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Phenotypic Variation and Repeatability of Semen Characteristics of Bulls

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Abstract: A total of 30 animals, belonging to three breeds and crossbreds (Friesian, Local × Friesian and Shahiwal × Friesian) were analyzed to study the magnitude of phenotypic variation and the repeatability of semen characteristics for volume of ejaculate, mass movement, forward movement and concentrations of semen. The co-efficient of variations ranges from 13.10 to 46.20% for various semen characteristics. Least square analysis of variance showed that breeds had significant effect on volume of ejaculate ($P<0.05$), mass movement ($P<0.01$), forward movement ($P<0.05$) and concentration ($P<0.05$) of semen. Pooled repeatability of volume of ejaculate, mass movement, forward movement and concentration ranges from 0.30 to 0.44, which indicated that more number of measurements should be considered for gain in accuracy in selecting the bulls. In semen out put, it was concluded that repeatabilities of semen characteristics was moderate. The breeds and crossbreds were found suitable for semen production. The crossbreds are as good as the purebreds for semen quality and output. Among the breed and crossbreds, Local x Friesian was found to be the most suitable. There was large phenotypic variation in semen characteristics in both between and within the breeds.

Key words: Variation, semen, age, repeatability, bulls

Introduction

Improvement of dairy cattle by genetic principle is one of the most important aspects in developing dairy industry. The total phenotypic variation of a trait may be partitioned into genetic and environmental components (Dalton, 1980). Effective selection and breeding is one of the basis of successful operation in the maintenance of satisfactory level of production and reproduction. The concept of repeatability is closely associated with relative importance of heredity and permanent environment, influencing the variations for a character. The amount of progress that could be made in selection is partially limited by the repeatability of the trait because it reflects the upper limits of heritability. Selection for a trait, which is low in heritability, will make little progress than a trait, which is highly heritable. A common term `the bull is half of the herd' is taught in dairy husbandry both past and present. The reason behind the statement is that the sire is one of the parents of all the calves in the herd; while a dam is one parent of one calf per season. Semen is the secretion of male reproductive glands containing the male reproductive units, spermatozoa, produced in the testis. Low reproductive efficiency of cattle is a problem to producers. Since fertility is determined from the results of mating between male and female, a part of low breeding efficiency is due to the bull (Hoque, 1968). Crossbreeding of indigenous cattle using exotic dairy breeds has been accepted as an effective method for bringing about a quick genetic improvement of cows for increased milk production (Sultana, 1995). In the process of evolving new types of crossbred cattle with different levels of exotic germplasm, the use of pure bred and crossbred bulls in the breeding program has become imminent. The information available on the semen characteristics of pure bred and crossbred bulls is very meager (Abraham *et al.*, 1982 and Rao and Rao, 1975). Among the reproductive traits, quality semen plays a major role in determining the fertility and reproductive efficiency of livestock production. Comprehensive studies of phenotypic variation and repeatability for semen characteristics of purebred and crossbred bulls have been attempted in this study.

Materials and Methods

Animals and data used: The information of semen characteristics of 30 bulls was collected on the basis of records maintained at the Central Cattle Breeding Station (CCBS), Savar, Dhaka during the period from 1984 to 1994. The experimental animals were divided into three groups according to their genetic composition: Friesian (F), Local x Friesian (L X F) and Shahiwal x Friesian (SL x F). The records of volume of ejaculate, mass movement, forward movement and semen concentrations were kept for the experimental animals. The experimental animals were also divided into three age groups: two years, three years and four years for the analysis of breed and age effect. The number of animals in each breed, the number of ejaculates, mass movement, forward movement and concentration measurements for the semen characteristics are shown in Table 1.

Feeding and Management of Bulls: Stall-feeding was practiced regularly and concentrate feeds were given two times a day (morning and evening). Concentrate feeds include chickpea, wheat bran, till oil cake, rice bran, urea molasses and salt. The green grasses like Para, Napier, Maize and Oats and in the form of silage were also supplied on the basis of year round availability. The bulls were also fed a balanced ration of 50% mixed concentrates hay and supplementation of vitamins and minerals. Bulls were tested for fertility before putting them in breeding herd. The weight of the bulls was recorded every month. Semen was collected using a standard artificial vagina from the bulls at an interval of 3 to 4 days. Every day 2 ejaculates were taken. A total of 600 ejaculates, (200 from each of the three groups) was obtained over a period of 1984 to 1994 to study the variations in semen characteristics. The bull calves after selection were brought up in the farm and trained for semen collection from 18 months of age. Records on date of collection, dates of culling, dates of death etc. were kept.

Semen characteristics, analyzed

Following three traits of semen were analyzed:

Ejaculate volume: Ejaculate volume was recorded from the graduated collection tube immediately after collection.

Motility: Percentage motility (mass movement and forward movement of spermatozoa) was estimated by microscopic examination and was recorded in intervals of 10%. Physical

Table 1: Number of animals, ejaculate volume, mass movement, forward movement and semen concentration measurements of different purebred and crossbred bulls

Genotypes	No. of animals	Number of ejaculate	Number of observations		
			Mass movement	Forward movement	Concentration
Friesian (F)	10	200	197	195	196
Local x Friesian (L x F)	10	200	199	200	198
Shahiwal x Friesian (SLxF)	10	200	197	198	198
Total	30	600	593	593	592

characteristics, volume, sperm concentration and motility (undiluted semen under phase contrast microscope) were recorded for every ejaculate. Satisfactory semen was deep frozen by the horizontal vapour freezing technique in 0.5 ml. French straws and the post thaw motility was recorded after day storage in liquid nitrogen.

Concentration: The score of millions per ml was given to each collection depending on number of spermatozoa found in semen sample.

Statistical procedure: Mean, variance, standard deviation and coefficient of variation of volume of ejaculate, mass movement, forward movement and concentration were calculated in each breed. Analysis of variances and least significant difference (LSD) for breed and age groups for each trait were calculated in each breed according to procedure described by Snedecor and Cochran (1980).

Results and Discussion

The phenotypic variation in different measurements of semen characteristics and coefficient of variations in different breeds/types presented in Table 2. The average values of volume of ejaculate, mass movement, forward movement and concentration of semen were 4.76±0.15 ml, 2.58± 0.06 grade, 54.85±0.90 % and 867.89±28.76 million/ml for Friesian, 6.00±0.15ml, 3.98±0.04 grade, 58.30±0.53% and 763.24±18.79 million/ml for Local x Friesian and 6.22±0.17ml, 2.49±0.05 grade, 52.78±0.78% and 805.06±22.07 million/ml for Shahiwal x Friesian respectively. Mean ± S.E for different age groups are given in Table 3

Table 2: Mean, standard deviation, coefficient of variation, range and mode of volume of ejaculate, mass movement, forward movement and concentration of semen of purebred and crossbred bulls

	Breeds		
	Friesian	Local x Friesian	Shahiwal x Friesian
Volume of ejaculate (ml)			
Mean±S.E	4.76±0.15	6.0±0.15	6.22±0.17
Range	1-11	1-10.5	1-11
Mode	5-7	5-7	5-8
SD	2.19	2.11	2.34
CV (%)	46.00	35.31	37.63
Mass movement (grades)			
Mean±S.E	2.58±0.06	3.98±0.04	2.49±0.05
Range	1-4	1-4	1-4
Mode	3	3	3
SD	0.86	0.57	0.73
CV (%)	33.34	19.27	29.51
Forward movement (%)			
Mean±S.E	54.58±0.90	58.30±0.53	52.78±0.78
Range	10-70	10-70	15-70
Mode	50-60	50-60	50-60
SD	12-51	7.64	11-10
CV (%)	22-81	13.10	21.03
Concentration (million/ml)			
Mean±S.E	867.89±28.76	763.24±18.71	805.06±22.07
Range	100-1900	100-1475	200-1400
Mode	900-1275	600-975	600-1100
SD	40.10	264.35	310.58
CV (%)	46.20	34.64	38.58

Phenotypic variations in semen characteristics: Phenotypic variation refers to the observable or measurable differences among individuals within a population for a particular trait. Causes of phenotypic variations in traits of farm animals are the heredity, environment and the joint effects (Lasley, 1978). The volume of ejaculate ranged from 1 to 11 ml. The mode of the ejaculate volume for Friesian, Local x Friesian and Shahiwal x Friesian were 5 to 7, 5 to 7 and 5 to 8 ml respectively. Most of the ejaculate volumes were 5 to 7 ml for Friesian and Local x Friesian and 5 to 8 ml for Shahiwal x Friesian. The results are in agreement with those of Hafez (1993). The coefficient of variation (CV) of ejaculate volume for Friesian (F), Local x Friesian and Shahiwal x Friesian were 46%, 35.31% and 37.63% respectively (Table 2). Similar studies were made by Orlovskii (1972), who showed that the CV of ejaculate volume for Russian Black Pied was 32% and Austrian yellow bulls was 33.3%. Range and mode of mass movement were 1 to 4 grades and 3 grades for Friesian, Local x Friesian and Shahiwal x Friesian and coefficient of variation were 33.34%, 19.27% and 29.51% for those breeds respectively. Range (10 – 70 %) and (50 –60 %) mode of forward movement were almost similar for the breeds and crossbreds. The coefficients of variation of forward movement for all these breeds were 22.81%, 13.10% and 11.10% respectively. The highest concentration (million/ml) of semen was obtained for Friesian breed (867.89±28.76) and lowest (763.20±18.79) for Local x Friesian crosses. Range and mode of concentration of semen were 100 to 1900, 100 to 1474 and 200 to 1400 million/ml respectively and 900 to 1275, 600 to 975 and 600 to 1100 million/ml respectively for Friesian, Local x Friesian and Shahiwal x Friesian. The highest coefficient of variation 46.20% was obtained for Friesian breed and lowest 34.64% for Local x Friesian crossbred. These results were partially supported by Orlovskii (1972) and Rao and Rao (1978). Hafez (1993) reported that concentration of bull spermatozoa was 800 to 2000 million/ml. Separate estimates of repeatability for volume of ejaculate, mass movement, forward movement and concentration of semen were made within each breed. A pooled estimate of repeatability was also made of all breeds for each trait (Table 4).

Table 3: Summary showing least square mean ± S.E in different age groups on semen characteristics

Parameters	Age groups (year)		
	2	3	4
Volume of ejaculate (ml)	7.86^{a}±0.16	6.76^{b}±0.35	6.89^{b}±0.290
Mass movement (grades)	2.65^{a}±0.46	2.67^{a}±0.26	3.38^{b}±0.086
Forward movement (%)	52.1^{a}±1.07	56.15^{b}±1.50	60.54^{c}±0.880
Concentration (million/ml)	760.81^{a}±31.4	750.1^{b}±61.42	1071.18^{c}± 32.65

Means with uncommon superscripts differ significantly (P<0.05) by LSD.

Intraclass correlation, which is the repeatability among the measurements of different characteristics in each individual, was calculated from the expected mean square estimated through analysis of variance. Repeatability estimates for volume of ejaculate, mass movement, forward movement and concentration are presented (Table 4). The pooled estimates of repeatability were 0.44±0.03 for volume of ejaculate,

Table 4: Repeatability of volume of ejaculate, mass movement, forward movement and Concentration of semen of pure bred and crossbred bulls

Genotypes	No. of bulls	Volume of ejaculate		Mass movement		Forward movement		Concentration	
		Repeatability	S.E (R)	Repeatability	S.E (R)	Repeatability	S.E (R)	Repeatability	S.E (R)
Friesian	10	0.34	0.12	0.24	0.10	0.37	0.12	0.20	0.09
Local x Friesian	10	0.59	0.12	0.39	0.12	0.44	0.13	0.39	0.015
Shahiwal x Friesian	10	0.39	0.16	0.23	0.10	0.36	0.12	0.50	0.13
Pooled estimate		0.44	0.05	0.33	0.03	0.39	0.04	0.30	0.02

0.33 ± 0.03 for mass movement, 0.39 ± 0.04 for forward movement and 0.30 ± 0.02 for concentration.

The repeatability estimates of volume of ejaculate were 0.34 ± 0.12, for Friesian breed 0.59 ± 0.12 for Local x Friesian crossbred and 0.39 ± 0.12 for Shahiwal x Friesian crossbred. Similar studies were made by Dalton (1980), Eckardt *et al.* (1973), Stalhmmar (1989), Jain (1990), Makulska (1993) and Hoque (1968). Eckardt (1973) observed and found that repeatability of ejaculate volume was 0.20 to 0.38. Stalhmmar (1989) found the repeatability for volume of ejaculate as 0.5 to 0.6. Dalton (1980) expressed the repeatability of ejaculate volume as 0.7 to 0.8. These results supported the present findings.

Repeatability of mass movement and forward movement were 0.24 ± 0.10, 0.39 ± 0.12, 0.23 ± 0.10 and 0.37 ± 0.12, 0.44 ± 0.13, 0.36 ± 0.12 for Friesian, Local x Friesian and Shahiwal x Friesian purebred and crossbreds respectively. Similar studies were made by Eckardt (1973), Stalhmmar (1989) and Hoque (1968). Eckardt (1973) observed and found that highest forward and mass motility in the Jersey crosses and he found the forward motility as 0.26 to 0.37. This result supported the present findings. Repeatability of semen concentration were found for Friesian, Local x Friesian and Shahiwal x Friesian as 0.20 ± 0.09, 0.39 ± 0.15 and 0.50 ± 0.13 respectively.

In present study the pooled repeatability of the components of semen characteristics ranged from 0.30 to 0.44, which indicate that more number of measurements should be considered for gain in accuracy in selecting the bulls.

From present study on semen characteristics, it may be concluded that there was large phenotypic variation and repeatability of semen characteristics was moderate. Semen of crossbred bulls was found to be of better quality and quantity than that of purebred.

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