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Evaluation of Semen Quality of Holstein Friesian and Jersey Bulls Maintained under Subtropical Environment

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ABSTRACT

Semen production data of Holstein-Friesian and Jersey bulls collected over a period of three years was analyzed to examine seasonal effects on quantity and quality of semen. Purebred breeding bulls of Holstein-Friesian and Jersey breeds (n = 18 for each breed), maintained under naturally ventilated open-sided sheds, were used for semen collection. Meteorological information on ambient temperature, relative humidity and rainfall was used to divide the calendar year into two stressful summer seasons viz; dry summer (April - June) and wet summer (July–September) and a stress free season (October - March). The number of ejaculates per bull recorded during three seasons were not significantly different (P>0.05) in both breeds. Friesian bulls produced lower ejaculatory volume during dry summer season, whereas Jersey bulls produced higher (P<0.05) volume during wet summer compared to other seasons. Seasonal pattern of mass motility and individual motility of semen was different between two breeds. The mass motility of semen in both breeds was significantly lower during wet summer. However, individual motility in the semen of Friesian bulls did not differ among seasons (P>0.05) but in Jersey bulls it was lower during wet summer than other seasons. Wet summer resulted in reduced number of semen doses frozen per bull in both breeds. The results of this study indicated that wet summer season deteriorated semen quality in terms of mass motility, individual motility and number of doses in both breeds, except individual motility in semen of Friesian bulls.

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INTRODUCTION

Pakistan is blessed with the best breeds of cattle and buffalo together with a sizeable number of cross-bred cows. Despite having the world's best breeds of zebu cattle and water buffalo, the production level of these breeds is much lower as compared to the dairy breeds of the developed world (Shah, 1994; Khan, 2002; Khan *et al*., 2008). Majority of cattle population (73%) in the country is non-descript with low milk producing ability (1500–1800 liters/lactation), late age at sexual maturity (3-4 years) and longer calving intervals (450 days). Lifetime productivity of these animals is low because of low growth rate, resulting into late maturity and light weight at the onset of production, long dry periods and calving intervals (Jabbar *et al*., 2000).

Crossbreeding of non-descript type of Bos *indicus* with genetically superior exotic breeds of *Bos taurus* such as Holstein Friesian (HF) and Jersey is an effective and shortest channel to improve dairy potential of the former (Anjum *et al*., 2009). In many countries of tropical and sub tropical regions, crossbreeding programmes were launched in mid seventies to increase herd productivity by combining the desirable characteristics of the superior dairy potential of *Bos taurus* and better resistance of *Bos indicus* to heat stress and local diseases. The objective was to produce crossbred progeny with early maturity, better milk producing ability and adaptability to the local hot and humid climatic conditions.

Pakistan, being a sub-tropical and hot region of South Asia (Sattar and Mirza, 2009), has a long summer period that extends from May to September, with average ambient temperature ranging from 30 to 45°C and very

severe hot and humid period from mid July to mid September. These environmental conditions are not suitable for exotic breeds from temperate regions. These conditions can adversely affect reproductive efficiency of Friesian and Jersey bulls and thus a continuous evaluation of their semen quality and quantity is required to achieve higher non return rates and also to keep the crossbreeding programme economically viable. Studies on male reproduction associated with season have shown significant effect on conception rates in cows due to poor quality semen collected during summer months (Barth and Waldner, 2002). The present study was undertaken to examine the effect of seasonal stress on quantity and quality of semen produced by the Holstein Friesian and Jersey bulls maintained under sub-tropical summer conditions of Pakistan.

MATERIALS AND METHODS

Experimental animals and housing

Semen production data of 18 locally born Holstein Friesian and 18 Jersey bulls maintained at Semen Production Unit, Kherimurat, Fateh Jang, District Attock (33.89N, 72.24E), Pakistan, were used in the present study. Data recorded over a period of three years (January, 2003 to December, 2005) were used for semen quality evaluation. Bulls were housed individually in their respective pens in open sided sheds situated in East-West direction. The sheds were designed properly to provide sufficient natural cross-ventilation and to minimize heat stress. Roof was painted white to reflect away the sunlight. The covered area per bull was $15m^2$ with small open courtyard of $23m^2$. Each bull pen was facilitated with water point and feeding manger.

Environmental data

Environmental variables like ambient temperature, relative humidity and rainfall data recorded daily by the Meteorological Centre of National Agricultural Research Centre, Islamabad, Pakistan with its satellite centre situated in the proximity of the Semen Production Unit, was used for the present study. The recorded ambient temperature during April to September ranged from 30 to 45°C, which is quite high than that of the thermo neutral zone (10 to 24°C) for European cattle breeds. The calendar year was divided into stressful season (April to September) and stress free season (October to March). The stressful season was further subdivided into dry summer (April to June) and wet summer (July to September) on the basis of relative humidity, which ranged from 20 to 30% during dry summer and 40 to 65% during wet summer.

Feeding and management

The feeding requirements of animals were calculated according to their body weight and season. The feeding regime per bull consisted of 4-6 Kg concentrate mixture, 6 Kg wheat straw and 40 Kg green fodder per day. In order to overcome the deleterious effects of dry and wet summer stress, a mineral mixture (per 100 Kg of mixture: Dicalcium phosphate 70.8 Kg, NaCl 18.9 Kg, $MgSO_4$ 8.64 Kg, $FeSO_4$ 0.89 Kg, $MnSO_4$ 0.49 Kg, $ZnSO_4$ 0.22 Kg, $CuSO_4$ 0.03 Kg, KI 8.77 gm, $CaCl_2$ 0.89 gm and $NaSiO_3$ 1.5 gm) was also added to the normal feeding regime at a rate of 2% of concentrate mixture. Regular vaccination was carried out twice a year against hemorrhagic septicemia in June and December and Foot and Mouth disease in February and September and once a year (April) against Black Quarter. Preventive measures against external and internal parasitic infestation were also routinely undertaken three times in a year.

Semen collection and processing

Semen collection schedule was Monday and Thursday every week. Bulls to be ejaculated went through preparatory measures including showering, drying and cleaning, brushing, grooming and half an hour exercise. The bulls were then allowed to mount a teaser bull and the semen was collected with the help of a pre-warmed (42 to 45°C) artificial vagina. Ejaculate volume was recorded directly from the graduated semen collection tube. Each ejaculate was examined for mass motility, individual motility and sperm concentration, as described earlier (PARC/JICA, 1998) and ejaculates having less than 50% sperm motility were discarded. Fresh semen were diluted depending upon microscopic evaluation of sperm concentration at 32°C with tris, citrate, fructose, egg yolk and glycerol extender (Table 1), cooled at 20°C for 30 minutes and at 5°C for 100 to 120 minutes.

The semen was equilibrated at 5°C for 4 hours, 0.5 ml straws (semen volume) were filled with diluted semen and sealed at the same temperature. Finally, the processed semen was frozen and stored in liquid nitrogen at –196ºC (PARC/JICA, 1998).

Table 1: Chemical composition of the experimental extender

Ingredients	Quantity
Tris (g)	24.2
Citric acid (g)	13.4
Fructose (g)	10
Glycerin (ml)	70
Egg yolk (ml)	200
Distilled water	Up to one liter

Data recording and statistical analysis

Semen parameters recorded included the number of ejaculates per bull, its volume (ml), mass motility (+0.5 to +5), individual motility (%) and the number of semen doses frozen per bull (PARC/JICA, 1998). The data were analyzed through analysis of variance under Completely Randomized Design. The difference among means was tested through Duncan Multiple Range Test (Steel *et al*., 1997).

RESULTS

Number of ejaculates and ejaculate volume

The overall number of ejaculates per bull recorded for Friesian and Jersey bulls were 1.98 ± 0.002 and 1.97 ± 0.009, respectively. Maximum numbers of ejaculates were produced by bulls of both breeds during stress free season. However, statistically no effect of season was recorded on the number of ejaculates per bull in both breeds (Table 2). Ejaculate volume was significantly lower during dry summer in Holstein Friesian bulls, whereas, it was higher

(3.025 ± 0.03 ml) during wet summer in Jersey bulls (P<0.05) compared to other seasons. The overall ejaculate volume was 4.047 ± 0.03 ml in Holstein Friesian and 2.92 ± 0.03 ml in Jersey breeding bulls (Table 2).

Mass and individual motility

Seasonal pattern of mass motility and individual motility of semen was different between bulls of the two breeds. The mass motility of semen in both breeds was significantly lower (P<0.05) during wet summer than other seasons (Table 3). Individual motility in the semen of Friesian bulls did not differ among seasons (P>0.05) but it was lower during wet summer compared to other seasons in semen of Jersey bulls (Table 3).

Number of semen doses frozen per bull

The pattern of seasonal fluctuation in the number of freezable semen doses showed minor variation due to breeds of bulls. In both Holstein-Friesian and Jersey bulls, lowest number of semen doses were frozen during wet summer season (P<0.05). The same number of semen doses were frozen in Friesian bulls during stress free and dry summer seasons (P>0.05) but in case of Jersey bulls, number of doses frozen during dry summer was higher (P<0.05) compared to that of stress free season (Table 3).

DISCUSSION

In the present study, effect of season was not observed on the number of ejaculates per bull in both breeds. Usmani *et al*. (1993) reported that seasonal stress had no effect on the number of ejaculates in crossbred (Friesian x Sahiwal) bulls. However, Zafar *et al*. (1988) observed lowest number of ejaculates in buffalo bulls during hot and humid season and Anchieta *et al*. (2005) observed lower ejaculates number during rainy season. These differences might be due to difference in management or semen collection times and animal species.

The ejaculate volume was significantly higher in Holstein Friesian bulls during stress free and wet summer and it was highest during wet summer in Jersey bulls. Javed *et al*. (2000) noted lowest ejaculate volume in humid summer in Nili Ravi buffalo bulls. However, Fonseca (1995) and Mathevon *et al*. (1998) reported that season had no effect on ejaculate volume for Nelore and Holstein bulls, respectively. These differences in findings might be attributed to differences in breeds of bulls studied and environmental conditions.

The pattern of effect of seasons on mass and individual motilities was little different between two breeds but mass motility and individual motility of semen was recorded as minimum during wet summer in bulls of the both breeds. Usmani *et al*. (1993) and Li-junjie *et al*. (2001) reported that motility was reduced significantly in hot and humid season. Similarly, Fawzy and Rabie (1996) and Mostari *et al*. (2005) reported that sperm motility was deteriorated during summer in Friesian bulls. However, Brito *et al*. (2002) and Fonseca (1995) could not find any significant effect of season on mass motility and individual motility during summer. These differences might be due to different breeds and geography. Kolev and Dimov (1998) reported significant increase in mass motility and individual motility during summer for buffalo bulls in Bulgaria. This increase was probably due to moderate climatic conditions of Bulgaria during summer.

In both Holstein-Friesian and Jersey bulls, smallest number of semen doses was frozen during wet summer season. These results are supported by Zafar *et al*. (1988) for buffalo and Dhami *et al*. (1998) for Friesian bulls. Both workers reported minimum number of doses frozen during hot humid season. Likewise, Asmat (2002) reported higher number of semen doses per ejaculate in spring than summer from Sahiwal bulls. However, Sarder (2007) reported highest number of semen doses produced during summer when temperature was more than 29°C and relative humidity more than 85%. This difference might be due to different breeds and management conditions in Bangladesh.

Results of the present study revealed that bulls of both breeds showed difference in ejaculate volume. Bulls of Jersey breed produced highest, whereas, Friesian bulls produced lowest ejaculate volume during stressful conditions of wet summer. This difference might be due to different tolerance ability of bulls belonging to two different breeds against environmental stress during wet summer. Wet summer season could not affect ejaculate volume but it deteriorated quality of semen in terms of mass motility, individual motility and number of dozes frozen during wet summer.

Conclusion

The stressful summer season deteriorated the quality of semen obtained from both Holstein Friesian and Jersey breeding bulls maintained under sub-tropical environment of Pakistan.

Table 2: Effect of seasonal stress on number of ejaculates and ejaculatory volume in Holstein Friesian and Jersey bulls (Mean ± SE)

Seasons	Holstein Friesian		Jersey	
	Number of ejaculates	Ejaculate volume (ml)	No. of ejaculates	Ejaculate volume (ml)
Stress free (October to March)	1.99 ± 0.003	4.150 ± 0.05[a]	1.99 ± 0.002	2.901 ± 0.03[b]
Dry summer (April to June)	1.98 ± 0.005	3.845 ± 0.06[b]	1.98 ± 0.006	2.796 ± 0.04[b]
Wet summer (July to September)	1.98 ± 0.004	4.071 ± 0.05[a]	1.95 ± 0.007	3.025 ± 0.03[a]
Over all	1.98 ± 0.002	4.047 ± 0.03	1.97 ± 0.009	2.923 ± 0.03

[abc]Values within the same column with different superscripts differed significantly (P<0.05).

Table 3: Effect of seasonal stress on mass motility, individual motility and number of doses frozen in Holstein Friesian and Jersey bulls (Mean ± SE)

Seasons	Friesian			Jersey		
	Mass motility (0.5-5.0)	Individual motility (%)	No. of doses frozen	Mass motility (0.5-5.0)	Individual motility (%)	No. of doses frozen
Stress free (Nov. to March)	1.76 ± 0.02^{b}	70.83 ± 0.6	110.41 ± 2.5^{a}	2.12 ± 0.04^{a}	70.08 ± 0.9^{a}	85.84 ± 2.07^{b}
Dry summer (April to June)	1.92 ± 0.07^{a}	70.95 ± 0.7	110.63 ± 4.0^{a}	2.21 ± 0.04^{a}	73.49 ± 0.8^{a}	90.74 ± 2.57^{a}
Wet summer (July to October)	1.59 ± 0.02^{c}	69.47 ± 0.8	97.04 ± 2.4^{b}	1.80 ± 0.03^{b}	67.70 ± 0.8^{b}	79.80 ± 2.04^{b}

[abc]Values within the same column with different superscripts differ significantly (P<0.05).

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