Testicular Biometry, Sexual Behavior and Semen Quality during the Period of Growth and Adolescence in Surti Goats

D.V. Chaudhari[1], A.J. Dhami[1]*, J.A. Patel[1], C.P. Parmar[2], K.K. Hadiya[1] and V.P. Belsare[2]

[1]*Department of Animal Reproduction Gynaecology & Obstetrics, College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, INDIA*
[2]*Pashu Sanshodhan Kendra, Ramna Muvada (Mahudha), College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, INDIA*

*Corresponding author: AJ Dhami, Email: ajdhami@aau.in

ABSTRACT

The literature on testicular/scrotal growth in relation to age in pre- and post-pubertal Surti kids is meager. The study was conducted on 11 Surti male kids of identical age and birth weight (1.53±0.05 kg) selected at the age of 14 weeks and then up to 47 weeks of age. The live weight and scrotal/ testicular biometry, i.e., length, width, circumference (cm) and volume (cm^3) were recorded using standard procedures at 3 weeks intervals. Sexual behaviour of bucks was observed and semen was collected in AV at weekly/fortnightly intervals from 7 months till 11 months of age. The mean live weights at the age of 14 and 35 weeks were 9.86±0.61 kg and 17.84±1.09 kg (p<0.01), respectively and thereafter it did not vary statistically till 47 weeks of age. The mean values of scrotal length, width, circumference (cm) and scrotal volume (cm^3) at 14 weeks of age were 2.89±0.22, 2.05±0.17, 8.82±0.72 and 21.36±0.93, respectively, which increased gradually (p<0.01) till 35 weeks of age reaching 10.65±0.30, 7.55±0.24, 19.45±0.65 and 200.45±16.67, respectively, and then remained almost stable till 47 weeks of age. The mean length and width of right testis at 14 weeks of age were 2.98±0.17 and 1.39±0.15 cm, and those of left testis 3.28±0.17 and 1.23±0.10 cm, respectively. These values increased significantly (p<0.01) till 32 weeks of age for width and till 38-41 weeks of age for length of both testes. The average age and weight at puberty were 27.00±0.75 weeks and 15.16±0.56 kg, respectively, and those at sexual maturity 38.18±0.90 weeks and 19.61±0.93 kg, respectively. Most of the growing bucks at the age of 6-7 months expressed strong libido. The semen quality observed at 7 month of age improved gradually with advancing age till 9-10 months. Thereafter it became almost stable suggesting that the Surti bucks attain puberty and sexual maturity around this age. The correlation coefficients among age, body weight and scrotal/testicular biometry were observed to be highly significant (p<0.01) and positive in the range of 0.854 to 0.954. It was inferred that the highest reproductive potential in Surti bucks is attained at around 9-10 months of age. Hence, these criteria should be considered while selecting Surti bucks for breeding purpose.

Keywords: Surti buck, Adolescence, Puberty, Scrotal biometry, Sexual behavior, Semen quality

Goats are kept primarily for meat and milk, and contribute substantially to household income and food security of downtrodden classes in the rural areas. Surti goat is a medium sized mostly stall-fed, dual purpose breed and found in small towns and cities of middle and south Gujarat and neighboring areas of Maharashtra state up to Nasik district. Surti goats are famous for their fertility, prolificacy, meat and milk quality as well as adaptability to the hot humid condition. It has distinct social, economical,

managerial, and biological advantages over other livestock species and is often termed as the "poor man's cow."

Male fertility is an important factor in caprine reproduction since numerous does are generally bred to a single buck. The potential fertility of breeding males can be evaluated in the field by assessment of mating ability; physical and sexual examination of genitalia including scrotal circumference and semen quality (Hoflack *et al.,* 2006). These methods are useful for screening out sub-fertile

males, although neither allows precise determination of the pregnancy rates that males actually achieve (Parkinson, 2004). There is need to establish measurable criteria for judging breeding soundness and guiding selection of males for breeding to facilitate effective genetic improvement of goat breeds (Gogoi *et al.,* 2005). The biometrical parameters of buck testis along with their seminal characteristics have importance for selection of superior breeding bucks. Scrotal circumference is an indirect measurement of testicular size and a marked increase in testicular size indicate the onset of active spermatogenesis (Bongso *et al*., 1982; Souza *et al*., 2011). The interaction between body weight, testis growth, testosterone secretion, and sperm production, especially during the pre-pubertal stage, is the key factor influencing puberty (Souza *et al*., 2010; Martinez *et al*., 2012).

Measurements of testicular size during the period of adolescence can provide fair indication to find out the age at which the males can be used for breeding purpose. The scrotal/testicular growth is an important parameter in breeding buck by virtue of its high correlation with sperm output, semen quality, testis weight as well as fertility. Moreover, the mean scrotal circumference and sperm concentration in male goat at around the age of puberty (7-9 months) documented are 18-20 cm and 1800-2200 million/ml, respectively, which varies according to breed (Jadav, 2008). The paucity of literature in respect of detailed postnatal study on body mass and testicular/scrotal measurements from birth till attainment of puberty and sexual maturity in Surti bucks prompted us to study the same including study of sexual behavior and semen quality with an objective to determine the suitable age for their possible commencement in breeding and to determine the influence of age and body weight on testicular traits as well as semen characteristics in growing Surti bucks.

MATERIALS AND METHODS

This study included 11 Surti male kids of identical birth weight and age born during September 10-19, 2016 at Surti Goat Breeding Farm, Ramana Muvada (District, Kheda), Gujarat. Geographically, Anand/Kheda is located in Central Gujarat at 20°15' to 21°23' North latitude and 70°38' to 74°23' East longitude at an elevation of 800 meters above the mean sea level. The climate of the region is sub-humid tropical with medium rainfall.

The average monthly minimum and maximum ambient temperatures ranges from 11.8 to 28.1°C and 25.6 to 42.2°C, respectively, and the relative humidity from 67.8 to 94.9 and 22.0 to 75.1 per cent in the morning and the evening, respectively.

The actual study was undertaken from 14 weeks (3.5 months) of age till puberty and sexual maturity and beyond, up to 47 weeks (11 months) of age. The animals were reared and managed under identical nutritional conditions as per the farm feeding schedule using green and dry fodder and concentrate. The experiment was approved by the Institutional Animal Ethics Committee. The initial work up to 6 months of age was carried out at Ramana Muvada and thereafter the pubertal bucks were transferred to Semen Lab of Gynaecololgy Department of the College in Anand for next 5 months to study scrotal biometry, sexual behavior and semen quality. The radial distance between two locations is around 34 km with similar climate.

The live weight was recorded using digital weighing platform and scrotal/testicular biometry, i.e., length, width, circumference (cm) and volume (cm^3) were recorded using standard procedures at 3 weeks intervals starting from 14 weeks till 47 weeks of age. Length and width of left and right testes were measured in centimeter using Vernier calliper, while scrotal circumference was measured at greatest diameter using scrotal (tailor's) tape (Bongso *et al.,* 1982). Scrotal volume was recorded by water displacement technique using calibrated beaker filled with water and dipping the scrotum up to its neck. Sexual behavior of bucks was observed and semen was collected on a male/female dummy goat in artificial vagina from the friendly/cooperative bucks at fortnightly and then weekly intervals from 7 months till 11 months of age. The ejaculates were evaluated for semen quality as per standard routine procedure. The sperm concentration was estimated by Accucell photometer (IMV Technologies, France). The sperm motility was determined at 37°C temperature under high power magnification (40 X) of phase contrast microscope (Longshou, USA) fitted with a biotherm stage and a closed circuit television. The viability of spermatozoa was assessed with eosin-nigrosin stained semen smears under oil emulsion lens of a phase contrast microscope (100x; Olympus BX20, Tokyo, Japan). Simultaneously, sperms were also examined for various types of abnormalities. The plasma membrane integrity of

spermatozoa was assessed using a hypo-osmotic swelling (HOS) test employing 150 mOs/L solution of sodium citrate and fructose with 30 minutes of incubation at 37°C (Jeyendran *et al.,* 1984). Data were analyzed statistically for ANOVA and DMRT using SPSS software version 20.00. Regression analysis based on raw data and mean values of age and body weight at different time intervals were also carried out using SPSS software to develop prediction equation for scrotal circumference and scrotal volume in Surti bucks.

RESULTS AND DISCUSSION

Age, growth rate and scrotal/testicular biometry

The mean birth weight of 11 Surti male kids selected for the study was recorded as 1.53±0.05 kg. The live weight of these kids at the age of 14 weeks (3.5 months) was 9.86±0.61 kg, which gradually and significantly (p<0.01) increased with an advancing age till 35 weeks (9 months) of age, where it was 17.84±1.09 kg, and thereafter it did not vary much till the recorded period of 47 weeks (11 months) of age. Similarly, the mean values of scrotal length, width, circumference (cm) and scrotal volume (cm^3) at 14 weeks of age were 2.89±0.22, 2.05±0.17, 8.82±0.72 and 21.36±0.93, respectively, which then gradually and significantly (p<0.01) increased with an

advancing age till 35 weeks of age reaching 10.65±0.30, 7.55±0.24, 19.45±0.65 and 200.45±16.67, respectively. These traits later remained almost stable till 47 weeks of age, except scrotal volume, which showed increasing trend till 38 weeks of age (229.09±15.91 cm^3) (Fig. 1). The mean length and width of right testis were recorded as 2.98±0.17 and 1.39±0.15 cm, and those of left testis 3.28±0.17 and 1.23±0.10, respectively, at 14 weeks of age. These values then gradually and significantly (p<0.05) increased till 32 weeks of age for width and till 38-41 weeks of age for length of both right and left testes (Table 1).

The increase in testicular measurements with advancing age was in agreement with the observations of earlier workers (Gogoi *et al.,* 2005; Jadav, 2008; Souza *et al.*, 2011; Akpa *et al.,* 2013; Moulla *et al.,* 2018) in different breeds of goat and sheep. The length, width and thickness of right and left testis differed significantly (p<0.01) between ages, bucks and due to interaction. This could be attributed to difference in body weight of bucks and individual variation. The significant age X buck interaction indicated that the rate of increase in the testicular dimensions with advancing age was not uniform in different bucks.

In the present study, all the testicular measurements were significantly affected by body condition /growth rate which suggest that bucks with larger body size and good body condition/growth might possess larger testicular size which may invariable result into a good reproductive capability,

Table 1: Average scrotal/testicular biometry of Surti kids in relation to age and body weight (Mean ± SE)

Age (wk)	Body wt (kg)	Scrotal length (cm)	Scrotal width (cm)	Scrotal circumf (cm)	Scrotal volume (cm^3)	RT length (cm)	RT width (cm)	LT length (cm)	LT width (cm)
14	9.86^a±0.61	2.89^a±0.22	2.05^a±0.17	8.82^a±0.72	21.36^a±0.93	2.98^a±0.17	1.39^a±0.15	3.28^a±0.17	1.23^a±0.10
17	11.46^{ab}±0.70	4.05^b±0.28	2.30^{ab}±0.28	8.42^a±0.49	24.09^a±1.13	3.85^b±0.20	1.70^{ab}±0.16	3.89^{ab}±0.17	1.69^b±0.19
20	11.87^{ab}±0.74	4.40^b±0.34	2.92^b±0.32	11.20^b±0.80	28.64^a±1.55	4.25^{bc}±0.21	1.78^b±0.14	4.15^b±0.18	1.86^b±0.19
23	12.40^{ab}±0.76	5.74^c±0.39	4.45^c±0.33	12.48^{bc}±0.75	56.91^{ab}±7.20	4.76^c±0.25	2.27^c±0.15	4.85^c±0.26	2.39^c±0.16
26	12.88^b±0.82	7.24^d±0.39	5.55^d±0.34	14.35^c±0.86	84.18^{bc}±12.60	5.42^d±0.32	2.80^d±0.14	5.69^d±0.34	2.96^d±0.16
29	15.49^c±1.01	8.67^e±0.28	6.35^e±0.31	16.91^d±0.84	117.73^c±14.73	5.55^d±0.24	3.12^d±0.16	5.83^d±0.28	3.26^d±0.15
32	16.57^{cd}±1.08	10.41^f±0.31	7.27^f±0.27	18.64^{de}±0.71	172.73^d±15.13	7.14^e±0.23	3.99^e±0.15	7.56^e±0.24	4.01^e±0.15
35	17.84^{cde}±1.09	10.65^f±0.30	7.55^f±0.24	19.45^e±0.65	200.45^{de}±16.67	7.55^{ef}±0.23	3.87^d±0.13	7.82^{ef}±0.24	4.05^e±0.13
38	19.18^{de}±1.06	10.97^f±0.36	7.77^f±0.23	20.14^e±0.65	229.09^{ef}±15.91	7.91^g±0.19	4.06^e±0.10	8.04^{efg}±0.19	4.15^e±0.12
41	19.47^e±1.02	11.19^f±0.32	7.98^f±0.20	20.71^e±0.60	237.82^f±14.23	8.46^g±0.15	4.15^e±0.08	8.54^g±0.14	4.26^e±0.09
44	19.65^e±0.98	11.26^f±0.37	7.95^f±0.22	20.59^e±0.60	239.00^f±14.41	8.14^g±0.19	4.15^e±0.09	8.29^{fg}±0.19	4.24^e±0.11
47	19.98^e±0.92	11.17^f±0.37	7.94^f±0.19	20.58^e±0.56	245.45^f±13.22	8.01^g±0.22	4.21^e±0.07	8.14^{fg}±0.23	4.30^e±0.09

Means bearing uncommon superscripts within the column differ significantly (p<0.05). RT/LT – Right/Left testis.
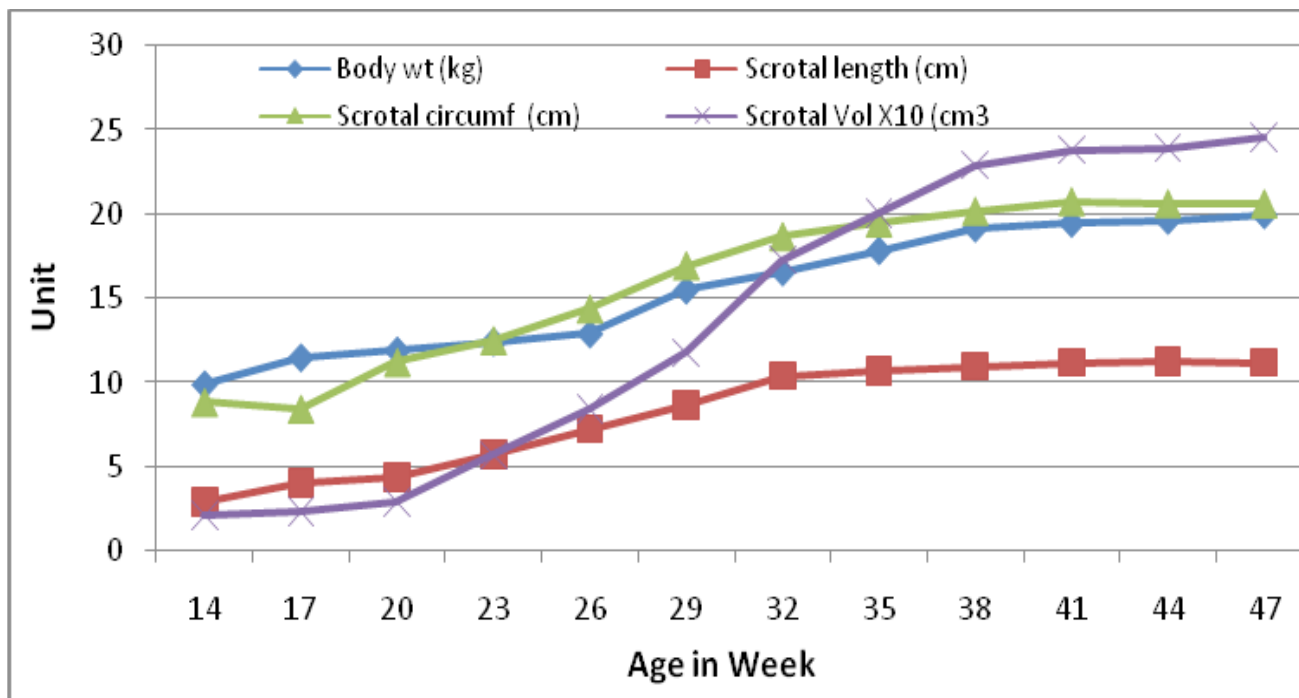
Fig. 1: Body weight, scrotal length, scrotal circumference and scrotal volume in relation to age of adolescent Surti bucks

better semen quality, and thus improve the fertility of the animal (Akpa *et al.,* 2013). Based on the body weight and scrotal/testicular biometry, it could be inferred that the highest reproductive potential in Surti bucks is attained at around 9-10 months of age. Moreover, great individual variation was also noted in all the biometric traits among bucks studied.

Age and weight at puberty/sexual maturity and its correlations with testicular biometry

For the eleven adolescent Surti bucks studied from pre- to post-pubertal periods, the average age and body weight at puberty were 27.00±0.75 weeks (6.5 months) and 15.16±0.56 kg, respectively, and those at sexual maturity with stable scrotal biometry and semen quality were observed to be 38.18±0.90 weeks (9 months) and 19.61±0.93 kg, respectively. There was a vast variation in individual bucks in respect of age and body weight at puberty and sexual maturity. The correlation coefficients among age, body weight and scrotal/testicular biometry in adolescent Surti bucks were observed to be highly

significant and positive in the range of 0.854 to 0.954 (Table 2).

Prediction equation

The prediction equation derived for scrotal circumference and scrotal volume based on age and body weight using raw data and periodic mean values were as under.

Prediction Equation (Based on 132 raw data):

1. SC = {0.203 (Age in wk) + 0.639 (B.Wt.kg) – 0.088}

2. SV = {4.620 (Age in week) + 12.193 (B.Wt. kg) – 195.072}

Prediction Equation (Based on 12 mean values):

1. SC = {0.052 (Age in wk) + 1.097 (B.Wt.kg) – 2.632}

2. SV = {0.711 (Age in week) + 22.625 (B.Wt. kg) – 235.483}

   Where: SC = Scrotal circumference (cm), and SV = Scrotal volume (cm^3)

Table 2: Correlations among age, body weight and scrotal/testicular biometry in adolescent Surti bucks

Trait	Age	Body weight	Scrotal length	Scrotal width	Scrotal circumference	Scrotal volume	Right testicular length	Right testicular width	Left testicular length
Body weight	.755**	—							
Scrotal length	.896**	.854**	—						
Scrotal width	.880**	.874**	.964**	—					
Scrotal circumference	.858**	.901**	.948**	.971**	—				
Scrotal volume	.886**	.914**	.930**	.931**	.942**	—			
Right testicular length	.894**	.865**	.958**	.949**	.943**	.938**	—		
Right testicular width	.883**	.878**	.952**	.974**	.965**	.932**	.951**	—	
Left testicular length	.889**	.860**	.966**	.955**	.948**	.939**	.987**	.958**	—
Left testicular width	.879**	.877**	.959**	.978**	.965**	.924**	.946**	.984**	.957**

No. of observations 132; **Significant at $p < 0.01$ level (2-tailed).

Table 3: Semen quality of adolescent Surti bucks

Seminal Attributes	Age of bucks					
	7 month (n=3/12)	8 month (n=4/18)	9 month (n=7/23)	10 month (n=7/28)	11 month (n=8/24)	12 month (n=8/25)
Ejaculate volume (ml)	0.33[a]±0.03	0.37[a]±0.06	0.58[b]±0.05	0.65[b]±0.04	0.63[b]±0.02	0.70[b]±0.04
Concentration (million/ml)	991.67[a] ±20.48	1508.00[b] ±38.98	2481.56[cd] ±86.12	2826.11[cd] ±126.41	3050.00[cd] ±31.19	3076.50[d] ±18.11
Mass activity (0-4 scale)	2.33[a]±0.17	2.71[a]±0.17	3.17[ab]±0.11	3.75[b]±0.11	3.70[b]±0.12	3.63[b]±0.08
Sperm motility %)	61.67[a]±1.67	65.00[ab]±0.01	73.33[b]±2.11	80.83[c]±0.83	84.00[c]±1.00	83.75[c]±0.82
Live sperm (%)	66.67[a]±0.88	70.67[ab]±1.45	75.00[b]±2.05	86.83[c]±1.70	90.20[d]±0.49	91.00[d]±0.50
Dead sperm (%)	33.33[d]±0.88	29.33[cd]±1.45	25.00±[c]2.05	14.17[b]±1.70	9.80[a]±0.49	9.00[a]±0.50
Abnormal sperm (%)	9.67[c]±0.33	8.00[b]±0.58	5.67[ab]±0.92	4.00[a]±0.45	4.80[ab]±0.73	4.50[a]±0.19
HOS reactive sperm (%)	65.82[a]±1.57	69.23[ab]±3.05	74.50[b]±2.55	76.33[b]±1.38	83.80[c]±0.66	85.63[c]±0.38

N= Number of bucks / ejaculates; Means bearing uncommon superscripts within the row differ significantly ($p < 0.05$).

Sexual behavior and semen quality of adolescent bucks

Most of the growing bucks at the age of 6-7 months were found to mount each other in the group with penile protrusion. The heavier bucks were observed thrusting their pelvis with protruded penis on other males in free living and expressed strong libido. However, when approached for semen collection with secured dummy male, many were reluctant to mount and protrude penis initially, hence a female goat was transferred from Instructional Livestock Farm Complex of the College to Sperm Station of Gynaecology Department for semen collection, where they gradually showed interest and started donating semen in AV. Out of 11 bucks, 3 bucks never reacted on secured dummy female even, hence their semen could not be harvested/ evaluated due to their shy breeding behavior and reluctance to react in presence of handler and semen collector, though they were mounting and protruding penis in free natural condition in yard.

The semen quality of 3-8 adolescent bucks observed from 7 months of age gradually and significantly ($p < 0.05$) improved in respect of all the seminal attributes with advancing age till 9-10 months of age with increasing in number of bucks donating semen. Thereafter the semen quality became almost stable till 11 months of age. The
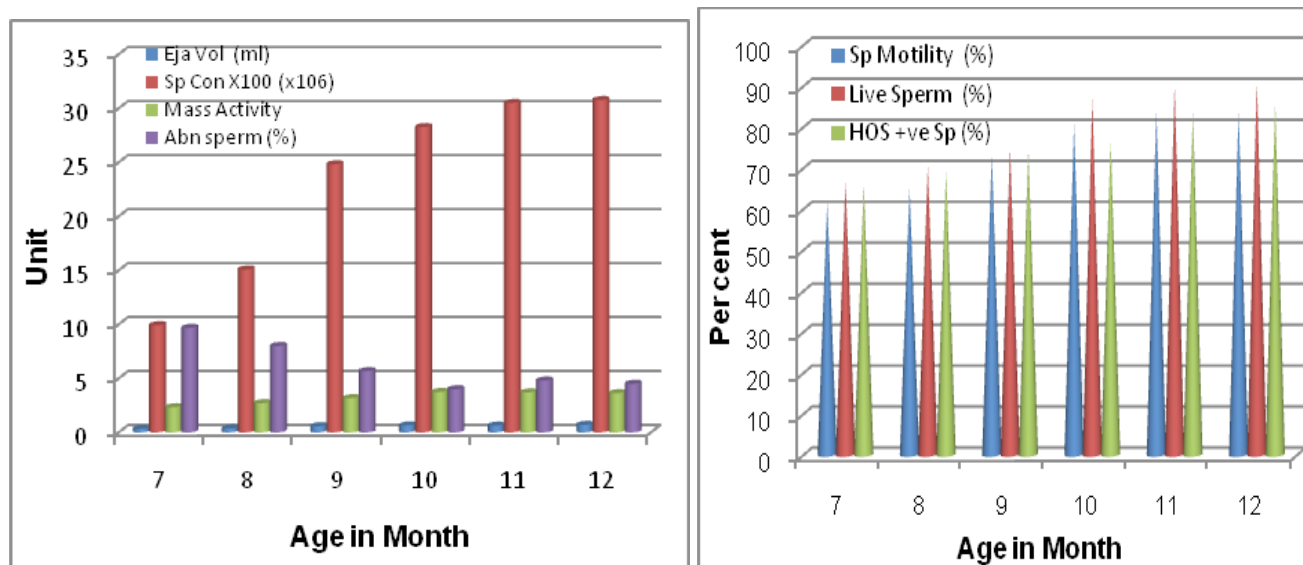
Fig. 2: Semen quality of adolescent Surti buck in relation to growing age

ejaculate volume and sperm concentration per ml of semen recorded at 7 months of age were 0.33±0.03 ml and 991.67±20.48 million, respectively. These values increased gradually and significantly (p<0.01) to 0.58±0.05 – 0.65±0.04 ml and 2481.56±86.12 – 2826.11±126.41 million by 9-10 months of age and then showed statistically similar values till 12 months of age. Mass activity and sperm motility (2.33±0.17 and 61.67±1.67 %) also followed similar trend reaching peak values by 9-10 months of age (3.71±0.11 and 80.83±0.83%). The live sperm and HOS reactive sperm per cent at 7 month of age were 66.67±0.88 and 65.82±1.57, which rose significantly and gradually (p<0.01) with advancing age till 11th month of age (90.20±0.49 and 83.80±0.66 %), while abnormal sperm had reverse trend with significantly lower value (<4.80±0.73%) after 10 months of age (Table 3, Fig. 2). These findings suggest that the Surti bucks attain puberty and sexual maturity around 6-7 months and 9-10 months of age, respectively.

The semen quality parameters observed in pubertal Surti bucks were in accordance with the findings of different authors in different breeds of goats and sheep (Afroz, 2005; Apu, 2007; Jadav, 2008; Souza *et al*., 2010, 2011; Moulla *et al*., 2018). According to Tutida *et al.* (1999) and Santos and Simplicio (2000), environmental factors such as nutritional status, seasonal variations, method of semen collection and ejaculatory frequency can influence the activity of accessory sex glands, which are responsible for semen quality and quantity. According to Aguiar *et al.* (2006), such increase in the spermatogenic activity at the referred age results from the significant development of the seminiferous tubules and to the Sertoli cell differentiation. Based on testicular biometry, sexual behavior and semen quality parameters Souza *et al.* (2011) reported that puberty was reached at the 20th week and sexual maturity at the 38th week of age in Anglo-Nubian male goats, which is in accordance to our study in Surti goats.

CONCLUSION

The study revealed that the adolescent Surti bucks attain puberty and sexual maturity on an average at 7-8 months and 9-10 months of age with an almost stable body weight, scrotal/ testicular biometry and semen quality. Hence, these criteria may be considered while selecting Surti bucks for breeding purpose for gaining optimum breeding efficiency.

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