

# EFFECT OF SEASON ON SEMINAL CHARACTERISTICS OF HOLSTEIN BULLS UNDER SEMI-ARID ENVIRONMENT

## II. SPERM ABNORMALITIES

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### Summary

Eight healthy Holstein bulls, 4-6 years old were used to study the effect of season of the year on the incidence of the morphologically abnormal spermatozoa. Semen was collected twice a week by A. V. over one-year period. The percentage of total abnormal spermatozoa was  $14.1 \pm 0.5$ . Ejaculates collected during hot summer season had significantly higher incidence of abnormal spermatozoa than those collected during winter time. Warm spring had moderate semen abnormality. In addition to its effect on the total number of morphologically abnormal spermatozoa, season affected significantly the primary as well as the secondary types of abnormalities. The differences between incidence of primary and secondary types of abnormalities were not significant for all seasons and seasons pooled together. The ratio between the total forms of abnormality in the head, mid-piece and tail of spermatozoa was as 1:1.5:1. Head and mid-piece had defected more during summer compared with both winter and spring. There was no variation in tail abnormalities due to season. The significant effect of season on head was observed by large, pyriform, free and detached heads, while that on mid-piece was by swollen, coiled mid-pieces and protoplasmic droplets.

(Key Words: Season, Sperm Abnormality, Holstein Bulls, Semi-Arid)

### Introduction

Under tropical conditions, the exotic breeds (*Bos taurus*) showed significantly seasonal fluctuations in semen characteristics with higher sperm cell abnormalities, lower percentage of live sperm cells and lower sperm concentration during the hot periods (Nishiyama et al., 1968; Holy, 1971; Fields et al., 1979; Bhosrekar et al., 1980; Gwasdauskas et al., 1980; Kumi Diaka et al., 1981; Saxena and Tripathi, 1984; Parkinson et al., 1985, 1987; Rekwot et al., 1987). Sekoni and Gustafsson (1987) reported that the peak in total sperm abnormalities was during the summer season. A high frequency of abnormal sperms has been associated with reduced fertility (Williams, 1920; Williams and Savage, 1925; Lagerlof, 1934; Rollinson, 1951; Hancock, 1955, 1959; Saacke, 1970; Reddy et al., 1975).

High ambient temperature has a deleterious effect upon the performance of dairy animals (McDowell et al., 1969; Hilliger, 1970; Maust and McDowell, 1971). In Saudi Arabia (semi-arid climates), the unusual prolonged hot season (over 35°C for up to 8 months) composes a stress on the imported exotic temperate-evolved Holstein cattle and their locally born generations, reflected in lower productivity (Salah et al., 1988; El-Nouty et al., 1990), and fertility (Salah and Mogawer, 1990). Salah et al. (1992) reported that ejaculates collected during hot summer season from locally born Holstein bulls had significantly lower quality than those collected during both winter and spring seasons. The present study concerned with the effect of season on sperm morphological abnormalities of the locally born Holstein bulls under the semi-arid conditions of Saudi Arabia.

### Materials and Methods

Eight healthy dairy Holstein bulls aged 4 to 6 years belonging to the Germ Plasm Bank and Artificial Insemination Center of El-Kharj Agriculture Project, Al-Hassa Irrigation and Drainage Authority, Ministry of Agriculture and Water,

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Saudi Arabia, were used in this study. The experiment was conducted during one-year period from June 1, 1989 to May 30, 1990. This period was categorized into three seasons according to the average mean monthly temperatures and relative humidities as follow: Summer (Hot Dry, June 1-October 31,  $33.8 \pm 0.4^\circ\text{C}$  and  $17.2 \pm 0.3\%$  RH); Winter (Cold-humid, November 1-February 28,  $18.9 \pm 0.6^\circ\text{C}$ ,  $46.3 \pm 1.3\%$  RH); Spring (Warm-humid, March 1- May 31,  $25.3 \pm 0.5^\circ\text{C}$ ,  $32.3 \pm 0.9\%$  RH). Bulls were maintained and fed individually (see Salah et al., 1991). Semen samples were collected twice a week from each bull at early morning (05-06 hour) by the AV method using a teaser male within 5 minutes after a false mount. Immediately after collection, the biophysical characteristics (see Salah et al., 1991) of each bull's semen were measured as well as the incidences of different types of sperm abnormalities.

The incidences of the primary and secondary types of abnormal spermatozoa were assessed under phase-contrast microscope using the nigro-sin-eosin vital with used for determination of the dead-live percentage of spermatozoa (Dott and Foster, 1972). Primary abnormalities seen

in different regions of sperm were as follows: (a) small and large size, elongated and pyriform heads; (b) double, swollen, or coiled mid-pieces, or mid-pieces with abaxial attachment and (c) double or coiled tails. Secondary abnormalities included knobbed head, loose normal head, detachment of galea capitis, sperm with protoplasmic droplets, sperm with bent mid-piece, and sperm with bent or looped tail.

The data were statistically analyzed to visualize the effects of season of the year on the morphological abnormal traits of the spermatozoa, using the procedures GLM and LSMEANS of the Statistical Analysis System (SAS USER'S GUIDE, 1986) after adjustments for the bull's age effect.

## Results

The mean values of different types of sperm abnormalities during different seasons and for the pool seasons together and their trend of variations are summarized in table 1; while figures 1a, 1b and 1c show the trends of the different forms of abnormalities in different regions of spermatozoa of the Holstein bulls under

TABLE 1. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR THE PERCENTAGES OF VARIOUS TYPES OF SPERM ABNORMALITIES IN HOLSTEIN BULLS ACCORDING TO REGION OF SPERMATOZOA AND SEASON OF THE YEAR (%)

Region of spermatozoa	Type of abnormality	Season <sup>1</sup>			
		Hot-Dry	Cold-Humid	Warm-Humid	Pool
Head	Primary	$2.65 \pm 0.21^a$	$1.14 \pm 0.28^b$	$1.30 \pm 0.32^b$	$1.80 \pm 0.18^{**}$
	Secondary	$4.17 \pm 0.33^a$	$0.09 \pm 0.04^b$	$0.52 \pm 0.16^b$	$2.20 \pm 0.24^{**}$
	Total	$6.83 \pm 0.45^a$	$1.23 \pm 0.59^b$	$1.82 \pm 0.67^b$	$4.00 \pm 0.35^{**}$
Mid-piece	Primary	$4.13 \pm 0.34^a$	$1.88 \pm 0.45^b$	$2.65 \pm 0.50^b$	$3.38 \pm 0.22^{**}$
	Secondary	$2.84 \pm 0.29^a$	$2.04 \pm 0.39^a$	$2.69 \pm 0.44^a$	$2.76 \pm 0.21^{ns}$
	Total	$6.97 \pm 0.48^a$	$3.92 \pm 0.64^b$	$5.34 \pm 0.72^b$	$6.14 \pm 0.34^{**}$
Tail	Primary	$1.21 \pm 0.10^a$	$1.05 \pm 0.13^a$	$1.18 \pm 0.15^a$	$1.10 \pm 0.06^{ns}$
	Secondary	$2.78 \pm 0.21^a$	$2.69 \pm 0.27^a$	$2.66 \pm 0.31^a$	$2.83 \pm 0.13^{ns}$
	Total	$3.99 \pm 0.26^a$	$3.74 \pm 0.35^a$	$3.95 \pm 0.39^a$	$3.93 \pm 0.16^{ns}$
Overall	Primary	$8.00 \pm 0.38^a$	$4.07 \pm 0.50^b$	$5.13 \pm 0.57^b$	$6.28 \pm 0.31^{**}$
	Secondary	$9.79 \pm 0.46^a$	$4.82 \pm 0.62^b$	$5.98 \pm 0.70^c$	$7.79 \pm 0.34^{**}$
	Total	$17.79 \pm 0.61^a$	$8.89 \pm 0.81^b$	$11.11 \pm 0.91^c$	$14.07 \pm 0.51^{**}$

\*\*  $p < 0.01$ .

<sup>ns</sup> non-significant.

<sup>1</sup> different small letters indicate significant differences among means of the same row.

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the semi-arid condition of Saudi Arabia.

Regardless of the region of the spermatozoa, analysis of variance revealed highly significant variations in the percentages of the total, primary and secondary, morphologically abnormal spermatozoa due to season. Total primary abnormalities were less than the secondary, but all the differences were not significant. The hot season had the highest, the cold season had the lowest, and the warm season had a moderate percentage of sperm abnormalities.

Total sperm abnormalities was distributed between the head, mid-piece and tail regions in a ratio of 1:1.5:1. Season affected significantly ( $p < 0.01$ ) the primary as well as the secondary type of abnormality of the head region, and the primary not the secondary abnormality of the mid-piece region; it had no effect on tail abnormalities (table 1).

The hot summer season showed more head secondary abnormality ( $p < 0.01$ ) than primary, while the inverse was in the other two seasons ( $p < 0.01$ ). Small, large, pyriform and loose heads were the main sources of abnormalities in the head of spermatozoa (figure 1a).

In the mid piece region, primary constituted the majority due to its significant ( $p < 0.01$ ) increase in the hot season. The swollen, coiled and bent mid-piece forms of abnormalities were greater than the other forms in all seasons (figure 1b). Summer season had significantly more proximal protoplasmic droplets than the other two seasons.

The primary tail abnormalities were lower ( $p < 0.01$ ) than the secondary in all seasons and seasons pooled together (table 1). Tail abnormalities, mostly coiled and bent tails (figure 1c), did not differ significantly between seasons.

### Discussion

Different types of sperm abnormalities were determined and it was observed that all the bulls under investigation had in average spermatozoal abnormalities within the recommended limits of the good quality semen, even during the hot summer season. The incidence of total sperm abnormalities herein was higher than those reported by Zemjanis (1970), Ball et al. (1974), Rao and Kotayya (1974), and Saxena and Tripathi (1983) in exotic pure bred bulls, and by Rekwot

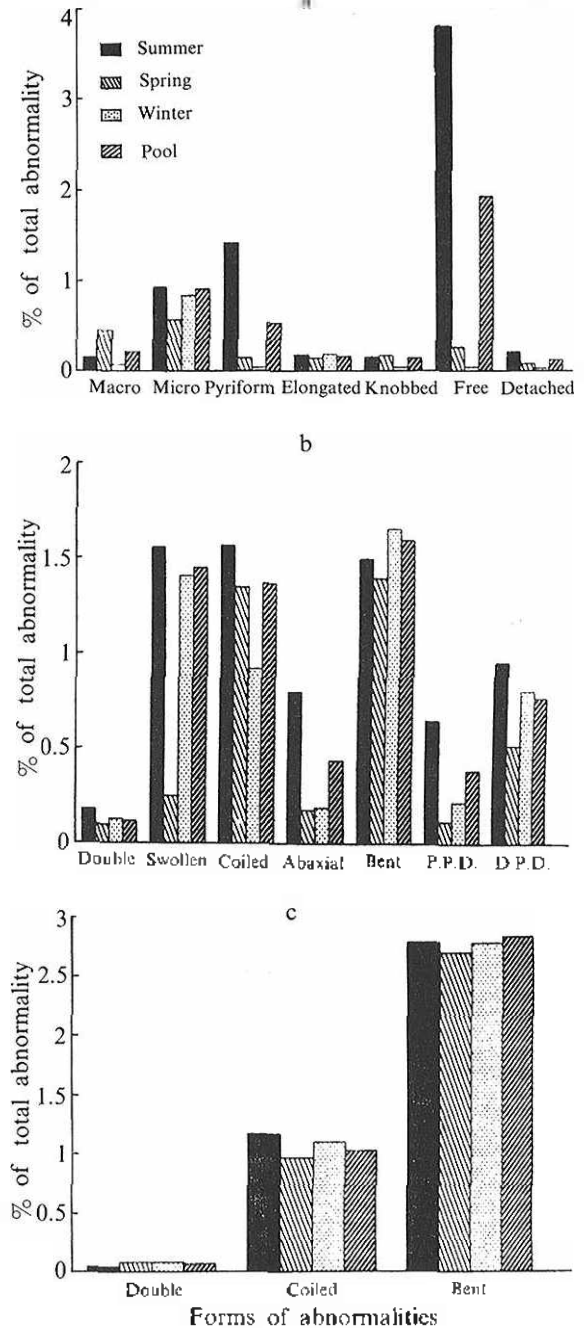


Figure 1. Forms of abnormalities in the head, a: mid-piece, b: tail, c: the Holstein bull spermatozoa as percentages of the total abnormalities during different seasons and pooled seasons together.

et al. (1987) in Zebu, Holstein-Friesian and their crosses bulls, but compared favourably with those

reported by Seiciu et al. (1975) in Holstein-Friesian and Romanian Brown bulls. This discrepancy in the investigations might be due to variation in the genotype of bulls and the definition of the environmental factors such as the season of the year or the agroclimatic conditions of the region where the bulls were maintained. Also, the manipulation and techniques used for semen examination of morphologically abnormal spermatozoa may have caused some variations among various reports.

The analysis of data revealed highly significant differences in the percentage of abnormal spermatozoa due to season. The high ambient temperature during the dry-summer season would be a direct cause in the elevation of sperm abnormalities during summer compared to winter and spring in which air temperatures were lower. Fayemi and Adegbite (1982) related the increase in sperm abnormalities in dry season to the high ambient temperature and nutritional deficiency. High temperature might have caused epididymal or accessory gland dysfunction reflected by the high incidence of the secondary type abnormalities in the head region, mainly free heads, as well as the increase in the number of spermatozoa bearing their protoplasmic droplets. Rao and Kotayya (1974) and Saxena and Tripathi (1981) reported high incidence of free heads in semen of different breeds. The negative effect of hot season on sperm abnormalities was also observed by various authors (Johnston and Branton, 1953; Kushwaha et al., 1955; Kodagli, 1962; Tripathi and Prabhu, 1968; Igboeli and Rakha, 1971; Saxena and Tripathi, 1981, 1983, 1984; Sekoni and Gustafsson, 1987). Ruttle et al. (1975) found non-significant difference in the percentage of abnormal spermatozoa due to season. During the hot summer months, Red Dane bulls (Dabas et al., 1982) showed slightly higher incidence of total sperm abnormalities than that observed in the Holstein bulls of the present study.

The incidence of head abnormalities in the present study was in favour of those reported by Rao and Kotayya (1974) and higher than those of Saxena and Tripathi (1983) in Jersey bulls. The abnormal mid-pieces were higher than those reported by Rao and Kotayya (1974) and Rao and Rao (1978), but was lower than those reported by Saxena and Tripathi (1983). Tail

defects were higher in the bulls of the present study than those in the study of Saxena and Tripathi (1983). Semen collected during summer season contained more spermatozoa bearing defected heads and mid-pieces than during the winter and spring. This seasonal effect was not observed in tail region. Working with Jersey bulls in tropical India, Saxena and Tripathi (1983) reported seasonal variations in total abnormalities of head, mid-piece and tail of spermatozoa, with the highest incidence in the summer months. However, Rao and Rao (1978) in cross-bred bulls, reported non-significant effect of season on tail and mid-piece abnormalities, while it was effective in respect to head abnormalities as reported also by Rao and Rao (1975) in purebred bulls.

The present study indicated that primary abnormal mid-pieces were more than the secondary. This is in agreement with Saxena and Tripathi (1983), but it disagrees in that the inverse was the case in respect to the heads and tails. Season affected significantly the primary and secondary abnormality of the head and only the primary abnormality of the mid-piece. Saxena and Tripathi (1983) reported significant seasonal effect on both primary and secondary abnormalities of the head and mid-piece but only affected the primary abnormality of the tail region of spermatozoa from Jersey bull semen. High incidence of mid-piece abnormality interferes with fertility by reducing sperm motility. Summer season had both higher mid-piece abnormality (present study) and lower initial sperm motility (Salah et al., 1992).

The main sources of head abnormalities in the present study were the spermatozoa of small, large, pyriform and loose heads. Season affected only the large, pyriform and loose heads in addition to the incidence of detached galea capitis. Since, acrosomal abnormalities (Knobbed and detached heads) were very much within the normal limits in bulls under investigation, the fertilizing ability of the sperm is likely not to be affected during the different seasons (Saacke and Amman, 1966; Saacke et al., 1968; Hafez, 1987). The high incidence of swollen and bent mid-pieces reported in the present study was reported also by Saxena and Tripathi (1983) during all seasons. Also, the latter authors are in agreement with the present finding in respect to the non-significant effect of season on the

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incidence of coiled tail which was common type of abnormalities in bulls. Rao and Hart (1948) related the appearance of bent-tailed sperm to the exposure of semen to extremes of high or low temperatures.

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