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Pre-pubertal growth performance and its inter-relationship with physiological responses of black Bengal goats in free range rearing system#

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Black Bengal goat (*Capra hircus bengalensis*) is one of the majestic breed of goats known globally for its fecundity, quality of meat, and skin and adaptation in extreme climate (Dixit and Shukla 1995, Hossain *et al*. 2004). The major constraints of rearing black Bengal goats are low milk production and higher kid mortality (Husain *et al.* 1996, Amin *et al.* 2001) which are due to the effects of dam weight at kidding, birth weight of kid, dam's milk yield, season, birth, size, parity, dam's nutrition and diseases (Chowdhury *et al*. 2002). The physiological responses (body temperature, pulse rate and respiration) are one of the contributing factors to maintain the homeothermy (Al–Tamimi 2007) and widely used as an important tool to evaluate health status. The alterations in physiological responses during different physiological stages and environmental conditions (Banerjee *et al*. 2014) is well documented, but the reports on age related alterations in physiological responses and its relationship with growth parameters are scanty, particularly under free range rearing systems. So, the present study was aimed to determine pre-pubertal growth performance and it's inter–relationship with physiological responses of black bengal goats in free range rearing system.

In this study, 100 male and 100 female kids having mean birth weight 0.97±0.05 kg were selected. The growth parameters (body weight, height, heart girth and linear length) as well as physiological responses (rectal temperature, pulse, respiratory rate) were recorded at the morning on day 15th, 30th, 60th, 90th, 120th, 150th and 180th day and marked as Group (Gr) I, Gr II, Gr III, Gr IV, Gr V, Gr VI and Gr VII respectively.

The experimental data were subjected to appropriate statistical analysis by using the method described by Snedecor and Cochran (1994) by using the software IBM–SPSS (version 20.0). General Linear Model technique repeated over age–groups and seasons was considered for all variables under study.

All the parameters increased significantly (P≤0.01) from day 15 to 180 days at each month interval and reached peak on 180 day. The male kids exhibited significantly (P≤0.01) higher growth responses compared to female kids of the same age group (Table 1). The growth parameters in the study was close to the report of Singh and Singh (2000) and higher than the report of Bera *et al.* (2008). Higher weight gaining capability in male was corroborated with the findings of Husain *et al.* (1996), Paul *et al.* (2011) and Mia *et al.* (2013) for black Bengal goats. Pralomkarn *et al.* (1996) also reported 20% higher weight gain in male kids compared to female in Thai native goats during pre weaning period as depicted in our study. The higher body weight gain in male kids may be due to the anabolic effect of male sex hormone (Hafez 1962).

Among the physiological responses, only pulse rate differed significantly (P ≤ 0.01) between age and sex (Table 2). The pulse rate was higher up to day 60 and gradually decreased till 180 day. The pulse rate was significantly (P≤0.01) more in male kids than female kids. The physiological responses are the important indicators of adaptation and reviewed by many workers (Phulia *et al*. 2010, Sharma and Puri 2013). The overall mean of rectal temperature in the black Bengal kids in our study was in accordance with the earlier reports of Chowdhury *et al*. (2002). The metabolic responses that occur during the transition from foetal to neonatal life present a change from a thermoregulatory quiescent state in which inhibitory stimuli dominate (Ball *et al.* 1995). In our investigation, the rectal temperature was unchanged throughout the pre-pubertal growth phase which was contrary to the reports of Alexander (1975). Dwyer (2008) reported that birth weight has significant effect on body temperature in sheep. The mean pulse rate of black Bengal kids in this study was higher than the value reported earlier (Ozung *et al*. 2011, Lorrie 2013). In this study, higher pulse rate was observed up to 60 days then gradually declined which was in accordance

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Table 1. Growth parameters of males and females of black Bengal goats during pre-pubertal growth (Mean±SE)

Parameter	Sex	G1	G2	G3	G4	G5	G6	G7	Overall	P value
Body weight (kg)	Male	$1.80^{g}\pm0.04$	$2.82^{f}\pm0.14$	$3.85^{e}\pm0.20$	$5.59^{d}\pm0.13$	$7.40^{c}\pm0.17$	$8.19^{b}\pm0.16$	$8.92^{a}\pm0.17$	$5.51^{p}\pm0.29$	0.00** (between sex,
	Female	$1.50^{g}\pm0.04$	$1.91^{f}\pm0.06$	$2.60^{e}\pm0.13$	$4.20^{d}\pm0.15$	$5.25^{c}\pm0.15$	$6.19^{b}\pm0.15$	$7.21^{a}\pm0.17$	$4.12^{q}\pm0.23$	male, female)
Weight gain (g/day)	Male	$50.17^{ab}\pm6.23$	$34.06^{c}\pm4.07$	$34.06^{c}\pm4.38$	$58.17^{a}\pm5.57$	$60.44^{a}\pm4.95$	$26.06^{d}\pm2.68$	$26.72^{d}\pm4.03$	$41.38^{p}\pm2.26$	0.00** (between sex)
	Female	$40.61^{b}\pm3.93$	$13.81^{e}\pm2.81$	$24.19^{d}\pm4.13$	$53.31^{a}\pm7.97$	$36.47^{b}\pm4.89$	$32.47^{bc}\pm6.58$	$34.06^{bc}\pm2.55$	$33.56^{q}\pm2.23$	and 0.03* (between male, female)
Height (cm)	Male	$26.83^{d}\pm0.56$	$31.17^{cd}\pm0.44$	$35.25^{bc}\pm0.70$	$37.08^{b}\pm0.51$	$38.92^{b}\pm0.71$	$41.08^{a}\pm0.60$	$43.08^{a}\pm0.51$	$36.20^{p}\pm0.62$	0.00** (between sex,
	Female)	$24.75^{d}\pm0.45$	$26.75^{d}\pm0.64$	$31.33^{c}\pm0.63$	$35.33^{bc}\pm0.36$	$36.50^{ab}\pm0.72$	$37.67^{a}\pm0.58$	$38.83^{a}\pm0.66$	$33.02^{q}\pm0.60$	male, female)
Heart girth (cm)	Male	$26.67^{e}\pm0.47$	$33.92^{d}\pm0.62$	$40.58^{c}\pm0.70$	$39.17^{c}\pm0.53$	$40.92^{c}\pm0.69$	$42.58^{b}\pm0.87$	$45.33^{a}\pm1.11$	$38.45^{p}\pm0.69$	0.03* (between sex)
	Female	$25.25^{de}\pm0.41$	$29.50^{d}\pm0.42$	$37.92^{c}\pm0.54$	$38.42^{bc}\pm0.97$	$39.67^{b}\pm0.60$	$41.08^{a}\pm0.65$	$41.92^{a}\pm0.70$	$36.25^{q}\pm0.68$	and 0.00** (between male, female)
Linear length (cm)	Male	$27.00^{d}\pm0.41$	$32.75^{bc}\pm0.62$	$34.17^{b}\pm0.67$	$34.67^{b}\pm0.43$	$35.67^{b}\pm0.51$	$39.83^{a}\pm0.47$	$40.33^{a}\pm0.50$	$34.92^{p}\pm0.50$	0.00** (between sex,
	Female)	$24.25^{d}\pm0.72$	$23.75^{d}\pm0.51$	$32.67^{bc}\pm0.50$	$34.50^{b}\pm0.62$	$33.50^{b}\pm0.71$	$34.83^{b}\pm0.41$	$36.92^{a}\pm0.58$	$31.49^{q\pm}0.58$	male, female)

Means having different superscript in the last column (p, q) for the specific parameter differ significantly between sex and means having different superscript in the same row (a, b, ... g) within a sex differ significantly between group (age). **P≤0.01, *P≤0.05.

Table 2. Physiological parameters of males and females of black Bengal goats during pre-pubertal growth (Mean±SE)

Parameter	Sex	G1	G2	G3	G4	G5	G6	G7	Overall	P value
Rectal temperature (°C)	Male	38.71±0.18	38.88±0.22	39.00±0.16	39.25±0.31	39.29±0.30	38.83±0.18	39.29±0.28	39.04±0.09	0.65
	Female	38.83±0.14	38.96±0.22	39.13±0.21	38.96±0.17	38.88±0.15	39.33±0.26	38.79±0.23	38.98±0.08	
Pulse rate (No./min)	Male	$114.33^{a}\pm1.02$	$112.17^{ab}\pm0.89$	$114.00^{a}\pm1.03$	$108.00^{c}\pm1.41$	$109.25^{c}\pm1.61$	$103.33^{de}\pm1.90$	$105.17^{d}\pm2.43$	$109.46^{p}\pm0.71$	0.01** (between
	Female	111.92^{a} 0.60	$110.25^{a}\pm0.83$	$112.75^{a}\pm1.22$	$103.25^{b}\pm2.21$	$103.33^{b}\pm1.41$	$98.00^{c}\pm1.49$	$100.67^{bc}\pm1.89$	$105.74^{q}\pm0.80$	sex, male, female)
Respiratory rate	Male	15.58±0.83	15.58±1.00	15.92±1.30	16.58±1.15	16.58±1.20	16.17±1.11	15.83±1.28	16.04±0.42	0.90
(No./min)	Female	15.17±0.52	17.08±0.93	16.17±1.23	16.33±1.10	16.17±1.60	15.67±1.05	16.33±1.04	16.13±0.38	

Means having different superscript in the last column (p, q) for the specific parameter differ significantly between sex and means having different superscript in the same row (a, b, ... e) within a sex differ significantly between group (age). **P≤0.01.

with the earlier reports of Ozung *et al*. (2011). In contrary to our study, Piccione *et al*. (2006) reported a gradual decrease in pulse rate of lambs during the first 30 days of their life. The negative association between heart rate and bodyweight was also reported in dogs (Hezzell *et al*. 2013). The respiration rate was found within the normal range reported by Chowdhury *et al*. (2002) in same breed of goats. Age had no effect on respiratory rate in black Bengal kids which was in contradiction to earlier reports of Bureau and Begin (1982), who stated that post natal maturation of the ventilator response to oxygen occurs within the first 10 days of life, reported in new born lambs and was largely due to an increase in sensitivity of the oxygen chemo–receptors.

All the growth parameters were positively correlated (P≤0.01) among themselves except average body weight gain and rectal temperature and pulse rate were positively correlated (P≤0.01) with respiration (Table 3). The pulse rate was negatively correlated with (P≤0.01) body weight, height, heart girth and linear length whereas rectal temperature (P≤0.01) and respiration rate (P≤0.05) were positively correlated with heart girth only. The Simple Regression equations between age as independent variable and other dependable variables has been made (Table 4), which depicted negative relationship between pulse rate and age, however, all other parameters showed positive relationship with the age.

In this investigation, pulse rate was negatively correlated with body weight, height, heart girth and linear length which was in accordance with the earlier reports of Piccione *et al*. (2006) and Ocak *et al.* (2009) in goats. Hence, any factor that can give rise to an increase in pulse rate may exert adverse effect on growth in kids. Earlier studies reported alteration in heart rate with age and sex (Ozung *et al.* 2011) which may be due to higher systolic function after birth (Piccione *et al*. 2006), or may be in response to suckling (Bushman *et al*. 1993).

In this study, we have reported some baseline data on physiological responses in black bengal goat kids of either sex under free range system during different phases of pre-pubertal growth and may be included for understanding the regulation of homeostasis during the accelerated phase of growth *vis-à-vis* for formulation of appropriate management strategies to monitor growth process under pathological conditions in view of reducing kid mortality.

SUMMARY

The growth performance of black Bengal male and female kids in relation to the physiological parameters during pre-pubertal growth period reared under free range system was assessed in 100 male and 100 female kids from day 15th to 180th day. All the growth parameters increased significantly from day 15 to 180 days with significantly higher growth in male. Among the physiological responses, only pulse rate differed significantly between age and sex with higher in male. The pulse rate was negatively correlated with body weight, height, heart girth and linear length whereas rectal temperature and respiration rate were positively correlated with heart girth only. In this study, some baseline data have been generated on physiological responses in black Bengal kids of either sex under free range system during different phases of pre-pubertal growth.

Table 3. Correlation coefficients between the growth parameters and physiological responses of black Bengal goat during pre-pubertal state

Parameter	Body weight	Average weight gain	Height	Heart girth	Linear length	Rectal temperature	Pulse rate
Average weight gain	0.120						
Height	0.892**	0.032					
Heart girth	0.807**	0.012	0.893**				
Linear length	0.829**	0.046	0.875**	0.876**			
Rectal temperature	0.099	– 0.039	0.131	0.219**	0.144		
Pulse rate	– 0.488**	– 0.001	– 0.405**	– 0.323**	– 0.362**	0.101	
Respiration rate	– 0.031	– 0.079	0.077	0.155*	0.061	0.469**	0.305**

**P≤0.01, *P≤0.05.

Table 4. Simple regression equations between age as independent variable and other dependable variables

Parameter	Male		Female	
	Equation	R^2 value	Equation	R^2 value
Body weight	= 1.27 Age + 0.42	0.98**	= 1.01 Age + 0.07	0.98**
Height	= 2.58 Age + 25.88	0.96**	= 2.47 Age + 23.13	0.93**
Heart girth	= 2.63 Age + 27.93	0.83**	= 2.68 Age + 25.55	0.83**
Linear length	= 1.99 Age + 26.96	0.91**	= 2.18 Age + 22.77	0.79**
Pulse rate	= – 1.78 Age + 116.60	0.81**	= – 2.42 Age + 115.40	0.80**

**P≤0.01.

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