman sheep and Topal, Macit (2004) [24] in Awassi sheep and Thiruvenkadan (2005) [22] in Kanni Adu kids.The moderate and significant correlation coefficients of BW with BL,BH, PG and HG at birth suggest that either of these variables or their combination could provide a good estimate for predicting live weight of Kagni kids.

Table 3: Phenotypic correlations among morphometric traits and birth weight of Bakerwal kids

Trait	BL	BH	HG	PG	CL	CC
BW	0.47±0.03**	0.45±0.03**	0.27±0.01*	0.34±0.01**	0.24±0.01 N	0.090.003 ±N
BL		0.54±0.04**	0.44±0.02**	0.38±0.02**	0.16 ±0.002N	0.23 ±0.01N
BH			0.30±0.03*	0.26±0.01*	-0.12±0.003 N	0.01± 0.003N
HG				0.43±0.02**	0.08 ±0.002N	0.29±0.01*
PG					0.42±0.02**	0.27±0.01*
CL						0.15 ±0.001N

**. Correlation is significant at the 0.01
*. Correlation is significant at the 0.05
N. Non-significant

Conclusion

It is concluded that heavy goats produce heavy kids and larger size whereas twining reduce the body weight and size at birth.

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