Original Research

Seasonal Influence on Semen Production Performance of Crossbred Buck (Saanen × Beetal) in an Organized Farm

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Abstract

Season plays an important role in semen production performance of caprines due to change in temperature, humidity, hormone level, vegetation and nutritional availability. Therefore, the present study was planned on five crossbred bucks (Saanen × Beetal) maintained at Livestock Research Centre, ICAR-NDRI, Karnal to evaluate seasonal effect (cold-humid winter: November-March; hot-dry summer: April-June; hot-humid summer: July-October) on fresh semen quality. Data on 625 ejaculates from five adult bucks (125×5) were collected for semen quality analysis and data was analyzed by using least square analysis. The mean ejaculate volume, mass activity (MA), progressive motility, live sperm percent, sperm concentration, hypo-osmotic swelling test (HOST) and intact acrosome percent were 1.05 ml, 3.28, 76.69%, 77.72%, 3.06×10^9/ml, 69.4% and 94.71%, respectively. There was significant individual variation of all fresh semen quality parameters among the bucks ($p<0.05$). It was observed that colour of semen was creamy with thick consistency during winter season, while slightly thin creamy during both hot-dry and hot- humid summer seasons. The semen volume in winter season was significantly ($p<0.05$) lower and higher in hot-dry summer. However, other parameters like MA, progressive motility, live sperm percent, sperm concentration and HOST positive sperm percent were significantly ($p<0.05$) higher in winter season but the values remained on lower side during hot-dry summer seasons but intact acrosome percent remained lower in hot-humid season. It can be concluded that there is individual variation in semen quality and winter season produces better quality semen fallowed by hot humid and hot dry season.

Key words: Individual Variation, Saanen × Beetal Crossbred Buck, Season, Semen Quality

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Introduction

Artificial insemination (AI) is playing an important role in goat breeding, especially in intensive production system to improve production performance of milk, meat and hair. Scientific breeding and management practices can further improve the productivity of Indian goats. There is increasing interest in use of frozen-thawed buck semen for AI or in-vitro fertilization (IVF) to improve the productivity of goat (Narwade *et al*., 2017). Success of natural service over AI and non-availability of cryopreserved semen restricting the widespread use of AI technology in goat. On the other side, the reproductive activity of goats is influenced by the season, with photoperiod being the main environmental signal. Reproductive cycle and reproductive activity of buck involves seasonal changes in testicular weight and size, sperm production, testicular secretion, mating activity and fertility. Male goats are seasonal breeder in temperate climate, but in tropical and sub-tropical climate they are continuous breeder. It is well known that the sexual behavior, semen quality and quantity are the main factors that limit male reproductive efficiency, which is influenced by different environmental, nutritional physiological and individual factors such as climate, breed, individual, seasonal feed and fodder availability, season of the year (Karagiannidis *et al.,* 2000; Bhakat *et al*., 2009). Season however, seem to be the principle cue affecting semen quality in goats (Barkawi *et al*., 2003). In Indian goats, volume and concentration decreased with high temperature, relative humidity and rainfall (Murugaiyah *et al*., 1992).Seasonal variations of fertility in goats are mainly due to the change of day length throughout the year (Talebi *et al*., 2009). Short days stimulate secretion of luteinizing hormone (LH), which in turn, induces testicular growth, release of testosterone, sperm production, mating activity and fertility (La Falci *et al*., 2002). Testosterone is the hormone responsible for spermatogenesis and sexual behavior, thus the seasonal pattern of testosterone secretion could limit the male reproductive efficiency during some periods of the year (Todini *et al*., 2007). Semen quality variation exists from different breeds, within breed and even the same male at different time of collection. Among different seasons hot-dry and hot-humid season reported to be unfavorable for production as well as reproduction (Bhakat *et al*., 2006).Thyroxin secretion declines during summer as compared to winter impaired the general metabolism and feed intake and is responsible for reduction in sperm production. Extreme heat stress during summer cause physical exhaustion, reduced eagerness, higher reaction time and total time for successful ejaculation, thus having an ultimate effect on spermatogenesis (Mandal *et al*., 2000). Researcher have reported significant individual variation in semen quality in buck (Karagiannidis *et al*., 2000 ; Sultana *et al*., 2013; Apu *et al*., 2008; Catunda *et al*., 2011) and bull (Mostari *et al*., 2004). Therefore, the aim of the present study was to evaluate the semen quality parameters of crossbred buck (Saanen × Beetal) under different seasons in sub-tropical hot humid climate of northern India.

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Materials and Methods

Study Area and General Management

The present investigation was conducted on five crossbred (Sannen×Beetal) bucks maintained at goat farm, Livestock Research Centre and Artificial Breeding Research Centre, ICAR-National Dairy Research Institute (NDRI), Karnal, India. The maximum ambient temperature goes up to 45ºC during summer and minimum about 2ºC during winter. The annual rainfall is about 760 to 960 mm, most of which is received during the month of July and August. Relative humidity ranges from 41 to 85 percent. Bucks were kept in individual pens (15′×5′) under loose housing system on concrete floor with the east-west orientation through its long axis. The pens were separated by wall and wire partitions that restricted direct physical contact but maintained eye contact in adjacent pens and a free movement within the shed. Bucks were fed concentrate ration with 21 percent CP and 70 percent TDN @ 1.0 kg per bucks early morning. Institute farm grown seasonal green fodder such as maize, cowpea, berseem, lucerne etc., depending on their availability was fed to the animals. The buck had free access to clean drinking water throughout the day. Vaccination, de-worming and other herd-health programme was followed as per the farm schedule, to ensure good health and vigour.

Classification of Season

Seasons were classified on the basis of monthly average maximum, minimum temperature and relative humidity *i.e.* cold-humid winter: November-March; hot-dry summer: April-June and hot-humid summer: July-October.

Semen Collection

Five crossbred bucks having 3-4 years age old were selected and bucks were trained initially before regular collection for experiments to donate semen in artificial vagina (AV) on dummy buck during early morning. Dummy buck was restrained in the wooden crate and other buck was allowed to mount on it. On each collection, only one ejaculates was taken. A period of sexual preparation was given which consist of at least two false mounts separated by about one minute restraint before collection of semen sample. Immediately after collection, each sample was placed in a water bath at 30°C and various standard laboratory tests were performed. Three ejaculates were collected per week for all seasons.

Evaluation of Seminal Parameters

The semen was collected in 15 ml graduated metal free glass tube (0.1 ml accuracy) and then volume, colour and consistency of semen samples were noted. The mass activity, progressive motility, live sperm

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percent, sperm concentration, HOST and intact acrosome percent were evaluated as per the standard procedure.

Statistical Analysis

The individual variation and seasonal variation of different semen parameters were compared by one way analysis of variance with general linear model. The means between two groups were compared by Tukey post-hoc test. The difference of means was considered as significant if $p<0.05$ and results were presented as mean ± SE. Statistical analysis was carried out using SPSS software package (Version 16.0, USA).

Results and Discussion

Semen quality parameters such as volume, mass activity, progressive motility, live sperm percent, sperm concentration, HOST and intact acrosome percent of fresh semen samples were 1.05 ml, 3.28, 76.69%, 77.72%, 3.06×10^9/ml, 69.4% and 94.71%, respectively (Table 1).

Table 1: Mean ± SE of semen quality parameters for fresh semen of Saanen × Beetal crossbred buck semen collected during the all seasons (N=625)

Bucks	Volume (ml)	MA (0-5)	Progressive motility %	Live %	Conc. $\times10^9$/ml	HOST %	Intact Acrosome %
SB1	1.32^{c}±0.35	3.47^{a}±0.05	79.51^{a}±0.91	80.93^{a}±0.73	3.33^{a}±0.34	69.92^{a}±0.57	94.76^{a}±0.17
SB2	0.89^{d}± 0.03	3.19^{b}±0.05	75.32^{b}±0.82	76.59^{bc}±0.67	3.17^{b}±0.04	69.74^{a}±0.54	94.85^{a}±0.28
SB3	0.79^{e}± 0.04	3.09^{b}±0.1	75.92^{b}±0.78	76.92^{bc}±0.64	3.12^{b}±0.41	67.12^{b}±0.45	93.78^{b}±0.28
SB4	1.15^{af}±0.4	3.30^{ab}±0.11	76.93^{ab}±1.12	76.91^{bc}±0.53	2.98^{bd}±0.05	70.58^{a}±0.53	95.06^{a}±0.31
SB5	1.10^{bf}±0.02	3.44^{ab}±0.11	76.76^{b}±0.98	77.22^{bc}±0.54	2.69^{c}±0.06	69.62^{a}±0.53	95.28^{a}±0.12
Overall	1.05±0.01	3.28±0.02	76.69±0.25	77.72±0.15	3.06±0.15	69.4±0.13	94.71±0.07

Means with different superscript in a column differed statistically (P<0.05)

The semen volume observed in Sannen × Beetal crossbred buck is higher as compared to pure indigenous Indian goat breeds such as Barbari (Pandey *et al*., 1985), Chegu (Thakur *et al*., 2005), Jamunapari (Kharche *et al*., 2013), Black Bengal (Mia *et al*., 2013), Surti (Jankiraman, 1990), Ganjam (Pattanaik *et al*., 1991) and Osmanabadi (Puranik *et al*., 1993) goats. However, authors reported very less volume per ejaculate in crossbred buck (Catunda *et al*., 2011; Kale, 1995; Mandal *et al*., 2000). Present estimate of mass activity were quite comparable with the earlier reports of Singh *et al*. (1985) in Jamunapari × Black Bengal; Kale (1995) and Naskar (1995) in Alpine x Beetal and Sannen×Beetal of crossbred buck semen. Progressive motility of semen samples observed in crossbred buck is within the range (61.24-80.85%) reported by previous authors (Kale, 1995; Naskar, 1995). In a similar line progressive motility was also reported by other worker in India in indigenous goat breeds (Pandey *et al*., 1985; Jankiraman, 1990; Kharche *et al*., 2013; Puranik *et al*., 1993; Kumar *et al*., 2014). The overall HOST positive sperm percent estimated in crossbred bucks was 69.4±0.13% .The estimated intact HOST was quite similar to 69.66±0.0.79% in seven

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Alpine x Beetal and three Saanen ×Beetal Crossbred bucks (Kale *et al*., 2000). There was significant individual variation of all semen quality parameters of fresh semen among the bucks (P<0.05). The results are in accordance with the finding of Sultana *et al*. (2013) and Apu *et al*. (2008) who reported significant individual variation on semen quality parameters among Black Bengal bucks. The individual buck wise variation of semen quality parameters observed in crossbred bucks are in agreement with previous report in crossbred buck (Kale, 1995), Black Bengal buck (Apu *et al*., 2008) and Alpine, Sannen and Damascus buck (Karagiannidis *et al*., 2000). Significant individual variation reported in semen quality traits such as ejaculate volume, sperm concentration, total number of sperm per ejaculated, mass motility, sperm motility and total sperm defects of crossbred bucks raised under tropical environment during the dry and humid season (Catunda *et al*., 2011). The five bucks belonged to the same breed and of similar age group, their management and nutrition status and general health condition were also similar. So the difference in semen quality might reflect their genetic potentiality and genetically superior bucks could produce good quality of semen.

The colour of the semen samples collected from bucks was creamy with thick consistency during winter season; whereas, slightly thin creamy during both hot-dry and hot-humid summer seasons. The results are in accordance with previous studies; Kale (1995) and Naskar (1995) reported creamy coloured crossbred (Alpine x Beetal and Saanen x Beetal) matured buck semen with thick consistency. In the present study during non-breeding season thin and creamy consistency semen was observed. However, Alpine × Beetal and Saanen × Beetal crossbred buck semen did not differ in consistency and colour in different seasons (Kale, 1995; Naskar, 1995). The variation of colour and consistency might be attributed to the volume and frequency of sample collection. Moreover, Ahmad and Noakes (1996) reported that semen colour varied from yellow or whitish-yellow colour during breeding season (September-December) to creamy-white colour during non- breeding seasons of the year, which is similar to our finding. Similar colour of semen was also reported in Boer and native Zambian goats (Igboeli, 1974).

The present study demonstrates that season had significant effect (P<0.01) on volume mass activity, progressive motility, live sperm percent, sperm concentration, HOST and intact acrosome percent in crossbred buck (Table 2).

Table 2: Mean ± SE of semen quality parameters for fresh semen of Saanen × Beetal buck semen in different seasons (N=625)

Seasons	Volume (ml)	MA (0-5)	Progressive motility %	Live %	Conc. $\times 10^9$/ml	HOST %	Intact Acrosome %
Winter (265)	0.98^{b} ±0.02	3.75^{a} ±0.04	82.60^{a}±0.36	80.86^{a}±0.22	3.87^{a} ±0.04	74.67^{a}±0.19	95.57^{a}±0.11
Hot-dry summer (130)	1.14^{a}±0.02	2.89^{c} ±0.06	71.81^{c}±0.52	74.67^{c}±0.31	2.59^{c}±0.05	66.37^{c}±0.28	94.47^{b}±0.12
Hot-humid summer (230)	1.04^{b}±0.02	3.20^{b}±0.04	75.66^{b}±0.39	77.63^{b}±0.23	2.72^{b}±0.03	67.16^{b}±0.21	94.10^{b}±0.13

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Means with different superscript in a column differed statistically (P<0.05)

Semen volume was significantly lower during winter and hot humid summer (0.98±0.02 and 1.04±0.02) season and the highest during hot dry summer (1.14±0.02) season. Mass activity, progressive motility, live sperm percent, sperm concentration and HOST percent were significantly highest during winter followed by hot humid summer and lowest in hot-dry summer season. During the winter season intact acrosome was significantly lower in hot humid and hot dry summer as compared to winter season, respectively. Present study indicated that in crossbred goat bucks, semen quality was best during winter season followed by hot-humid summer and it was poor during hot-dry summer season.

Different workers have also reported significant seasonal variation in different semen quality parameters of Black Bengal bucks (Mia *et al*., 2013; Kumar *et al*., 2014). In similar line, Catunda *et al*. (2011) reported that season had significant effect on semen volume, sperm concentration, total number of sperm per ejaculate, mass motility, sperm motility and total sperm defects in crossbreed male goats. Similarly, Elsheikh and Elhammali (2015) reported significant (P<0.05) effect of season on semen volume, sperm concentration, individual motility, sperm concentration and percentages of abnormal and dead sperms in crossbred (Nubian × Saanen) bucks. Semen production performance is usually better in winter and spring than in summer (Mathevon *et al*., 1998). Semen quality varied with the season, including high production of spermatozoa in autumn and winter and low production in summer (Ciereszko *et al*., 2000). Crossbred animals are more sensitive to high ambient temperature and humidity compared to purebred, which leads to lower productivity. In general, of all seasons, summer exerts comparatively more adverse effect on the overall semen quality parameters. It affects the normal process of reproduction in a multi-dimensional way by reducing feed intake or by inhibiting the release of important reproduction hormones (GnRH) and increase the release of ACTH which in turn affected the release of LH an important hormone responsible for spermatogenesis (Bhakat *et al*., 2014). Besides that thyroxin level declined during hot-dry and hot-humid seasons as compared to winter impaired the general metabolism and feed intake and could be instrumental in causing reproductive dysfunctions. Increase in core body temperature during summer leads to increase in testicular temperature results in epididymal dysfunction and decrease in activity of enzymes responsible for spermatogenesis and impaired the normal process of reproduction. Due to extreme heat stress animals get physically exhausted and their reduced eagerness might result in higher reaction time and subsequently total time for successful ejaculation also increase, thus having an ultimate effect on production of sperms (Mandal *et al*., 2000). Good quality seminal ejaculates during winter might be attributed to the congenial weather condition which favoured the testosterone activity, process of spermatogenesis and secretions of accessory reproductive glands as well as better feed intake may be due to higher thyroxin level during cold as compared to hot-dry and hot-humid seasons (Mandal *et al*., 2005).

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Conclusion

The present finding concluded that, Individual variation significantly influenced the semen quality parameters. Hot-dry or summer season adversely affect the various bio-physical characteristics of semen in crossbred bucks. Winter is the most favourable season for good quality semen production and the rainy season might be considered as the intermediate between the two extremes. This variation emphasizes the need of management interventions such as photoperiod manipulation, cooling, and nutritional manipulation etc. during summer months to improve the semen quality.

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