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Effect of Seasonal Variation on Semen Quality and Herd Fertility

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Abstract: The data of the present study were collected from Bangladesh Milk Producer's Co-operative Union Limited (BMPCUL) at Baghabarighat, Sirajgonj to investigate the bull performance among various seasons through semen quality and 30-day non return rate. To evaluate the seasonal variation on semen quality and bull fertility the experimental period was divided into three seasons; a) Summer season (March to June), b) Rainy season (July to October) and c) Winter season (November to February). Data on 245 ejaculates and 12,750 services of almost same aged 5 Sahiwal bulls (B_1, B_2, B_3, B_4 and B_5) over a period of 5 years were collected from Animal Breeding section and Cattle Feed Unit of BMPCUL. The performance of five bulls was compared in three seasons i.e. summer, rainy and winter and summer was observed to be the best for most parameters studied. Seasons had significant ($p<0.05$) effect on semen volume, initial and post- thawing sperm motility and pH of semen but not on sperm motility of diluted semen and fertility. The significant ($p<0.01$) bull × season interaction was noticed in semen volume, sperm motility at initial and post-thawing stages, pH and fertility but not on sperm motility of diluted semen.

Key words: Season, semen quality, herd fertility

INTRODUCTION

The quality of semen in relation to fertility is determined largely by the motility (%) of sperm, which again depends on concentration of spermatozoa, proportion of live and morphologically normal spermatozoa, seminal pH and optimum metabolic features of individual sperm[1]. About 10-15% of the total variation in the male fertility on the basis of non-return rate are due to sperm motility[2]. Since fertility is obtained from the results of mating between male and female and it is obvious that fertility of bull is a matter of great importance[3]. So particular attention should be paid in this parameter of bulls all the year round during the tenure of their life at any breeding station. The information available on the semen characteristics of pure bred and crossbred bull is very meagre[4]. Moussa[5] reported the significant sire effect for the volume, concentration and number of motile spermatozoa per ejaculate. Bangladesh Milk Producer's Co-operative Union Ltd. (BMPCUL), Baghabarighat, Sirajgonj is one of the self sufficient and profitable milk producing enterprises and the reliable breeding and reproductive record keeper organization in Bangladesh. It is believed that exploitation of suitable genetic resource available at the location could be the most important elements of the story behind the success of BMPCUL. Crossing of local cows with Sahiwal by generations, has enabled the farmers of Baghabarighat milk pocket area to develop a type of cattle notable for milk and the type has been popularly known as Pabna type[6]. Many researchers[7,8] reported that the quality of semen i.e. ejaculate volume, sperm motility, viability and concentration etc. was variably affected by breeds and season. But contradictory results were provided by some others[9,10]. The present investigation was, therefore, undertaken to assess the effect of season on semen quality and herd fertility.

MATERIALS AND METHODS

Time and place of study: The study was undertaken at Baghabarighat milk shed area under Bangladesh Milk Producer's Co-operative Union Limited (BMPCUL), a large dairy pocket of Bangladesh, popularly known by the brand name "Milk Vita", located at Sirajgonj district, Bangladesh. The whole activities considered in this study covers the period from 1996 to 2000.

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Animals and data used: In 1994, five Sahiwal bulls were imported at BMPCUL from Pakistan. These bulls were numbered as B_1, B_2, B_3, B_4 and B_5. Collected semen was evaluated and processed for freezing and these bulls provided a total of 12,750 services. The deep frozen semen is used at BMPCUL. Cows under the study area have developed through crossing of the local cows with Sahiwal bulls by generations and develop a type of cattle provisionally called Pabna type[6]. They were free from reproductive diseases and were identified in heat and inseminated using the semen thus introduced. The information regarding semen quality of these bulls were collected from the records kept in Animal Breeding Section and Cattle Feed Unit while the data of fertility based on 30-day NRR of each bull were accumulated from the record sheets maintained by relevant Livestock Field Assistant and Inseminators (LFAI).

Semen collection, evaluation and preservation: Semen was collected by Artificial Vagina (AV) method. Artificial Vagina was prepared appropriately having proper temperature (40-44°C), pressure and softness and semen was collected 5 to 6 times per month from each bull. The volume per ejaculate was recorded from the graduated collection vials after collection. Just immediately after collection the pH of the semen was estimated by using indicator paper stripes. The concentration of spermatozoa per cubic milliliter for each ejaculate was measured by direct cell count method[11]. Semen, which contained more than 1000 million spermatozoa per mL was used for AI purpose otherwise discarded. Sperm motility, at initial, on dilution and post-thawing stages was assessed by microscopic examination as described by Settergren[12] and was recorded in percentage. Semen with motility of more than 50% was diluted with the freezing extender of egg-yolk citrate glycerol. The diluted semen was subsequently loaded in 0.25 mL/straw, cooled to 4°C and equilibrated for 4 h. Straws were frozen in freezer with a cooling rate of -60°C/min from +4 to -120°C. Loaded straws were then transferred to liquid nitrogen until subsequent evaluation or insemination.

Assessment of fertility: The fertility of bulls was estimated on the basis of Non-return Rate (NRR%) and NRR is defined as the number of cows, which are not represented for a subsequent insemination within 30 to 60 days[13]. In the present study the following formula has used to calculate the NRR:

$$\text{Non-return rate} = \frac{\text{Number of served cows not requested further service within 30-day}}{\text{Total number of cows served}} \times 100$$

Statistical analyses: Collected data were analyzed using "MSTAT" computer program to compute analysis of variance (ANOVA) for Completely Randomized Design[14]. Duncun's Multiple Range Test was performed to identify significant difference among the treatment means[15].

RESULTS AND DISCUSSION

Seasonal variation in the semen quality of bulls

Volume of semen: The highest volume of semen was found during summer (5.09±0.07 cc) followed in order by winter (3.98±0.10 cc) and rainy season (3.16±0.12 cc). The values were significantly ($p<0.01$) affected by seasons (Table 1). This may be due to the reason that the temperature in summer (March to June) was optimum for the maximum secretion of semen from Sahiwal bulls at Baghabarighat area. Many researchers[7,16,17] noticed the significant effect of season on semen volume in bulls and the present study agrees with the result of Sharma *et al.*[18] where they got highest volume in summer and lowest in winter but contradicts with Amir *et al.*[19]. The later group found insignificant variation in semen volume between seasons. This discrepancy may be due to the fact that the months comprising the seasons in this study, were not exactly similar in the season of their study and also the difference of temperature between seasons of this study and their study was not equal.

Sperm motility: The significant ($p<0.01$) variation was observed in initial motility among the seasons. The best motility was observed in summer (74.70±0.45%), next in order was in the winter (71.82±0.50%) and rainy season (71.58±0.35%). The variation between the later two seasons did not reach the significant level. The reason of low mass activity in winter and rainy season was not well understood. The possible postulates were that these two seasons would be unfavorable which lead to the production of many abnormal sperms with short span of life. This findings agrees with the work of Lagerlof[20], who created unfavorable condition on spermatogenesis by applying insulation over scrotum and thus ratio of pathogenic sperms was greatly increased and initial motility was also decreased. Moreover it might so happen that sperm cell already produced and stored in the epididymis or seminiferous tubules, had some adverse effect on their longevity due to environmental condition. As such, ejaculated semen had less viable sperms showing low much activity. The present work further confirms the work of Tomar *et al.*[21] and Kodagali[22]. They found highly significant variation in initial motility among the seasons. The motility of spermatozoa in diluted semen revealed that there were no significant variations among the seasons, which agrees with the study of

Table 1: Mean±SE of effect of seasons on semen quality

	Parameters				
		Sperm motility (%)			
Season	Volume/ejaculate (cc)	Initial	On dilution	Post- thawing	Semen pH
Summer	5.09±0.07[a]	74.70±0.45[a]	65.58±0.32	59.22±0.30[a]	6.33±0.02[a]
Winter	3.98±0.10[b]	71.82±0.50[b]	65.28±0.32	56.67±0.30[b]	6.22±0.06[b]
Rainy	3.16±0.12[c]	71.53±0.35[b]	66.08±0.40	58.58±0.35[ab]	6.35±0.01[a]

Means with different superscript(s) within the same column differed significantly ($p<0.05$) among themselves
Each parameter represents mean of 40 observations

Table 2: Fertility (NRR%) of bulls in three seasons

Season	Fertility (NRR%)
Summer	66.35±0.27
Winter	66.07±0.27
Rainy	65.88±0.30
Level of significance	NS

Saxena and Tripathi[9], Verma *et al.*[10]. As the initial motility of spermatozoa was found significantly ($p<0.01$) highest in summer, the on dilution motility was expected to be higher in the same season but the cause of this discrepancy is unknown as yet. The results of post-thawing motility in different seasons are shown in Table 1. Significant ($p<0.05$) variation in motility was observed between summer and winter seasons. The best motility was observed in summer (59.22±0.30%) followed in order by rainy (58.580±35%) and winter season (57.67±0.30%) . The highest post-thawing motility was observed in summer, which again supports the finding of the highest initial motility in the same season and further confirms that the summer is the best season for the production of good quality semen. Since the fertility were same breed and age it can be assumed that the changes in motility percentage might due to environmental variation in different seasons along with individual variations. The observation of this study was in agreement to Phillips *et al.*[23] as they found the highest motility in summer.

Semen pH: The data were analyzed statistically and the seasonal influence on this parameter was observed. The significantly ($p<0.01$) highest semen pH was obtained in rainy (6.35±0.01) and summer (6.33±0.02) season than in winter (6.22±0.06) (Table 1). These findings were supported by the other researchers[7, 21, 24].

Fertility of bulls in three seasons: A total of 12,750 inseminated cows were included in this study to ascertain the bull fertility in three seasons. Analysis of variance showed that there was no significant variation in NRR among the bulls in different seasons with the highest NRR being in summer (66.35±0.27%) followed in order by winter (66.07±0.27%) and rainy (65.88±0.30%). Though the variation did not reach significant level, the higher NRR found in summer was very much expected because of the good quality of semen as found the same season (Table 2) On the other, the lower NRR was observed both in winter and rainy season because of the poor quality of semen as found previously in these two seasons. The present study agrees with Blokhuis[25] who stated that in Netherlands and Germany goats were most likely to conceive in October and November as the semen found excellent quality during these months.

The interaction of bull and season on semen quality: The highly significant ($p<0.01$) bull × season interaction on semen volume, initial and post-thawing sperm motility was observed (Table 3). But no significant interaction was found in motility of sperm in diluted semen. The interaction of bull and season on semen pH was also observed and the values ranged from 5.98 to 6.54. The significant bull × season interaction of the present study agrees with the study of Al-Hakim *et al.*[7]. The significant interaction showed that all the bulls did not perform in the similar manner during different seasons. This could be due to differences in the individual genetic make up of the bulls. The interaction results in general indicated that the bull B_4 is the best performer among the bulls.

The interaction of bull and season on fertility (non-return rate): The significant interaction of bull and season on fertility (NRR) was found similar to the parameters of semen quality (Table 4). While considering one bull in a group, bull B_4 group in different seasons was found as higher performer than those of other groups. Within this group the significantly ($p<0.01$) highest NRR was found in winter (72.40%) followed in order by rainy and summer season, though the difference between winter and rainy season was not significant. The highest NRR values in B_4 group indicated that the genetic potentiality is obviously important for the best performance, although seasonal variation might affect the genetic potentiality of the individual.

From the present study, finally it can be concluded that there is much variability in the potentiality of semen quality and fertility of bulls among various seasons. It revealed from the statistical analysis of volume per

Table 3: The interaction of bull and season on semen quality

Bull× season	Volume/ejaculate (cc)	Sperm motility (%) Initial	On dilution	Post-thawing	Semen pH
B_1× S_1	5.06^{bc}	74.75^{a-c}	64.63	57.38^{bc}	6.00^{ef}
B_1× S_2	3.69^{d}	71.38^{b-f}	65.38	65.00^{cd}	5.98^{f}
B_1× S_3	2.75^{e-g}	67.25^{f}	65.13	53.50^{d}	6.15^{ef}
B_2× S_1	4.88^{c}	74.63^{a-c}	64.75	58.13^{bc}	6.19^{c-f}
B_2× S_2	3.00^{ef}	73.25^{a-e}	65.88	58.25^{bc}	6.18^{d-f}
B_2× S_3	2.38^{fg}	75.38^{ab}	67.50	58.25^{bc}	6.40^{a-c}
B_3× S_1	5.69^{ab}	75.38^{ab}	62.50	59.25^{b}	6.50^{a}
B_3× S_2	4.63^{c}	73.75^{a-d}	61.88	56.50^{b-d}	5.98^{f}
B_3× S_3	3.25^{de}	69.38^{ef}	63.50	58.00^{bc}	6.44^{a}
B_4× S_1	6.00^{a}	75.75^{a}	70.13	64.88^{a}	6.41^{ab}
B_4× S_2	5.69^{ab}	70.00^{d-f}	68.88	64.63^{a}	6.40^{a-c}
B_4× S_3	5.12^{bc}	74.38^{a-c}	69.25	64.88^{a}	6.53^{a}
B_5× S_1	3.18^{d}	73.00^{a-e}	65.88	56.50^{b-d}	6.54^{a}
B_5× S_2	2.88^{e-g}	70.75^{c-f}	64.38	54.00^{d}	6.14^{ef}
B_5× S_3	2.31^{g}	71.25^{b-f}	65.00	58.25^{bc}	6.21^{b-e}

Note: S_1, S_2 and S_3 denote summer, winter and rainy season, respectively.
Means with different superscript(s) within the same column differ significantly ($p<0.01$). Each parameter represents mean of 8 observations.

Table 4: Fertility (NRR%) of bulls in three seasons

Bull× season	Fertility (NRR%)
B_1× S_1	65.86
B_1× S_2	66.19
B_1× S_3	65.56
B_2× S_1	68.08
B_2× S_2	66.31
B_2× S_3	66.82
B_3× S_1	69.38
B_3× S_2	68.00
B_3× S_3	69.54
B_4× S_1	68.20
B_4× S_2	72.40
B_4× S_3	71.44
B_5× S_1	57.86
B_5× S_2	57.45
B_5× S_3	58.40

ejaculate, sperm motility at three stages (initial, on dilution and post-thawing) that the bull B_4 was the best and B_5 was found as the poorest among the bulls. Season and interaction between bull and season also affected the semen quality of Sahiwal bulls except sperm motility on dilution state. The test of significance showed significant differences among the bulls for 30-day NRR and the highest fertility was observed in the same bull B_4 with the lowest in B_5. Seasonal variations in the fertility of bulls were not found significant but the interaction was found significant. The result of this study gives an important criterion for sire evaluation on the basis of semen quality and herd fertility.

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