Research Article

Effect of Season on Semen Quality of Crossbred (Karan Fries) Bulls

Mukesh Bhakat[1], Tushar Kumar Mohanty[2], Ashok Kumar Gupta[1], Muzamil Abdullah[1]

[1]Artificial Breeding Research Centre, National Dairy Research Institute, Karnal – 132001, Haryana, India; [2]Livestock Research Centre, Livestock Production Management, National Dairy Research Institute, Karnal – 132001, Haryana, India.

Abstract | One hundred and fifty six ejaculates from eight Karan Fries (KF) bull were collected to study the effect of season (summer, rainy and winter) on semen quality parameters at Artificial Breeding Research Centre, NDRI, Karnal, India. The data was analysed using least square analysis. Season had no significant effect on ejaculate volume, mass activity, total sperm output and pH of the semen, whereas it had significant (P<0.05) effect on initial motility, non-eosinophilic count and acrosome integrity of sperms as well as highly significant (P<0.01) effect on HOST, sperm concentration, sperm abnormalities and osmolality of semen in KF bulls. The results clearly indicate that during summer season, the highest values of sperm abnormalities, pH and OSMOL and lowest values of IM, SPC, SPCE, LIVE, HOST and AI was observed. During winter season highest magnitude of MA, IM, SPC, SPCE, LIVE, HOST and AI and lowest value of VOL, sperm abnormalities, pH and OSMOL were observed in KF bulls. It was concluded that the semen qualities were optimal during winter, poor during summer and intermediate during rainy season.

Keywords | Season, Summer, Rainy, Winter, Semen quality, Karan Fries Bull, NDRI

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***Correspondence** | Mukesh Bhakat, National Dairy Research Institute, Karnal, Haryana, India; **Email**: bhakat.mukesh@gmail.com
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INTRODUCTION

Animal productivity and quality of produce is mainly affected by adverse climatic condition especially heat stress in tropical environment. The summer stress in northern India prevails for 50 to 100 days and further aggravated due to long exposure of sun over 12 hrs, leads to influence physiology of the animals through decrease in productivity. The impact of heat stress on libido and semen production of the breeding bulls is well documented. Among different seasons hot-dry and hot-humid season reported to be unfavourable for production as well as reproduction (Bhakat et al., 2011). The environment has both direct and indirect impact; directly through change in macro and micro climatic factors (Barth and Waldner, 2002) like temperature, humidity, rainfall and photo-period, whereas indirectly by affecting the vegetation, forage quality and soil-plant-animal interaction. The information regarding the effect of seasons on semen characteristics in dairy bulls has been reported to be of a conflicting nature (Bhakat et al., 2009), Some research workers have reported significant effect of season (Rekwot et al., 1987; Goswami et al., 1991 and Singh and Raina, 2000), while others observed non-significant effect (Mathur et al., 2002; Helbig et

al., 2007) of season on semen quality parameters.

India has different agro-ecological zones having wide variety of climatic conditions and this can naturally lead to variations in findings of various authors. In general, of all seasons, summer exerts comparatively more adverse effect on the overall quality of semen. It affects the normal reproduction process multi dimensionally, by reducing feed intake, inhibiting release or response of GnRH, FSH and LH. LH is the important hormone, responsible for spermatogenesis. It is inhibited by increasing level of plasma corticosteroids due to heat stress. During summer, thyroxin secretion declines leading to reduced intake of feed by the animal, subsequent metabolism and is responsible for reduction in sperm production. Due to extreme heat stress bulls get physically exhausted and their reduced libido 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). Therefore, present study was planned to investigate the seasonal influence on characteristics of semen production in crossbred bulls.

MATERIALS AND METHODS

Eight Karan Fries (crossbred) bulls (nearly 24 to 37 months of age and body weight of 423.17 to 570.33 kg) were selected randomly from Artificial Breeding Research Centre, NDRI, Karnal, India to study seasonal effect on 156 ejaculate collected during one year period (May 2006 to April 2007). The farm is situated at an altitude of 250 meters above the mean sea level on 29.43°N latitude and 72.2°E longitude. The average highest ambient temperature during the study was recorded to be 31.82°C in the month of June, followed by 31.65°C in the month of May and lowest average ambient temperature was observed 12.17°C in January. The average relative humidity was maximum in July (95.46%) and minimum in June (43.59%). The bulls were maintained identical and optimal conditions of feeding and management during the entire course of the experiment. The bulls were healthy, free from diseases, sexually mature, good libido and clinically normal. All the bulls were vaccinated against FMD, HS & BQ annually. The year was subdivided into three seasons: Hot Dry or Summer (April to June); Hot Humid or Rainy (July to October) and Cold or Winter (November to March). Semen was collected in the morning once a week from the bulls using sterilized bovine artificial vagina (IMV model-005417) (maintained between 42-45°C), over a male dummy. Soon after collection, each ejaculate was placed in a water bath at 30°C and various standard laboratory tests for semen were recorded. Quality of the semen was assessed for Volume and microscopic tests such as mass activity (Tomar et al., 1966), individual motility, concentration (Haemocytometer), non-eosinophilic count (Blom, 1950 and Hancock, 1951)., HOST (Correa and Zavos, 1994), acrosomal integrity (Hancock, 1952), sperm abnormalities using DIC phase contrast microscope (Nikon Eclipse E600, Tokyo, Japan) with Tokoiheat thermal stage as per standard method. Fresh semen pH was determined within 15 minutes of collection with Cyberscan 510 pH meter (Eutech Instrument, Singapore) and osmolality by WESCOR vapour pressure Osmometer (WESCOR model 5500, INC, USA).

Statistical Ananlysis

The recorded data were subjected to statistical analysis using LSML-91 software package, Walter Harvey.

RESULTS AND DISCUSSION

Spermatogenesis is a continuous process in male once it has reached reproductive maturity, the semen of farm animals exhibits a distinct climatic pattern with respect to its quality and fertilizing efficiency.

Colour of Semen

Karan Fries bulls produced 27.56%, 51.92%, 11.54% and 8.97% watery, milky, lemon and creamy colour semen, respectively (Table 1). During all the three seasons; hot-dry (Summer), hot-humid (Rainy) and cold-humid (Winter) season the frequency of milky variety of semen (50.00, 50.98 and 53.97%) was the maximum, followed by that of watery (35.71, 25.49 and 23.81%). Lemon and creamy colour of semen was produced less during all the three seasons. During winter season milky (53.97 vs. 50.00 and 50.98%) and creamy (11.11 vs. 4.76 and 9.80%) variety of semen was more whereas during summer season frequency of watery semen (35.71%) was more, which is stating the fact of higher sperm concentration during winter season and lower during summer season. There was no significant ($P<0.05$) effect of season on colour of semen.

Table 1: Frequency distribution of color of semen of Karan Fries (HF cross) bulls

Color	Hot dry (Summer) season	Hot humid (Rainy) season	Cold humid (Winter) season	Overall	Chi square value
	(N=42)	(N=51)	(N=63)	(N=156)	
Watery	15 (35.71)	13 (25.49)	15 (23.81)	43 (27.56)	2.0 (NS)
Milky	21(50.00)	26 (50.98)	34 (53.97)	81 (51.92)	0.2 (NS)
Lemon	4 (9.52)	7 (13.73)	7 (11.11)	18 (11.54)	0.6 (NS)
Creamy	2 (4.76)	5 (9.80)	7 (11.11)	14 (8.97)	1.8 (NS)

Figures in the parenthesis indicate percentage, NS= Non Significant (P<0.05)

Table 2: Least squares means ± S.E. for effect of season on semen quality parameters of Karan Fries bulls

Parameters	Hot Dry (Summer) (N=42)		Hot Humid (Rainy) (N=51)		Cold Humid (Winter) (N=63)		Overall (N=156)		Level of Significance
	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	
Ejaculate volume (ml)	4.72	0.19	4.48	0.17	4.15	0.15	4.45	0.10	NS
Mass activity (0-5 Scale)	1.77	0.15	1.81	0.13	1.85	0.12	1.81	0.78	NS
Initial motility (%)	42.29^{a}	0.12	45.38^{ac}	0.10	52.54^{bc}	0.08	46.73	0.03	p<0.05
Sperm concentration (10^6/ml)	721.50^{a}	51.05	835.17^{ac}	47.21	961.08^{bc}	42.49	839.25	27.38	p<0.01
Total sperm output (10^6)	3268.89^{a}	272.55	3738.39^{ac}	252.05	4061.36^{bc}	226.83	3689.55	146.17	p<0.05
Non-eosinophilic count (%)	47.90^{a}	0.15	51.69^{ac}	0.13	60.50^{bc}	0.10	53.38	0.04	p<0.05
HOST (%)	36.41^{a}	0.09	36.44^{a}	0.08	50.00^{b}	0.06	40.88	0.03	p<0.01
Acrosome integrity (%)	51.08^{a}	0.13	53.82^{ac}	0.11	62.22^{bc}	0.09	55.73	0.04	p<0.05
Head abnormality (%)	3.89^{a}	0.001	3.55^{b}	0.001	2.16^{c}	0.001	3.16	0.02	p<0.05
Mid-piece abnormality (%)	2.99^{a}	0.001	2.12^{b}	0.001	1.67^{c}	0.001	2.23	0.007	p<0.01
Tail abnormality (%)	9.93^{a}	0.003	7.32^{b}	0.003	5.61^{c}	0.002	7.53	0.001	p<0.01
Total abnormality (%)	16.86^{a}	0.005	13.03^{b}	0.004	9.47^{c}	0.003	12.97	0.001	p<0.01
pH	6.93	0.04	6.90	0.03	6.88	0.03	6.91	0.19	NS
Osmolality (mOsmol/Kg)	295.77^{a}	4.36	290.25^{a}	4.03	275.89^{b}	3.63	287.30	2.34	p<0.01

Least squares means in a row bearing different superscripts differ significantly; NS: Non significant

Seminal Attributes

Least squares means of various seminal attributes of Karan Fries bulls during different season are presented in Table 2. The results of the present study depicted that season had no significant effect on ejaculate volume (VOL), mass activity (MA), total sperm output (SPCE) and pH of the semen and significant (P<0.05) effect on initial motility (IM), non-eosinophilic count (LIVE) and acrosome integrity (AI) of sperms (Table 2). The results clearly indicated that there was highly significant (P<0.01) effect of season on seminal attributes such as HOST reacted sperm percent, sperm concentration (SPC), sperm abnormalities and osmolality (OSMOL) of semen (Table 2).

In the present study the overall least squares mean of ejaculate volume of Karan Fries bulls was found to be 4.45 ± 0.10. The ejaculate volume was highest during summer and lowest during winter season. However, Rekwot et al. (1987) and Igboeli et al. (1987) obtained highest ejaculate volume during rainy season; whereas Goswami et al. (1991) found highest semen volume during winter season. No significant (P<0.05) seasonal difference was observed in ejaculate volume which is in agreement with the findings of Tomar et al. (1966) in Hariana bulls and Helbig et al. (2007) in American bison. On the contrary, significant (P<0.01) seasonal difference was observed in ejaculate volume was reported by Singh et al. (2000) in zebu-exotic half breds and Mathur et al. (2002) in Frieswal bulls. Several factors such as, age of the animal, level of nutrition, management practice etc. may be responsible for the differences in results. The overall least squares mean of mass activity (MA) was found to be 1.81 ± 0.78. Mass activity was highest during winter, followed by rainy and summer season. Similar to our finding the highest mass activity during winter season had been reported in Zebu-taurus bulls (Goswami et al. 1991) and Singh et al. (2000) in zebu-exotic half breds, Whereas Mathur et al. (2002) in Frieswal bulls and Helbig et al. (2007) in American bison obtained no significant (P<0.05) seasonal variation in mass activity. Significant (P<0.05) seasonal difference was observed in initial motility percent (IM) which is in agreement with the findings of Igboeli et al. (1987) in Bos brachyceros and Goswami et al. (1991) in Zebu-taurus bulls. On the contrary, Rekwot et al. (1987) in Exotic and Crossbred bulls and Mathur et al. (2002) in Frieswal bulls did not obtain any significant seasonal variation in IM. The initial motility was found to be maximum during winter, which varied significantly (P<0.05) in comparison to summer.

The sperm concentration per ml (SPC) varied significantly (P<0.01) among seasons being maximum during winter followed by rainy and summer season. The difference in SPC between summer and winter season was significant (P<0.01). However, Rekwot et al. (1987) obtained highest value during rainy season and Singh et al. (2000) obtained highest value during cold-dry in zebu-exotic half breds. On the contrary, Mathur et al. (2002) in Frieswal bulls and Helbig et al. (2007) in American bison reported no significant seasonal variation in sperm concentration. In the present finding lower concentration of spermatozoa during the summer may be due to significant reduction in the feed intake and increase in dead and abnormal spermatozoa. Dead and abnormal spermatozoa, which are normally absorbed through phagocytosis as well as increased resorption of abnormal spermatozoa leads to reduction in epididymal sperm reserves, thus decreasing concentration. This finding support to the conclusion that the spermatozoa produced during summer were either intrinsically less active and vigorous at the time of production or that they, though normal at the time of genesis, suffered deterioration at some stage of their passage down the male reproductive tract prior to their release in the ejaculate under sustained impact of a climatically stressful summer environment.

Total sperm output (SPCE) was maximum during winter followed by rainy and summer season. Significant (P<0.05) seasonal variation in non-eosinophilic sperm percent was observed. Highest live sperm percent was observed during winter, followed by rainy and summer season. Similar to our observation, Tomar et al. (1966) and Goswami et al. (1991) also reported lowest live sperm count during summer season. The occurrence of lowest percentage of live spermatozoa synchronizing with the part of year characterized by the highest mean ambient temperature suggests that the summer environment becomes instrumental in causing death and abnormality to a high percentage of spermatozoa even before they have an opportunity to come out in the ejaculate. Significant (P<0.01) seasonal variation in hypo-osmotic swelling test (HOST) reacted spermatozoa were observed in the present investigation being maximum

during winter season followed by rainy and summer season. However the variation between summer and rainy season was non-significant. Percentage of spermatozoa with intact acrosome were found to be significantly (P<0.05) affected by seasons. The lowest acrosome integrity percent was observed during summer and highest during winter season. The variation in head, mid-piece, tail and total abnormality percent were significant (P<0.01) among the seasons. All the abnormalities were found to be higher during summer followed by rainy and winter seasons (HEAD- 3.89, 3.55 and 2.16; Mid-piece- 2.99, 2.12 and 1.67; TAIL- 9.93, 7.32 and 5.61; TOTAL- 16.86, 13.03 and 9.47 %). Significant (P<0.05) variation between season were also observed in case of all the abnormalities, which is in agreement with the findings of Singh et al. (2000) in zebu-exotic half breds regarding significant seasonal variation in total abnormality.

No significant seasonal difference in pH was observed in the present study. This may be due to seasonal fodder changes. During summer pH was high may be due to silage feeding. Whereas, significant (P<0.01) variation due to season were observed in case of osmolality, being maximum during summer, followed by rainy and winter seasons. Heat stress increases loss of body fluid due to sweating and panting, if the stress continues for a longer period the fluid loss can reach critical level (Kadzere et al., 2002) and may be reflected in the seminal plasma which is evident from the above finding that osmolality was highest during the hot dry season. The reason for variation in osmolality of seminal plasma is not clearly known, however, it may be due to fluctuation in core body temperature, seasonal fodder changes and changes in thermodynamics of body. On the other side may be variation of environmental temperature has effect on the osmolality reading by the vapour pressure machine to the extent of 5 to 7%. Individual variation might be attributed to the genetic makeup, age, nutrition and the influence of the climatic components, which might have transduced variably into endocrine messages controlling hypophyseal-hypothalamo-gonadal axis.

Crossbred animals are produced by use of exotic semen from HF and they are having more than 50% exotic blood inheritance level and are sensitive to high ambient temperature and humidity, which leads to less productivity. In general summer may be regarded as the season exerting relatively more adverse effect on the overall semen quality than the other seasons. This appears quite likely in view of the high ambient temperature, a relatively long spell of that high temperature, hot blast of wind and a continuous stream of radiation impinging directly and indirectly through reflection from terrains or shed on the animal's body and thereby precipitating a really distressing challenge to the animal's thermo-regulatory mechanism. Under experimental conditions it appeared that they were more tolerant towards the colder months as compared to the hotter months. It will be apparent from the climatic table that winter in this part can be considered neither extreme nor severe to the extent to being definitely detrimental. The semen picture during winter was better and poor during summer season. It might be attributed to the fact that heat stress affect the normal process of reproduction in a multi-dimensional way by reducing feed intake or impairing release of GnRH and increase the release of ACTH which in turn affected the release of LH an important hormone responsible for spermatogenesis. 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. Januskauskas et al. (1995) reported that semen quality at any time is likely to reflect the environmental influences upon the sensitive stages of spermatogenesis, which is highly sensitive to even short increases in scrotal temperature, in Bos taurus AI sires kept in temperate regions. In summer, extreme heat stress causes physical exhaustion, which might reduce the eagerness of the bulls and thus, result in higher reaction time and total time for successful ejaculation, thus having an ultimate effect on production of sperms (Mandal et al., 2000). Reasons for 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 (Mandal et al., 2005) as well as better feed intake may be due to higher thyroxin level during cold as compared to hot-dry and hot-humid seasons. A few investigators have attributed the low breeding efficiency of buffaloes during summer due to deterioration of semen quality, but this has been disputed by

others (Chaudhary and Gangwar, 1977).

CONCLUSION

Thus, it is concluded that the hot-dry or summer season adversely affect the various bio-physical characteristics of semen in Karan Fries bulls. Winter was the most favourable season for good quality semen production and the rainy season might be considered as the intermediate between the two extremes. In general it is suggested that during summer, breeding bulls should be kept cool and comfortable by splashing water at least 3-4 times a day, protected from direct wind blasts, housed in a place with comfortable micro-environment with least humidity, fed during cool hours and have a free access to cool drinking water.

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CONFLICT OF INTEREST

The authors have no conflict of Interest.

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