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AS Kardani

PG Scholar, Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari, Gujarat, India

Dr. LC Modi

Assistant Professor, Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari, Gujarat, India

NF Chaudhari

Assistant Professor, Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari, Gujarat, India

AA Pathan

PG Scholar, Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari, Gujarat, India

CT Khasatiya

PG Scholar, Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari, Gujarat, India

JM Chaudhary

PG Scholar, Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari, Gujarat, India

Corresponding Author:

Dr. LC Modi

Assistant Professor, Department of Veterinary Gynaecology and Obstetrics, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari, Gujarat, India

Seminal parameters and their correlations in surti buck Semen

AS Kardani, Dr. LC Modi, NF Chaudhari, AA Pathan, CT Khasatiya and JM Chaudhary

Abstract

The present research work was carried out to study the neat semen parameters of freshly ejaculates from the Surti bucks. Four apparently healthy mature Surti bucks above 1 year of age were selected. Fresh semen was collected twice a week for 8 weeks from each buck (16 ejaculates/buck). Neat semen was analyzed for colour, volume, density, mass activity, sperm concentration and total sperm count per ejaculate. Fresh semen was pale yellow in colour. The overall mean values of semen volume, density, mass activity, sperm concentration and total sperm count analyzed were 0.43 ± 0.01 ml, 3.52 ± 0.07 , 3.66 ± 0.06 , 3796.88 ± 34.88 million/ml, 1624.61 ± 47.46 million, respectively. Only total sperm count was varied significantly ($p < 0.05$) among bucks. Ejaculate volume was significantly ($p < 0.01$) positively correlated with total sperm count ($r = 0.942$) and non-significantly negatively correlated with density ($r = -0.232$), mass activity ($r = -0.228$) and sperm concentration ($r = -0.245$). Results showed all the neat semen parameters of Surti buck were observed within its normal physiological range.

Keywords: Correlations, Semen parameters, Surti bucks

1. Introduction

According to archaeologists, the "Fertile Crescent" in the Eastern Mediterranean is where the goat originally domesticated. Since they were brought into domestication, goats have served a variety of purposes in food production, labour, folklore and even religion. The dairy industry in India contributes to reducing unemployment and poverty. About 27.8% of the total livestock population is contributed by goats as per 20th Livestock Census. The Goat population in the country in 2019 (20th livestock census) is 148.89 million showing an increase of 10.1% over the previous census. As per 20th livestock census, the nation produces the most goat milk in the world, accounting for 26.31% of global production. The entire goat milk production is 5377.59 thousand tonnes, accounting for approximately 3% of overall milk production. Maximum numbers of goat breeds are found in dry climatic areas and Gujarat being one among the areas harbours diversity of more than 18 domestic animal breeds. The Gujarat state is home to many different goat breeds, including Kutchi, Surti, Mehsani, Jhalawadi, Gohilwadi, Marwari *etc.* The Surti breed, also known as Khandeshi, is most prevalent around Surat and Nasik. To increase the milk production and satisfy the increasing demand of milk and meat, genetic gain in production is required which is contributed by reproduction. So efficient use of good quality semen is key point to improve reproduction in field condition *via* Natural service or implementation of Artificial insemination. Artificial Insemination is one the important assisted reproductive technologies, which causes widespread propagation of semen, limiting the spread of venereal transmitted diseases (Thangamani *et al.*, 2018) ^[1] and an important tool to conserve the valuable germplasm to improve the genetic quality of farm animals. Hence, the present study was carried out to study the neat seminal attributes of Surti buck.

2. Materials and Methods

The study was conducted on four apparently healthy mature Surti bucks above one year of age maintained under the All India Coordinated Research Project (AICRP) on Surti Goat at Livestock Research Station, Kamdhenu University Navsari.

The selected bucks were housed in a common covered pen and under naturally existing photoperiod and air temperature of the South Gujarat. The animals were allowed to graze between 2:30 PM to 4:30 PM and fed with good quality fodder ad libitum along with 500 gm of concentrate per animal per day. They were dewormed four times in a year using different types of dewormer and regularly vaccinated against common diseases *viz.* Peste des Petits Ruminants (PPR) and Foot and Mouth Disease (FMD). The selected bucks were housed in a common covered pen and separated from females. The bucks were trained to donate the semen in artificial vagina by using female (doe) as dummy. After completion of the training period of about one month, semen was collected regularly by using artificial vagina twice a week from each buck for up to 8 weeks and total 64 semen ejaculates (16 ejaculates from each buck) were collected. Semen was collected from all the selected bucks at early morning between 6.30 AM to 7.30 AM with the help of Eight-inch Artificial Vagina (AV) maintaining inner temperature of 40 °C to 42 °C and sufficient pressure. A small pinch of K-Y jelly (Johnson and Johnson, France) was applied at the opening end of the artificial vagina as lubricant at the time of semen collection. In order to maintain quality of

semen, all the parts of Artificial vagina are properly sterilized and for each buck separate Artificial vagina was used and during collection buck apron was applied to prevent further contamination. Immediately after collection, the semen samples were evaluated for various parameters *viz.* semen volume, colour, density, mass activity, sperm concentration, and total sperm count following standard methods in practice. For statistical analysis, Descriptive analysis was carried out and mean \pm SE was calculated for all the neat semen parameters. The test of significance for above parameters was made by analysis of variance (ANOVA) and the mean difference between the bucks were tested by using Duncan's new Multiple Range test (DNMRT) at 5 and 1 percent level of significance. Finally, correlation coefficient among all the above neat semen parameters were carried out at 5 and 1 percent level of significance.

3. Results and Discussions

3.1 Neat Semen parameters

The neat semen parameters *viz.* semen colour, semen volume, semen density, mass activity, sperm concentration and total sperm count are presented in table 1.

Table 1: Buck-wise neat semen parameters (Mean \pm SE) of Surti bucks.

| Sr. no | Buck No. | N | Volume (ml) | Density | Mass activity | Sperm Concentration ($\times 10^6$ /ml) | Total Sperm count ($\times 10^6$) |
|---------|----------|----|-----------------|-----------------|-----------------|--|-------------------------------------|
| 1 | 37/21 | 16 | 0.39 \pm 0.02 | 3.44 \pm 0.18 | 3.63 \pm 0.13 | 3753.13 \pm 87.97 | 1456.25 \pm 71.55 ^b |
| 2 | 39/21 | 16 | 0.40 \pm 0.02 | 3.56 \pm 0.13 | 3.75 \pm 0.11 | 3821.88 \pm 54.58 | 1529.69 \pm 96.47 ^{ab} |
| 3 | 02/22 | 16 | 0.46 \pm 0.02 | 3.50 \pm 0.16 | 3.63 \pm 0.15 | 3787.50 \pm 70.19 | 1747.50 \pm 93.27 ^a |
| 4 | 07/22 | 16 | 0.46 \pm 0.03 | 3.56 \pm 0.13 | 3.63 \pm 0.13 | 3825.00 \pm 67.55 | 1765.00 \pm 99.53 ^a |
| Overall | | 64 | 0.43 \pm 0.01 | 3.52 \pm 0.07 | 3.66 \pm 0.06 | 3796.88 \pm 34.88 | 1624.61 \pm 47.46 |
| F value | | | 2.37 | 0.16 | 0.23 | 0.23 | 2.91* |
| P value | | | 0.08 | 0.92 | 0.88 | 0.88 | 0.04 |

^{a-b} Means values with different superscript within column differs significantly at $p < 0.05$

In the present study, the semen colour was pale yellow in all ejaculates of Surti buck, which is comparable with the earlier study of Ahmad and Noakes (1996) [2] in British Saanen, British Alpine and British Toggenberg breeds of Goat; Oyeyemi *et al.* (2000) [3] in West African Dwarf bucks; Hafez and Hafez (2000) [4] in buck; Sharma *et al.* (2018) [5] in Gaddi buck; Kumbhar *et al.* (2019) [6] in Osmanabadi buck; Sharma and Sood (2019) [7] in Chegu buck; Patil *et al.* (2019) [8] in Berari buck; Kumar *et al.* (2022) [9] and Karthik (2022) [10] in Surti buck, who recorded an ejaculate colour of buck semen varies from yellowish to creamy white, white creamy, pale yellow to cream, creamy white to yellowish, yellowish white, creamy white to yellowish, creamy and pale yellow colour, respectively. In fact, colour varies between bucks and between ejaculates from the same buck.

The mean semen ejaculate volume (ml) was highest in buck no. 02/22 (0.46 \pm 0.02) and lowest in buck no. 37/21 (0.39 \pm 0.02). The mean semen ejaculate volume was non-significantly differs between the bucks with an overall mean ejaculate volume of Surti buck semen was 0.43 \pm 0.01 ml from the different bucks. Which was agreement the mean semen ejaculate volume (ml) as 0.42 \pm 0.12 reported by Swarna *et al.* (2022) [11] in Indigenous buck; 0.47 \pm 0.02 reported by Kumar *et al.* (2022) [9] and 0.45 \pm 0.03 reported by Karthik (2022) [10] in Surti buck.

The mean semen ejaculate volume (ml) of Surti buck in the present study was little bit lower than that observed as 0.51 \pm 0.01 ml by Kalyani *et al.* (2015) [12] in Black Bengal buck; 0.81 \pm 0.02 by Kumbhar *et al.* (2019) [6] in Osmanabadi bucks; 0.80 \pm 0.07 by Sharma and Sood (2019) [7] in Chegu

goat and 0.66 \pm 0.04 and 0.77 \pm 0.04 by Sharma and Sood (2021) [13] in Gaddi and Chegu goats, respectively. Whereas, some other studies reported higher ejaculate volume (ml) than that recorded in the present study. The mean ejaculate volume (ml) in these studies observed as 1.31 \pm 0.09 by Al-Ghalban *et al.* (2004) [14] in Damascus bucks; 1.21 \pm 0.09 by Kridli *et al.* (2005) [15] in Mountain black goat buck; 0.91 \pm 0.03 by Barkawi *et al.* (2006) [16] in Zaraibi bucks; 1.47 \pm 0.07 by Kridli *et al.* (2007) [17] in Black Bedouin buck; 0.58 \pm 0.03 by Apu *et al.* (2008) [18] in Black Bengal bucks; 1.2 \pm 0.06 by Talebi *et al.* (2009) [19] in Markhoz bucks; 1.60 \pm 0.04 by Zamiri *et al.* (2010) [20] in Moghrani rams; 1.04 \pm 0.11 by Sultana *et al.* (2013) [21] in Bengal bucks; 1.18 \pm 0.06 by Patil *et al.* (2019) [8] in Berari bucks; 1.00 \pm 0.10 and 0.97 \pm 0.09 by Gore *et al.* (2020) [22] in Toggenburg and Saanen bucks, respectively; 1.08 \pm 0.05 and 1.18 \pm 0.04 by Goswami *et al.* (2020) [23] in Beetal and Sirohi bucks, respectively.

Seminal attributes are affected by many factors, including the breed, body weight, age, management, climatic conditions, nutrition, method of semen collection, degree of sexual stimulation (Zamiri and Heidari, 2006) [24]. Therefore, this could be the reason for variations in the ejaculate volume reported by various researchers.

The mean semen density was highest in buck no. 39/21 (3.56 \pm 0.13) and lowest in buck no. 37/21 (3.44 \pm 0.18) with an overall mean semen density of Surti buck semen was 3.52 \pm 0.07 in the ejaculates of different bucks. The mean semen density was non-significantly differs between the bucks. Which was corroborated the mean semen density as 3.31 \pm 0.08 reported by Kumar *et al.* (2022) [9] and 3.25 \pm 0.11 to

3.56 ± 0.13 by Karthik (2022) ^[10] in Surti buck, whereas, higher mean semen density was observed by Farshad *et al.* (2012) ^[25] in Markhoz bucks during breeding season as 3.91 ± 0.03; Atara *et al.* (2018) ^[26] in Surti buck as 3.91 ± 0.03 and Patel *et al.* (2020) ^[27] in Surti buck during rainy season as 3.99 ± 0.01. Contrary to present findings Kridli *et al.* (2005) ^[15] in Mountain black goat buck, Kumbhar *et al.* (2019) ^[6] in Osmanabadi bucks; Gore *et al.* (2020) ^[22] in Saanen and Toggenburg bucks reported lower mean semen density in their experiments.

The mean mass activity was highest in buck no. 39/21 (3.75 ± 0.11) and lowest in buck no. 37/21 (3.63 ± 0.13) with an overall mean mass activity of Surti buck semen was (3.66 ± 0.06) in the ejaculates of different bucks. The mean mass activity was non-significantly differs between the bucks. Which was corroborated the mean mass activity as 3.58 ± 0.14 reported by Kharche *et al.* (2013) ^[28] in Jamunapari bucks; 3.69 ± 2.87 by Gore *et al.* (2020) ^[22] in Saanen bucks; 3.60 ± 0.52 to 2.40 ± 0.52 by Swarna *et al.* (2022) ^[11] in Indigenous buck and 3.50 ± 0.13 to 3.38 ± 0.13 by Karthik (2022) ^[10] in Surti buck. whereas, higher mean mass activity was observed by Kridli *et al.* (2005) ^[15] in mountain black buck (71.6 ± 8.00%); Atara *et al.* (2018) ^[26] in Surti buck (4.73 ± 0.04); Patil *et al.* (2019) ^[8] in Berari bucks (4.42 ± 0.15) to (3.58 ± 0.15); Patel *et al.* (2020) ^[27] in Surti buck during rainy season (4.84 ± 0.04) and Gore *et al.* (2020) ^[22] in Toggenburg bucks (4.02 ± 0.16). Contrary to present findings Kumbhar *et al.* (2019) ^[6] in Osmanabadi bucks and Kumar *et al.* (2022) ^[9] in Surti buck reported lower mass activity in their experiments.

The mass activity is individually measure, it may differ with operator's skill and scale pattern. The variation in the mean mass activity of semen in present and other research may be due to the used of different scale pattern which varies from 0 to 4 and 0 to 5.

The mean Sperm concentration ($\times 10^6$ /ml) was highest in buck no. 07/22 (3825.00 ± 67.55) and lowest in buck no. 37/21 (3753.13 ± 87.97) with an overall mean Sperm concentration of Surti buck semen was 3796.88 ± 34.88 in the ejaculates of different bucks. The sperm concentration was non-significantly differs between the bucks. Which was corroborated the mean Sperm concentration as 3417.36 ± 59.48 with a range of 3000 to 3700 million per ml reported by Patil *et al.* (2019) ^[8] in Berari bucks and 3932.81 ± 43.25 reported by Kumar *et al.* (2022) ^[9] in Surti buck. Contrary to present findings Kridli *et al.* (2005) ^[15] in Mountain black goat; Sultana *et al.* (2013) ^[21] in Bengal bucks; Kharche *et al.* (2013) ^[28] in Jamunapari goats; Atara *et al.* (2018) ^[26] in Surti buck; Kumbhar *et al.* (2019) ^[6] in Osmanabadi bucks; Patel *et al.* (2020) ^[27] in Surti bucks; Goswami *et al.* (2020) ^[23] in Sirohi and Beetal bucks; Gore *et al.* (2020) ^[22] in Saanen and Toggenburg bucks; Swarna *et al.* (2022) ^[11] in Indigenous buck and Karthik (2022) ^[10] in Surti buck reported lower mean Sperm concentration in their experiments.

The mean total sperm count ($\times 10^6$) was highest in buck no. 07/22 (1765.00 ± 99.53) and lowest in buck no. 37/21 (1456.25 ± 71.55) with an overall mean total sperm count of Surti buck semen was 1624.61 ± 47.46 in the ejaculates of different bucks. Total sperm count ($\times 10^6$ /ml) was significantly ($p < 0.05$) higher in buck no. 07/22 and 2/22 as compared to buck no. 37/21. Moreover, total sperm count ($\times 10^6$ /ml) in buck no. 39/21 was non-significantly higher as compared to buck no. 37/21 while non-significantly lower as compared to buck no. 7/22 and buck no. 2/22. Which was corroborated the mean total sperm count ($\times 10^6$ /ml) as 2001.67 ± 142.56 to

1834.17 ± 147.35 reported by Patel *et al.* (2020) ^[27]; 1839.69 ± 72.75 by Kumar *et al.* (2022) ^[9]; 1708.44 ± 82.02 to 1386.88 ± 64.37 by Karthik (2022) ^[10] and 1546.93 ± 62.96 by Atara *et al.* (2018) ^[26] in young Surti buck. Contrary to present findings Farshad *et al.* (2012) ^[25] in Markhoz bucks; Atara *et al.* (2018) ^[26] in adult Surti buck; Goswami *et al.* (2020) ^[23] in Sirohi and Beetal bucks and Souri and Mirmahmoudi (2014) ^[29] in Merghoz buck reported low mean total sperm count in their experiments.

3.2 Correlation coefficients among various semen parameters of Surti buck neat semen

The correlation coefficients (r) observed between various neat Surti buck semen parameters under study are presented in Table 2. In the present study, correlation coefficients (r) between various parameters of Surti buck fresh semen revealed that the semen volume showed significant ($p < 0.01$) positive correlation with total sperm count ($r = 0.942$) and non-significant negative correlation with semen density ($r = -0.232$), mass activity ($r = -0.228$) and sperm concentration ($r = -0.245$). Similarly, Sharma and Sood (2021) ^[13] also reported semen volume of Gaddi buck was negatively correlated with sperm concentration (-0.161) and mass motility (-0.075). The semen density showed significant ($p < 0.01$) positive correlation with sperm concentration ($r = 0.814$) and non-significant positive correlation with semen mass activity ($r = 0.176$) and total sperm count ($r = 0.040$). The semen mass activity showed non-significant positive correlation with sperm concentration ($r = 0.226$) and negative correlation with total sperm count ($r = -0.163$). Similar results were also observed by Karthik (2022) ^[10].

Table 2: Correlation coefficients (r) among various seminal attributes of Surti buck neat semen

| Seminal attributes | Ejaculate Volume | Density | Mass activity | Sperm concentration |
|---------------------|------------------|---------|---------------|---------------------|
| Volume | 1 | -- | -- | -- |
| Density | -0.232 | 1 | -- | -- |
| Mass activity | -0.228 | 0.176 | 1 | -- |
| Sperm concentration | -0.245 | 0.814** | 0.226 | 1 |
| Total sperm count | 0.942** | 0.040 | -0.163 | -0.086 |

**Correlation is significant at the 0.01 level

The sperm concentration showed non-significant negative correlation with total sperm count ($r = -0.086$). Similarly, Karthik (2022) ^[10] also found sperm concentration was negatively correlated with total sperm count ($r = -0.818$) and ejaculated volume ($r = -0.901$) whereas positively correlated with density ($r = 0.915$) and mass activity ($r = 0.208$). In accordance with the present study Kumar *et al.* (2022) ^[9] reported that the ejaculate volume was negatively correlated with sperm concentration and positively correlated with total sperm count. Furthermore, Contrary to the present findings Kumar *et al.* (2022) ^[9] reported mass activity was negatively correlated with sperm concentration ($r = -0.197$) whereas positively correlated with total sperm output ($r = 0.083$) and semen density ($r = 0.152$).

4. Conclusion

All neat semen parameters *viz.* colour, volume, density, mass motility, sperm concentration and total sperm count were observed within the normal physiological range of Surti buck semen. The study established normal values for the quality parameters of neat semen of Surti bucks. Additionally, the study found that bucks over one year old can be used for

semen collection twice a week. The semen harvested has good quality, as indicated by its physical semen parameters.

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6. References

1. Thangamani A, Srinivas M, Prasad BC, Anusha K, Rao KS. Semen additives to improve motility and fertility of bovine spermatozoa-a review. *Int. J Environ Sci. Technol.* 2018;7(2):554-560.
2. Ahmad N, Noakes DE. Seasonal variations in the Semen quality of young British goats. *Br Vet J.* 1996;152(2):225-236.
3. Oyeyemi MO, Akusu MO, Ola-Davies OE. Effect of successive ejaculations on the spermogram of West African dwarf goats (*Capra hircus* L.). *Vet Arh.* 2000;70(4):215-221. <https://hrcak.srce.hr/100591>
4. Hafez B, Hafez ESE. *Reproduction in Farm Animals.* 7th ed. Lippincott Williams and Wilkens; c2000. p. 366.
5. Sharma A, Sood P, Dogra PK. Seminal plasma removal improves cryopreserved semen quality in Gaddi bucks. *Indian J Anim Reprod.* 2018;39(2):25-28.
6. Kumbhar UB, Gulavane SU, Gaikwad SM, Shelar RR, Deshpande VP, Rebeiro R, et al. Correlation of testicular ultrasonography, testicular biometry, serum testosterone levels and seminal attributes in pre- and post-pubertal age for breeding soundness evaluation in Osmanabadi bucks. *Trop Anim Health Prod.* 2019;51(6):1467-1480.
7. Sharma A, Sood P. Cryopreservation and fertility of frozen thawed Chegu goat semen. *Indian J Anim Res.* 2019;53(11):1414-1419.
8. Patil MG, Ingawale MV, Birade HS, Kuralkar SV, Waghmare SP, Hajare SW. Studies on seminal attributes of Berari bucks. *J Entomol Zool Stud.* 2019;7(2):85-88.
9. Kumar D, Khasatiya CT, Chaudhari NF, Modi LC, Singh VK. Seminal Attributes and their Correlations in Surti Bucks. *Indian J Vet Sci. Biotechnol.* 2022;18(1):113-115.
10. Karthik. Effect of clarified tris egg yolk citrate diluter and seminal plasma removal on cryopreservation of Surti buck semen. M.V.Sc. Thesis, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Navsari; 2022.
11. Swarna M, Saha NG, Biswas S, Paul AK. Collection and evaluation of indigenous buck semen at the coastal region of Bangladesh. *Insights Vet Sci.* 2022;6:1-4.
12. Kalyani R, Gojen SL, Bidhan S. Cryopreservation of Black Bengal buck semen by Tris-based extenders containing different levels of egg-yolk. *Ann Vet Anim Sci.* 2015;2(3):47-54.
13. Sharma A, Sood P. Seminal quality attributes and their interrelationships in Gaddi and Chegu bucks. *Indian J Small Ruminants.* 2021;27(1):50-55.
14. Al-Ghalban AM, Tabbaa MJ, Kridli RT. Factors affecting semen characteristics and scrotal circumference in Damascus bucks. *Small Rumin Res.* 2004;53(1-2):141-149.
15. Kridli RT, Tabbaa MJ, Sawalha RM, Amashe MG. Comparative Study of Scrotal Circumference and Semen Characteristics of Mountain Black Goat and Its Crossbred with Damascus Goat as Affected by Different Factors. *Jordan J Agric Sci.* 2005;1(1).
16. Barkawi AH, Elsayed EH, Ashour G, Shehata E. Seasonal changes in semen characteristics, hormonal profiles and testicular activity in Zaraibi goats. *Small Rumin Res.* 2006;66(1-3):209-213.
17. Kridli RT, Tabbaa MJ, Barakeh FS. Seasonal variation in scrotal circumference and semen characteristics of Black Bedouin and Black Bedouin-Damascus crossbred bucks. *Asian-Australas J Anim. Sci.* 2007;20(3):359-364.
18. Apu AS, Husain SS, Khandoker MAMY, Rahman AHMS, Notter DR. Investigation on seminal attributes and fertility of Black Bengal goat. *Bangladesh J Anim. Sci.* 2008;37(2):17-24.
19. Talebi J, Souri MONA, Moghaddam A, Karimi I, Mirmahmoudi M. Characteristics and seasonal variation in the semen of Markhoz bucks in western Iran. *Small Rumin Res.* 2009;85(1):18-22.
20. Zamiri MJ, Khalili B, Jafaroghli M, Farshad A. Seasonal variation in seminal parameters, testicular size, and plasma testosterone concentration in Iranian Moghani rams. *Small Rumin Res.* 2010;94(1-3):132-136.
21. Sultana F, Husain SS, Khatun A, Apu AS, Khandoker MAMY. Study on buck evaluation based on semen quality and fertility. *Bangladesh J Anim. Sci.* 2013;42(2):101-108.
22. Gore DLM, Muasya TK, Okeno TO, Mburu JN. Comparative reproductive performance of Saanen and Toggenburg bucks raised under tropical environment. *Trop Anim Health Prod.* 2020;52:2653-2658.
23. Goswami MK, Sinha S, Deka BC, Biswas RK, Dutta A. A comparative study on seminal attributes of Sirohi and Beetal bucks. *Pharma Innovation J.* 2020;9(6):262-266.
24. Zamiri MJ, Heidari AH. Reproductive characteristics of Rayini male goats of Kerman province in Iran. *Anim Reprod Sci.* 2006;96(1-2):176-185.
25. Farshad A, Yousefi A, Moghaddam A, Khalili B. Seasonal changes in serum testosterone, LDH concentration and semen characteristics in Markhoz goats. *Asian-Australas J Anim Sci.* 2012;25(2):189.
26. Atara VB, Chaudhari CF, Ramani UV, Chaudhary M, Patel D, Patel YR, Patel NG. Semen characteristics in young and adult Surti buck. *Indian J Anim Health.* 2018;57(2):219-224.
27. Patel DK, Chaudhari CF, Chaudhari NF, Modi LC, Atara VB, Panchal PP. Monthly variations in fresh semen parameters of Surti buck in rainy season. *Int J Curr Microbiol Appl Sci.* 2020;9(12):1398-1403.
28. Kharache SD, Jindal SK, Priyadharsini R, Kumar SA, Goel AK, Ramachandran N, Rout PK. Fertility following frozen semen artificial insemination in Jamunapari goats. *Indian J Anim Sci.* 2013;83(10):1071-1073.
29. Souri M, Mirmahmoudi R. Effect of season on dry matter intake and reproductive activity of Merghoz buck goats in West of Iran. *Iran J Appl. Anim. Sci.* 2014;4(2):317-323.