Research article

DOI: 10.48165/ijar.2024.45.01.7

The Indian Journal of Animal Reproduction

The official journal of the Indian Society for Study of Animal Reproduction

ACS Publisher www.acspublisher.com

Year 2024, Volume-45, Issue-1 (June)

ISSN 0970-2997 ***(Print)*** *ISSN 2583-7583* ***(Online)***

Testicular Biometry and its Relationship with Body Weight and Semen Parameters of Sirohi and Jamnapari Bucks

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ABSTRACT

The objective of this study was to examine the relationship between testicular biometry and body weight, as well as semen parameters (ejaculate volume and total sperm concentration/ejaculate) in Sirohi and Jamnapari bucks. A total of six bucks (2 Sirohi and 4 Jamnapari) were chosen for testicular biometry. The average body weight for Sirohi and Jamnapari bucks was 48.7±3.0 kg and 38.82±1.3 kg, respectively. Similarly, the average scrotal circumference was measured to be 27.35±0.57 cm for Sirohi bucks and 25.11±0.4 cm for Jamnapari bucks. The semen volume of Sirohi and Jamnapari bucks was recorded to be 1.15±0.1 ml and 0.79±0.0 ml, respectively. Additionally, the total sperm concentration per ejaculate was found to be 3120±165.6 million for Sirohi bucks and 2263±101.0 million for Jamnapari bucks. There was a positive correlation between scrotal circumference and body weight in both the breeds.

The measurements of the left testis exceeded those of the right testis at the same age. The semen volume and total sperm concentration per ejaculate showed a strong and statistically significant correlation with almost all testicular indices ($p< 0.01$). In conclusion, this study could provide valuable insights for the selection of breeding bucks.

Key words: Testicular biometry, Sirohi, Jamnapari, buck semen, scrotal circumference

How to cite: Alam, K., Srivastava, S., Kumar, R., Saurabh, Verma, A. K., Verma, S. K., Jaiswal, A., & Verma, H. C. (2024). Testicular Biometry and its Relationship with Body Weight and Semen Parameters of Sirohi and Jamnapari Bucks. *The Indian Journal of Animal Reproduction, 45*(1), 29–34. 10.48165/ijar.2023.45.01.7

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Received 09-02-2024; Accepted 07-03-2024

INTRODUCTION

Buck plays a crucial role in ensuring a high conception rate and establishing superior genetic traits in the offspring (Ford *et al.,* 2009). The fertility of bucks plays a crucial role in goat production, impacting herd performance and reproductive efficiency (McGowan 2004). Therefore, it is essential to carefully select highly fertile bucks in order to enhance goat production (Chacon *et al.,* 1999; Memon *et al.,* 2007). The evaluation of semen characteristics, including ejaculate volume, colour, consistency, mass motility, progressive motility, and sperm concentrations, may not be sufficient to determine the suitability of breeder bucks (Al-Ghalban*et al.,* 2004; Al-Omari, 2012). However, in order to improve goat production, an assessment of testicular biometry is crucial for the optimal and economical utilization of the breeding stock. Testes circumference, length, width, and other related measurements can serve as reliable indicators of the sperm-producing capacity of male goats (Datta *et al.,* 2009). Keith et al. (2009) have highlighted the significance of scrotal size and testicular measurements in enhancing sperm production in breeding males. According to Ashutosh (2014), there was a strong positive correlation between testicular measurements and both semen volume and sperm concentration. Hannan et al. (2017) observed a positive correlation between scrotal circumference and sperm parameters, as well as other reproductive factors. Therefore, this study aimed to determine the relationship between body weight, testicular measurements and semen parameters in indigenous goats.

MATERIALS AND METHODS

The research trial was conducted at the Frozen Semen Laboratory, Acharya Narendra Deva University of Agriculture & Technology, Kumarganj, Ayodhya, from September 1 to November 30, 2023. A group of six bucks (3-4 year old); i.e. two Sirohi and four Jamnapari was chosen for the trial. Before selecting the experimental bucks, a thorough assessment of their overall physical well-being was observed. Further examination was conducted on the testes and scrotum to ensure no abnormalities were present. All the chosen male bucks were raised in a highly controlled management system. All selected bucks underwent deworming, vaccination, and dipping following the MSP guidelines. The weight of each animal was measured in kilograms on a weekly basis. The measurement of body weight was conducted using a weighing balance with the weight recorded in kilogram's (kg). Scrotal circumference (SC) was determined by using a measuring tape to measure the largest diameter of the testes and scrotum in centimetres (cm), after applying pressure to push the testes securely into the scrotum. Vernier calliper (Raji *et al.,* 2008) was used to measure the diameter and length of the testicles in millimetres (mm). Testicular volume was measured using the formula TV= $TD^2xTLx0.5$. All these measurements were obtained concurrently with the recording of body weight on the same day.

Semen samples from all bucks were collected biweekly using the artificial vagina at a temperature of 45°C. The semen samples were promptly assessed for colour, volume, and concentration upon collection. The semen volume was quantified using a graduated semen collection tube, measured in milliliter. The sperm concentration of all samples was quantified using an Accucell photometer (IMV, France).

The mean and standard error for body weight, testicular biometric data, and semen parameters were analyzed using Graph Pad Prism software (version 5). A study was conducted to analyze testicular biometry in relation to body weight and semen parameters using One-way ANOVA analysis. Duncan multiple range tests were conducted to detect any significant disparities among the average values. A Pearson's correlation analysis was conducted to examine the correlation between various traits.

RESULTS AND DISCUSSION

Testicular biometry with relation to body weight and semen parameters of all selected bucks is summarized in the Table 1. The average body weight of Sirohi and Jamnapari bucks was 48.7±3.0 kg and 38.82±1.3 kg, respectively. The scrotal circumference for Sirohi bucks was 27.35±0.57 cm, while for Jamnapari bucks it was 25.11±0.4 cm. Kadam et al. (2020) also reported similar findings regarding the Beetal and Osmanabadi buck. In another investigation, Kabiraj et al. (2011) found that the average body weight of adult black Bengal goats was 27.81±0.46 kg, a significantly lower value compared to the findings of the current study. Various factors can contribute to this, such as breed and/or sex differences, the physical condition of the selected

Table 1: Average values of body weight, different testicular biometry indices and semen parameters in Sirohi and Jamnapari bucks

Bucks/ Parameters	BW (KG)	SC (cm)	RTL (cm)	LTL (cm)	RTD (cm)	LTD (cm)	RTV (cm^3)	LTV (cm^3)	PTV (cm^3)	EV (ml)	TC/Ejac. (million)
SIROHI	48.7 ± 3.0^{cdefg}	29.99 ± 0.3^{bcdef}	11.44 ± 0.1^{abcd}	12.18 ± 0.1^{abcde}	5.5 ± 0.1^{ab}	5.62 ± 0.1^{abc}	173.7 ± 5.9^{defg}	186.6 ± 5.8^{efg}	360.3 ± 11.0^{fg}	1.15 ± 0.1^{a}	3120 ± 165.6^{g}
JAMNAPARI	38.82 ± 1.3^{efgh}	25.11 ± 0.4^{defg}	10.09 ± 0.3^{bcde}	10.25 ± 0.3^{cde}	4.6 ± 0.1^{abc}	4.74 ± 0.1^{abc}	113.6 ± 7.4^{fghi}	117.7 ± 7.2^{ghi}	231.3 ± 14.5^{hi}	0.79 ± 0.0^{a}	2263 ± 101.0^{i}

Means with different superscripts within the row differ significantly($p<0.05$)

BW=Body weight, SC=Scrotal circumference, RTL=Right testicular length, LTL= Left testicular length, RTD=Right testicular diameter, LTD=Left testicular diameter, RTV=Right testicular volume, LTV=Left testicular volume, PTV=Pool testicular volume, Ejaculate volume, TC=Total concentration.

Table 2: Correlation of Body weight and different testicular biometry indices with various semen parameters in Sirohi bucks (Pooled)

Particulars	BW (KG)	SC (cm)	RTL (cm)	LTL (cm)	RTD (cm)	LTD (cm)	RTV (cm^3)	LTV (cm^3)	PTV (cm^3)	EV (ml)	TC/Ejac. (million)
BW (KG)	1	0.74^{**}	0.64^{**}	0.56^{*}	0.16	0.23	0.22	0.30	0.31	0.74^{**}	0.76^{**}
SC (cm)	0.74^{**}	1	0.90^{***}	0.77^{**}	0.72^{**}	0.61^{**}	0.76^{**}	0.69^{**}	0.81^{***}	0.74^{**}	0.45^{*}
RTL (cm)	0.64^{**}	0.90^{***}	1	0.69^{**}	0.70^{**}	0.56^{*}	0.73^{**}	0.62^{**}	0.75^{**}	0.67^{**}	0.39
LTL (cm)	0.56^{*}	0.77^{**}	0.69^{**}	1	0.74^{**}	0.70^{**}	0.78^{**}	0.77^{**}	0.80^{**}	0.81^{***}	0.65^{**}
RTD (cm)	0.16	0.72^{**}	0.70^{**}	0.74^{**}	1	0.67^{**}	1.00^{***}	0.71^{**}	0.93^{***}	0.40	0.05
LTD (cm)	0.23	0.61^{**}	0.56^{*}	0.70^{**}	0.67^{**}	1	0.67^{**}	0.99^{***}	0.84^{***}	0.70^{**}	0.29
RTV (cm^3)	0.22	0.76^{**}	0.73^{**}	0.78^{**}	1.00^{***}	0.67^{**}	1	0.73^{**}	0.94^{***}	0.44^{*}	0.11
LTV (cm^3)	0.30	0.69^{**}	0.62^{**}	0.77^{**}	0.71^{**}	0.99^{***}	0.73^{**}	1	0.88^{***}	0.76^{**}	0.37
PTV (cm^3)	0.31	0.81^{***}	0.75^{**}	0.80^{**}	0.93^{***}	0.84^{***}	0.94^{***}	0.88^{***}	1	0.60^{*}	0.23
EV (ml)	0.74^{**}	0.74^{**}	0.67^{**}	0.81^{***}	0.40	0.70^{**}	0.44^{*}	0.76^{**}	0.60^{*}	1	0.83^{***}
TC/Ejac.(milli.)	0.76^{**}	0.45^{*}	0.39	0.65^{**}	0.05	0.29	0.11	0.37	0.23	0.83^{***}	1

***Significant at 5%, ** Significant at 1%**

BW=Body weight, SC=Scrotal circumference, RTL=Right testicular length, LTL= Left testicular length, RTD=Right testicular diameter, LTD=Left testicular diameter, RTV=Right testicular volume, LTV=Left testicular volume, PTV=Pool testicular volume, Ejaculate volume, TC/Ejac. =Total concentration per ejaculate

Table 3: Correlation of Body weight and different testicular biometry indices with various semen parameters in Jamnapari bucks (Pooled)

Particulars	BW (KG)	SC (cm)	RTL (cm)	LTL (cm)	RTD (cm)	LTD (cm)	RTV (cm^3)	LTV (cm^3)	PTV (cm^3)	EV (ml)	TC/Ejac. (million)
BW (KG)	1	0.91***	0.92***	0.91***	0.68**	0.62**	0.89***	0.86***	0.89***	0.76**	0.73**
SC (cm)	0.91***	1	0.97***	0.87***	0.66**	0.55*	0.88***	0.78**	0.84***	0.64**	0.65**
RTL (cm)	0.92***	0.97***	1	0.92***	0.65**	0.51*	0.89***	0.79**	0.85***	0.68**	0.65**
LTL (cm)	0.91***	0.87***	0.92***	1	0.54*	0.52*	0.81***	0.81***	0.81***	0.65**	0.62**
RTD (cm)	0.68**	0.66**	0.65**	0.54*	1	0.92***	0.89***	0.85***	0.90***	0.59*	0.72**
LTD (cm)	0.62**	0.55*	0.51*	0.52*	0.92***	1	0.77**	0.88***	0.84***	0.51*	0.63**
RTV (cm^3)	0.89***	0.88***	0.89***	0.81***	0.89***	0.77**	1	0.93***	0.99***	0.66**	0.77**
LTV (cm^3)	0.86***	0.78**	0.79**	0.81***	0.85***	0.88***	0.93***	1	0.97***	0.60*	0.71**
PTV (cm^3)	0.89***	0.84***	0.85***	0.81***	0.90***	0.84***	0.99***	0.97***	1	0.66**	0.77**
EV (ml)	0.76**	0.64**	0.68**	0.65**	0.59*	0.51*	0.66**	0.60*	0.66**	1	0.88***
TC/Ejac.(milli.)	0.73**	0.65**	0.65**	0.62**	0.72**	0.63**	0.77**	0.71**	0.77**	0.88***	1

*Significant at 5%, ** Significant at 1%

BW=Body weight, SC=Scrotal circumference, RTL=Right testicular length, LTL= Left testicular length, RTD=Right testicular diameter, LTD=Left testicular diameter, RTV=Right testicular volume, LTV=Left testicular volume, PTV=Pool testicular volume, Ejaculate volume, TC/Ejac. =Total concentration per ejaculate

animals, agro-climatic conditions, nutritional levels, housing, disease prevalence, and other management procedures.

It was observed that the Sirohi buck had higher body weight and scrotal circumference compared to the Jamnapari buck, with statistical significance ($p<0.05$). These differences may be attributed to larger body sizes of Sirohi bucks in comparison to Jamnapari bucks. In a study conducted by Kadam et al. (2020), it was found that the average scrotal circumference of adult Beetal Bucks was 27.35±0.57 cm. This finding is consistent with the results of our current study. In contrast, Kabiraj et al. (2011) reported lower values as compared to present findings. It is possible that breed differences, post-weaning feed level, contemporary group/feed level, age of dam, and covariates age, weight, and height of bucks may have contributed to this phenomenon (Bourdon and Brinks, 1986).

The ejaculate volume obtained was 1.15±0.1 ml in Sirohi bucks and 0.79±0.0 ml in Jamnapari bucks. It was observed that the ejaculate volume was significantly ($p<0.05$) higher in Sirohi bucks compared to Jamnapari bucks. The possible reasons for the higher semen volume in Sirohi goats could be attributed to larger scrotal circumferences in comparison to the Jamnapari bucks. The observations we made provide strong support for the findings of Kadam et al. (2020). In contrast, Kabiraj et al. (2011) found that the volume in black Bengal buck ranged from 0.32 to 0.68 ml, which is lower than the value observed in our findings. These variations could be attributed to variances in breed and nutrition. The production of semen is influenced by various factors, including age, sexual maturity, nutritional status, overall health, hormonal balance, and the condition of the reproductive organs and season (Karagiannidis *et al.,* 2000).

The total sperm concentration in Sirohi bucks was significantly higher ($p<0.05$) compared to Jamnapari bucks. The findings of the present study strongly agree with those of Kadam et al. (2020). Sharma et al. (1991) documented that sperm concentration can vary based on factors such as age, breed, collection frequency, feeding regimen, and climatic conditions.

The correlation coefficients (r) between body weight, scrotal circumference, testicular length, testicular diameter, ejaculate volume, and total sperm concentration/ejaculate in Sirohi and Jamnapari bucks are presented in Tables 2 and 3. In the Sirohi breed, it was observed that body weight had a strong correlation coefficient ($p<0.05$) with scrotal circumference ($r = 0.74$), ejaculate volume ($r = 0.74$), and total sperm concentration/ejaculate ($r = 0.76$) (Table 2). The current study's findings align with those of Kabiraj et

al. (2011), who observed a substantial positive correlation coefficient ($p<0.01$) between body weight and both ejaculate volume ($r = 0.88$) and total sperm concentration per ejaculate ($r = 0.75$) in black Bengal goats in Bangladesh. Nevertheless, Fonseca et al. (2021) also detected a statistically significant ($p<0.01$) positive association between scrotal circumference and body weight ($r = 0.66$) in Sanen goats in Brazil.

In the Jamnapari breed, there was a significant ($p < 0.01$) and positive correlation between body weight and scrotal circumference ($r =0.91$), ejaculate volume ($r=0.76$), and total sperm concentration per ejaculate ($r=0.73$) (Table 3). The correlations observed in this study were consistent with the results reported by Kadam et al. (2020) in the Beetal and Osmanabadi goat breeds. The study found that as age and body weight increased, there was an observed increase in both testicular parameters and semen parameters (Kabiraj *et al.*,2011). In addition, Okere *et al.* (2011) found a positive correlation between body condition scores and body weight, as well as a positive correlation between scrotal circumference and semen volume. This is consistent with the current finding in all bucks with scrotal circumference. Moreover, Kabiraj et al. (2011) observed that there is a positive correlation between testicular circumference and spermatozoa concentration. This may be attributed to increased testicular size and heightened spermatogenic activity. Aliyuet al. (2016) discovered a positive correlation between body weight and scrotal circumference with semen parameters such as semen colour, semen volume, semen concentration, and sperm motility. Furthermore, the scrotal circumference and the body weight have shown negative and positive correlation with various semen parameters but they were statistically not significant (Pratibha *et al.,* 2019). The present findings align with the Aliyu et al. (2016) regarding semen concentration and ejaculate volume. Finally, it is important for a potential breeding buck to have an appropriate scrotal circumference, as this is directly related to the concentration of sperm and the total number of spermatozoa in each ejaculation. Moreover, Chaudhari et al. (2018), reported that highest reproductive potential in Surti bucks attained at 9-10 months of age and this criteria can be used to select Surti breeding bucks.

CONCLUSIONS

The study concluded that as age and body weight increased, there was a corresponding increase in testicular biometry and semen parameters. The dimensions and length of the left testis were greater than those of the right testis in the same individual in both breeds of goat. The quality of semen, including ejaculate volume and total sperm concentration per ejaculate, showed a strong correlation with scrotal circumference and testicular biometry. However, additional research is advised for further elucidation. This study could provide valuable insights for the selection of a breeding buck.

ACKNOWLEDGEMENTS

The authors are highly thankful to Dean, C.V.Sc. & A.H., ANDUAT, Kumarganj, for providing fund and facilities required for this research work.

CONFLICT OF INTEREST

The authors declare that they have no competing interest with this manuscript.

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