Semen characteristics of breeding bulls at the Central Cattle Breeding and Dairy Farm of Bangladesh

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Abstract

The experiment was conducted on 97 breeding bulls at the central cattle breeding and dairy farm, Savar, Dhaka to find out the physical and chemical properties of different bull semen. Out of 97 bulls, 9 were Local (L), 9 were Friesian (F), 13 were Sahiwal (SL), 12 were Local×Friesian (L×F), 10 were Sahiwal×Friesian (SL×F), 26 were Local×Friesian×Friesian (LF_1×F), 18 were Local×Friesian× Friesian×Friesian (LF_2×F) bulls. The semen of different crossbred and local bulls was examined for ejaculate volume, concentration, pH and motility percent of sperm before and after freezing. It was observed that, the maximum average ejaculate was obtained from SL×F and the mean value was 12.9 ml. However, the minimum average ejaculate was obtained from LF×F and the mean value was 7.4 ml. Before freezing, the maximum average sperm concentration was obtained from SL and the mean value was 1858.4 million/ml. The minimum average sperm concentration was obtained from LF_1×F and the mean value was 1286.6 million/ml. The maximum average pH was obtained from LF_2×F and the mean value was 6.5. The maximum average motility was obtained from SL and the mean value was 68.8%. However, the minimum average motility was obtained from L×F and the mean value was 63.7%. After freezing, sperm concentration, pH and motility reduced substantially irrespective of type of breed. It could therefore be inferred that freezing of semen should be undertaken with special care to maintain optimum semen quality.

Key words: Bull semen, Ejaculate volume, Sperm concentration, pH, Motility

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Introduction

Main objective of the dairy farm in a cow-calf operation is to produce one calf from each cow annually. Meeting this goal influences net income of the farm. A crucial component of efficient calf production is high quality bull semen for successful fertilization and improved herd health (Swanson and Herman 1940). Since individual bull serves many females, poor quality semen may affect herd fertility and productivity of the farm by lengthening calving intervals. Herd fertility is a combination of genetic and environmental factors. Physical and chemical properties of bull semen particularly ejaculate volume, density, pH and motility may influence herd fertility and play important role in successful dairy operation. Wide variations exist in properties of semen among different bulls as well as different ejaculates of the same bull. In case of artificial insemination, semen is obtained from bull by allowing male to mount the female and deflecting the penis into an artificial vagina through which the semen is ejaculated into suitable receptacle. It is a process for deposition of male reproductive cells in the female reproductive tract by mechanical means rather than natural service by a male. A number of physical and chemical changes occur in these processes, which may alter properties of bull semen and impair herd fertility. In tropical countries, low reproductive rate is a problem, which is associated with semen quality of bull. Therefore, current study was aimed to observe the physical and chemical properties of different bull semen and to compare sperm motility with storage condition.

Materials and methods

Study site

The experiment was carried out on 97 breeding bull at the Central Cattle Breeding Station and Dairy Farm, Savar, Dhaka. The farm was situated adjacent to the Dhaka Aricha highway

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and 30 km northwest side from Dhaka city. The farm was surrounded by plain land with plenty of green vegetation. The highest and lowest ambient temperature of the experimental area was recorded as 37-38^{0}C and 15-21^{0}C, respectively. Average humidity was 76.6%.

Experimental bull and ration

Among 254 breeding bulls of the AI section, 97 were selected according to quality and quantity of semen production. Out of 97 bulls, 9 were Local (L), 9 were Friesian (F), 13 were Sahiwal (SL), 12 were Local×Friesian (L×F), 10 were Sahiwal×Friesian (SL×F), 26 were Local×Friesian×Friesian (LF_1×F), 18 were Local×Friesian×Friesian×Friesian (LF_2×F) bulls. Bulls were given *ad libitum* green grass supplemented with concentrate mixture prepared with maizegrain, wheat bran, khesari, soybean meal and common salt (Table 1).

Table 1. Ration for breeding bulls at the central cattle breeding and dairy farm

Ingredients	Amount (kg)	DM (kg)	DCP (kg)	TDN (kg)	Ca (kg)	P (kg)
Maize grain	10.0	8.9	0.89	7.7	-	-
Wheat bran	52.0	46.3	6.76	36.4	-	-
Khesari	15.0	13.4	3.6	10.5	-	-
Gram	16.0	14.2	4.48	11.2	-	-
Soybean meal	06.0	5.3	2.52	4.2	-	-
Bone meal	0.75	0.7	-	-	0.18	0.09
Common salt	0.25	0.2	-	-	-	-
Total	100	89.0	18.4	70	0.18	0.09

Collection of semen

The semen was collected by artificial vagina (Arthur et al. 1982). Prior to collection of semen, all parts of artificial vagina (AV) set were cleaned, sterilized and assembled. The inner liner was put into the cylinder and both ends of inner liner were reflected over the cylinder forming water like space between them. The cone along with vial was slipped over one of the ends of the cylinder and then tightened with rubber band. Two third of the outer jacket of vagina was filled with warm water. The temperature inside the artificial vagina was 110^0-115^{0}F. An air screw was used for blowing air between two layers to create desired pressure. Required amount of lubricant was applied inside the artificial vagina with a glass rod. When the bull was sufficiently excited to jump over the dummy, the penis of the bull was directed into the artificial vagina by holding the sheath to collect the semen in a vial. After collection, the vial containing semen was put into hot water at 110^{0}F for preventing cold shock. It was closed with cotton and labeled (Almaquist et al. 1978).

Semen examination

The volume of ejaculate was measured directly with the help of graduated collection vial (Mortimer 2000). Color of semen varied from bull to bull. All semen had seminal/egg yolk odor. pH of semen was determined by indicator paper strips (Salisbury et al. 1978). Sperm concentration was determined by direct cell count (Bane 1952; Elliot 1978). Motility of semen was tested according to following Table as per Herman et al. (1994).

Table 2. Grading of semen according to motility

Scale	Grade	Characteristics
5	(+++++) Excellent	More than 80% of the spermatozoa are in vigorous motion. Swirls and eddies formed due to movements of the sperms are extremely rapid and changing constantly. Movements are so vigorous that it is impossible to observe individual spermatozoon in undiluted semen.
4	(++++) Very good	About 70-80% of the spermatozoa are in vigorous motion. Waves and eddies are formed rapidly but not so vigorous as in excellent grade.
3	(+++)	About 50-75% of the spermatozoa are in motion. Motion is vigorous but waves and eddies formed slowly across the field.
2	(++) Fair	About 30-50% of the spermatozoa are in motion. Movements are vigorous. No waves and eddies.
1	(+) Poor	Less than 30% of the spermatozoa are in motion. The motion is mostly weak and oscillatory, not progressive.
0	(O) Zero	No motility found.

Data analysis

The data related to ejaculate volume, sperm concentration, pH and motility were collected and compiled by using Microsoft Excel 2007. Compiled data were analyzed by using χ^2 test (Gomez & Gomez, 1984) in SPSS 19.5.

Results and Discussion

Accurate evaluation of freshly drawn bull semen before use is important in artificial insemination. Detection of the quality of semen before use ensures in achieving optimum reproductive efficiency. Therefore, physical and chemical properties, particularly volume of ejaculate, concentration of sperm, pH and motility of sperm have been investigated in this study. Average volume (ml) of semen among 97 breeding bulls didn't differ ($P>0.05$) and the mean values were 9.3, 11.5, 9.8, 12.9, 7.4, 12.8 and 9.9 for Local (L), Friesian (F), Sahiwal (SL), Shahiwa×Friesian (SL×F), Local×Friesian (L×F), two times Local×Friesian (LF_1×F) and three times Local× Friesian (LF_2×F), respectively (Table 3).

In previous study, Shaha et al. (2008) found the ejaculate volume 4.1-7.6 ml for Holstein Friesian cross Zebu cattle. In fact, volume of semen varies from breed to breed (Ahmed et al. 1993; Raja and Rao 1982) and influenced by a number of factors such as age, breed, weight and season. Laing (1988) reported that a bull of high fertility produced greater semen volume than that in a in a lower fertility bull. Thus, volume of an ejaculate may be a good indicator of fertility.

Average concentrations of sperm before freezing were varied ($p<0.01$) from 1286.6-1858.6 million/ml (Table 3). Highest concentration of sperm (1833.5 million/ml) was obtained from SL and lowest (1286.6 million/ml) from LF_1×F bulls. This result differs with Shaha et al. (2008) who found comparatively low (1000 million/ml) sperm concentration from Friesian cross Zebu cattle.

The number of viable bovine spermatozoa deposited in the female reproductive tract influences the fertilizing ability of the cow up to an upper threshold level (Pace et al. 1981; Schenk et al. 1987; Gerard and Humblot, 1991). Sperm concentration in ejaculate is one of the important criteria of semen characteristics to qualify fertile males for breeding purposes (Graffer et al. 1988).

Significant differences in sperm concentration have been shown in semen from different bulls (Graffer et al. 1988; Seidel and Foote, 1969; Shelke and Dhami 2001). Sperm concentration in semen could be considered as an initial indicator of semen quality in semen used for cryopreservation (Shelke and Dhami, 2001; Belorkar et al. 1988). A positive correlation between sperm concentration at semen collection and motility has been reported (Everett et al. 1978; Mathevon et al. 1998) which relies on overestimation of motility in more concentrated samples (Everett et al. 1978). Nevertheless, still now literature regarding whether sperm concentration at the time of semen collection is an indicator of fertilization among normal fertility sire is quite scarce.

Table 3. Physical and chemical properties of bull semen at the Central Cattle Breeding and Dairy Farm

Parameter	L	F	SL	SL×F	L×F	LF_1×F	LF_2×F	Sig. level
Before freezing								
Ejaculate vol. (ml)	9.3	11.5	9.8	12.9	7.4	12.8	9.9	NS
Sperm conc. (mill./ml)	1654.8	1355.3	1858.4	1477	1530.3	1286.6	1406.4	**
pH	6.4	6.4	6.4	6.4	6.4	6.4	6.5	NS
Motility (%)	68.1	64.0	68.8	66.6	63.7	65.8	68.6	*
After freezing								
Sperm conc. (mill./ml)	1572.1	1287.5	1765.5	1403.2	1453.8	1222.3	1336.1	**
pH	6.1	6.1	6.1	6.1	6.1	6.1	6.2	NS
Motility (%)	62.2	62.3	63.6	62.9	62.6	62.6	63.6	*

*L, Local; F, Friesian; SL, Sahiwal; LF_1, 50% Friesian + 50% Local; LF_2, 75% Friesian + 25% Local NS, non-significant; *, $p<0.05$; **, $p<0.01$*

Semen pH is a measure of the acidity or alkalinity of semen. Average pH before freezing was similar (P>0.05) for all breeds and the mean value was 6.4 except for $LF_2 \times F$ which was 6.5. This result is in agreement with the observation of Mukherjee and Banerjee, 1980. Roberts (1986) also reported similar result. In another study, Shaha (2008) found that the pH of Friesian cross Zebu varied from 6.1-6.5. Therefore, the result of the current study and other relevant findings indicate that pH of semen is not markedly influenced by the variation due to breed.

Average motility of sperm before freezing was varied (P<0.05) from 63.7 to 68.8 % (Table 3). The highest motility (68.8 %) was found from SL and lowest (63.7 %) from L×F. Motility is one of the most important requirements of fertile semen. Donham et al. (1926) found that semen below normal motility (≥ 90 %) was less than half as effective in producing optimum conception rate. Davis (1939) reported motility of spermatozoa as one of the best single evidence of viability. Duration of motility in stored semen was reported by Comstock (1939) as another reliable index of fertility. Lasley (1943) found no significant difference in fertility of semen containing 55 to 95 per cent live sperm, however, semen containing 20 per cent of live sperm was infertile.

Average motility of sperm after freezing varied from 62.2-63.6%. It indicated that freezing of semen reduced sperm motility irrespective of breed. It could be assumed that the consequences of sperm cryo-injury caused by cryopreservation resulted impaired motility and poor survival of sperm in the female reproductive tract (Salmon and Maxwell 1995). The sperm plasma membrane is the primary site of damage induced by cryopreservation (Hammerstedt et al. 1990; Parks and Graham 1992; Watson 1995). Both freezing and thawing implicate tremendous alterations in cell water volume, which result considerable mechanical stress on the membrane and consequently reduce sperm motility (Hammerstedt et al. 1990).

Conclusion

Semen characteristics of 97 different types of breeding bulls at central cattle breeding and dairy farm, Savar, Dhaka have been discussed. It was evident that ejaculate volume, concentration, pH and motility of sperm were substantially influenced by freezing and the type of breed. Semen characteristics were better in Sahiwal followed by local and sahiwal Friesian crosses. It could therefore be summarized that, a certain part of the local cattle could be upgraded by pure Sahiwal and Friesian breeds.

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