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Age at Puberty and the Effect of Season of Birth on Age and Bodyweight at First Conception in Holstein-Friesian Heifers Born in the Sudan

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Abstract: This study was conducted in the farm of the dairy unit of the Arab Company for Agricultural Production and Processing (ACAPP), about 45 km south of Khartoum City near the northern boarder of the Gezira State. Pure Holstein-Friesian heifers and cows were raised in this farm under intensive system of management in a semi-arid zone, in the Sudan. Age at puberty was determine in 130 heifers, and the effect of season of birth on age and weight at first conception was invetigated in 63 locally bred heifers. Age at puberty was determined by using Radioimmunoassay (RIA) for detection of serum progesterone concentration, rectal palpation to check the presence of corpora lutea and visual observation of oestrous signs. The correlation between Bodyweight (BW), Heart Girth circumference (HG) and progesterone (P4) concentration were computed. The age of 18 months was considered as the age of puberty where more than 50% of heifers (61.5%) were recording progesterone concentration of >1 ng/mL and this was confirmed by visual observation of oestrous signs and presence of corpora lutea on the ovaries. The effect of season of birth on age and bodyweight at first conception was not significant. The winter born heifers conceive at 21.3±4.2 months with a BW of 317.9±26.3 kg, summer born heifers at 24.3±6.9 months with BW of 323.6±46.9 kg and autumn born heifers at 24.5±4.4 months of age and 304.7±33.6 kg bodyweight.

Key words: Puberty, Holstein-friesin, Heifers Born.

INTRODUCTION

Puberty is a period of sexual development after which an in ividual becomes capable of reproduction. The onset of puberty is marked by the initiation of regularly occurring oestrous cycles[1]. Mazouz and Asri,[2] defined the age at puberty as the age at which 50% or more heifers were shown to ovulate through measurement of plasma progesterone level.

The onset of puberty is more related to the attainment of a critical body weight, although age genotype, climate, social environment and photoperiod are important[3,4]. Increased protein level in the diet accelerates age and weight at puberty, this implies that nutrition can accelerate the age at first conception by accelerating attainment of the target weight for conception. Low plane of feeding during early life was found to reduce growth rate and delay puberty[5]. Fee intake was the main factor affecting the performance of heifers[6]. There is an evidence that long periods of daylight hasten puberty when compared to short duration, but these effects, however, are limited in cattle[1]. Both season of the year at which puberty was reached and the system of rearing [2]influenced the time of puberty.

The local cattle breeds in northern Sudan are belonging to the Zebu breeds which were originally founded in Asia (the Indian Subcontinent). Although the population of cattle reach about 34.581 million head[7], but most of these are low producing animals and are found in remote areas far from large towns, under the traditional system of management, owned by nomadic tribes where large numbers of animals are considered a measure of social prestige. The in igenous cattle are well adapted to the environment, but their productive performance is poor. A trial to settle the nomadic tribes at the suburb of Khartoum was started since the early 1960s (Kuku dairy project). In 1976, the National Centre of Artificial Insemination was established. Frozen semen from superior dairy bulls was imported for upgrading of the local breeds of cattle. The ever increasing demand for milk and its products in urban centres particularly Khartoum State which was occupied by almost 25% of the total population in the country, necessitates the importation of cattle of temperate origin particularly Holstein Friesian for direct use in milk production and upgrading of the local breeds. Temperate cattlegenerally show superior productive and reproductive records only under more favorable conditions[8]. During 1984-1985, about one thousand

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Holstein-Friesian cows were imported to the Arab Company (ACAPP) followed by many batches by other companies. These imported foreign breds were confronted by many troubles such as iseases, hot climates, nutritional and other management stresses. In Khartoum State the total number of dairy cows is about 179275, about 90% of which are cross-breeds and 5% are pure temperate zone cattle mainly Holstein Friesian cows, kept in four large commercial farms and some small holder private farms[7]. Reports on reproductive and productive performance of the Holstein Friesian cattle in the Sudan are very scarce[9-11]. The objectives of this study include:-

- Determinations of age at puberty in Holstein-Friesian heifersborn in the Sudan.
- Studying the effect of season of birth on age and body weight at first conception.

MATERIALS AND METHODS

This study was conducted in the farm of the dairy unit of the Arab Company for Agricultural Production and Processing (ACAPP), about 45 km south of Khartoum City near the northern boarder of the Gezira State. Khartoum State lies wholly within the semi-ari zone with a rainy season between July and October with rainfall of 136 to 150 mm annually. The maximum temperature reaches and average of 40.3°C and a minimum of 25.1°C during dry summer and 38.2°C maximum and 25.6°C minimum during wet summer.

This farm was establishe since 1984 when Holstein-Friesian 4-7 months pregnant heifers were imported from Germany. The cows were house in barns with exercise yards. It is composed of so many sheds for different age and production categories of cows. All green fodders were cultivated in the farm where there is a field of some 5000-acres allotted for this purpose.

The cows were subjected to the general management system applied on the farm. They were fed Abu 70(Sudan grass), pioneer, and some-times alfa alfa (Barseem) as green fodder or rydroughage diets. The concentrated rations were mostly prepared in the farm from groundnut cakes, cotton see cakes, sorghum grains and molasses. Mineral salt licks were offered at free choice. Sometimes b-products of the starch and glucose factory (Protofeed) were also fed to the growing heifers and weaners. Clean fresh drinking water was provided *ad libitum*. The feed intake and the chemical analysis of feed in Dry Matter basis (DM) are shown in Table 1 and 2, respectively.

Disease control: A firm system of hygienic measures, avoidance of direct or indirect contact with other animals, restriction of personal and vehicle movement to or inside the farm was adopted. Effective veterinary services were available for isolation, diagnosis and treatment of any disease condition up to complete recovery. A routine vaccination program was also applied annually and periodically as follows: -

- Annual vaccination was conducted against Rinder pest, Anthrax, Haemorrhagic Septicaemia (HS), Black Quarter (BQ), Contagious Bovinepleuro-Pneumonia (CBP) and Brucella (Strain45/20).
- Periodic vaccination was conducted against Foot and Mouth Disease (FMD) twice per year and, Brucella (S19) in heifers between 3-8 months of age.

Tick control is affected by spraying all of the animals twice monthly. In adition a blood serum survey for detection of blood parasites and brucellosis was adopted three times per year.

Table 1: Feed intake DM kg/cow/Day) of roughage and concentrates

	Roughage (Kg)	Concentrates	Mj/cow/day
Lactating cows	8	9	148.6
Dry cows	8	5	97
Pregnant Heifers	4-5	5	74
Growing heifers	3.7	4	50
Weaners	2	2	25

Table 2: Chemical analysis of roughage and concentrate ration in dry matter basis

Fee	DM%	NFE%	CP%	CF%	F%	Ash%	ME
Roughage	52.07	13.18	10.1	22.7	0.54	5.55	3.74 Mj/Kg
Concentrate	93.1	47.2	17.2	15.3	5.1	8.3	11.3 Mj/Kg

Experiment 1

Determination of age at puberty: A total of 130 Holstein-Friesian heifers age between 7to 18 months were assigned for determination of puberty using progesterone radioimmunoassay.

Age group	7	8	9	10	11	12	13	14	15	16	17	18	Total
No. of heifers	12	10	11	11	7	10	10	10	11	12	13	13	130

Two samples of blood were collected from each heifer via jugular venopuncture at an interval of ten days. After clotting the samples were centrifuged at 3000 r.p.m. for 10 min to separate the serum which was kept at-20°C till the time of assay. All heifers were weighed and the heart girth circumferences were measured at the time of collection of the first blood samples.

Experiment 2

Effect of season of birth on body weight and Age at first conception: A sum of 63 heifers were divided into 3 groups of 21 heifers, each according to the season of birth:

The first group (G1) winter born heifers November to February. The second group (GII) summer born heifers March to June. The third group (GIII) autumn born heifers July to October .

These groups were assigned to investigate the effect of season of birth on age an body weights at first conception. The first conception was determined by non-return to oestrus during the first 30 days post insemination and by rectal palpation 50 to 60 days after insemination.

RESULTS

Determination of age at puberty: As illustrated in Table 3, average body weight (kg), heart girth circumference (cm) and serum progesterone concentration (ng/mL) of 130 Holstein Friesian heifers between 7-18 months of age were shown. The body weight an heart-girth were steadily increasing with age. The pattern of the overall average of serum progesterone concentration was fluctuating between 0.35 and 0.72±0.36 ng/mL before the age of 18 months, where it sharply rises to 3.10±0.45 ng/mL (Fig. 1). Body weight of heifers recording ≥ 1 ng/mL were ranging between 159.5±33.2 (7 month) and 290.4±25.5 kg, (18 month) as in (Table 2), which was slightly higher than the overall averages (144.5±33.3 and 281.3±23.7 kg). Serum progesterone concentration ≥ 1 ng/mL were recorded in all age groups, except in 11,14 and 16 months of age (Table 4). The percentage of heifers expressing high level of progesterone ranged between 9.10 and 30% before 18 months of age. A remarkable increase in the percentage of heifers showing high level of blood progesterone occurred at 18 months of age. There was a strong correlation (r=0.943) between body weight, an heart girth (Table 5), whereas the correlation between bodyweight and progesterone and heartgirth and progesterone were medium. Visual observation of oestrus revealed that only 2 heifers (15.4%) from age-group 17 months and 9 heifers (62.9%) from age-group18 month, expressed oestrous signs. Rectal examination of the heifers in all age groups revealed presence of corpora lutea only in heifers that showed oestrous signs. The age group of 18 months could be considered as the age of puberty where more than 50% of the heifers recorded progesterone concentration > 1 ng/mL and showed clear manifestation of oestrous signs.

Effect of season of birth on age and body weight at first conception: The comparison between bodyweights of Holstein-Friesian heifers according to the season of birth revealed no significant differences (Table 6). However, the winter born heifers conceived at an earlier age (21.3±4.2 months) than summer born heifers (24.3±6.9 months) and, autumn born heifers (24.5±04.4 months).

Summer born heifers recorded the eaviest body-weights at first conception (323.67±46.9 kg) followed by winter born heifers (317.9±26.3 kg) and autumn born heifers (304.7±33.6 kg).

DISCUSSION

Determination of age at puberty: The prepubertal concentrations of peripheral serum progesterone of the Holstein-Friesian heifers in this study were variable, ranging between 0.35±0.18 and 0.72± ng/mL. The progesterone concentration of ≥ 1 ng/mL which is considered as an indicator of age at puberty[12,2] was observed among all age groups from 7-18 months. The percentages of heifers reaching this level were ranging between 9.10%-61.5%. It worthmentioning that none of the heifers in age groups of 11, 14 and 16 months attaine progesterone level ≥ 1 ng/mL. Moreover heifers in these age-groups were recording a decreased progesterone concentrations (0.35-0.45 ng/mL) compared to other groups before the age of 18 months (0.6-0.72 ng/mL. The pattern of plasma maximal values of progesterone concentrations during the prepubertal period was similar to that described by Balakrishnan *et al.*[13] in Zebu X Holstein heifers. Clear observable signs of oestrus were shown in two heifers (15.4%) in the age group of 17 months and nine heifers (62.9%) at the age of 18 months, but one heifer from this group was recording less than 1 ng/mL progesterone concentration despite the presence of a corpus luteum. This could be attributed to a defect in sample labeling, handling, storage or assay proceures. The highly significant correlation ($r<0.01$) between both body weight and heart girth, with maximum serum progesterone concentration and, that the heifers reached puberty at the age of 18 months, may explain that the initiation of puberty is largely a function of animal age and maturity[4] and, the onset of puberty is largely related to the attainment of a critical body weight[3,1]. The results in this study revealed that the Holstein Friesian heifers intensively reared in the Sudan were adapted to the prevailing climatic conditions and reached puberty within the range of

Table 3: Mean (±S.D) bodyweight kg), heartgirth cm) and progesterone concentrations ng/mL of Holstein Friesian heifers between 7 and 18 months of age.

Age group (months)	No. of heifers	Body weight (kg)	Heart girth (cm)	Progestérone concentration (ng/mL)
7	12	144.50±33.30	118.30±10.12	0.64±0.40
8	10	169.80±43.60	128.20±5.50	0.71±0.39
9	11	189.50±34.60	132.20±5.60	0.72±0.36
10	11	192.60±85.20	134.40±7.40	0.57±0.49
11	7	194.10±35.40	135.40±9.10	0.35±0.18
12	10	208.00±29.20	136.60±10.20	0.59±0.33
13	10	209.10±24.80	137.50±6.60	0.56±0.43
14	10	217.50±27.40	142.00±6.60	0.38±0.25
15	11	229.60±26.40	144.6±8.40	0.58±0.28
16	12	237.10±24.10	145.40±8.70	0.45±0.39
17	13	246.30±25.98	147.00±5.90	0.69±1.35
18	13	281.30±23.70	156.80±8.30	3.10±2.50

Table 4: Means (±S.D) of bodyweight kg), heartgirth cm) and progesterone concentrations ng/mL) of Holstein Friesian heifers recording ≥ 1 ng/mL

Age group (month)	No. of heifers	Bodyweight (kg)	Heart girth (cm)	Progesterone (ng/ml)
7	2 (16.7%)	159.50±33.20	123.00±11.30	1.40±0.19
8	3 (30%)	188.30±16.07	131.70±5.51	1.20±0.11
9	3 (27.3%)	223.00±47.16	133.30±5.50	1.20±0.17
10	1 (9.10%)	235	1420	1.53
12	1 (10%)	239	144	1.30
13	2 (20%)	243.00±0.00	147.00±4.24	1.13±0.13
15	1 (9.10%)	275	157	1.00
17	2 (15.4%)	277.00±14.10	150.50±2.12	3.03±0.70
18	8 (61.5%)	290.40±25.50	159.60±9.02	3.90±2.19

Table 5: Correlation between body weight, heartgirth and progesterone concentration of Holstein Friesian heifers

	Bodyweight	Heart girth	Progester one
Bo yweight	1.0		
Heart girth	0.943**	1.0	
Progesterone	0.628**	0.555**	1.0

** = Highly significant correlation ($p<0.01$)

Table 6: Mean (±SD) Bodyweight kg) and age month) at first Conception as influenced by season of birth in Holstein-Friesian heifers

Season of birth	No. of heifers	Bodyweight (kg)	Age (months)
Winter	21	317.9±26.3	21.3±4.2
Summer	21	323.8±46.9	24.3±6.9
Autumn	21	304.7±33.6	24.5±4.4

7-18 months of age similar to their counterparts in colder zones[1,4]. The present results were in agreement with those reported by Swanson *et al.*[14,15,16,6]. The results were within the ranges recorded by Blackly and Bade[17,10] for the summer borne Holstein-Friesian heifers in the Sudan. The present Figures were more than those reported by Sastory[18,19,20,2].

Effect of season of birth on body weights and age at first conception: In this study, age and bodyweight at first conception did not significantly differ between winter, summer and autumn born Holstein-Friesian heifers. However, the winter born heifers conceived in an earlier age (21.3±4.2 months) followed by summer born heifers (24.3±6.9 months) and autumn born heifers (24.5±4.4 months). Summer born heifers recorded the heaviest bodyweights at conception followed by winter and autumn born heifers, respectively (Table 6). In contrast to Honoramooz, *et al.*[21] the summer born heifers tended to mature in a wide range of ages and weights and this may be due to the difference in genotypes and environmental conditions. The differences in ages of first conception could be attributed to the effect of the season of birth, because the same level of management and feeding to these heifers was maintained throughout the year. This suggests that only the season of birth was the major cue that influenced the ages an weights at first conception. The present results agreed with Mazouz and Asri[2,4] in that, age is one of the important factor that couls affect the onset of puberty and the time of puberty was influenced by the season of the year at which puberty was reached. As previously mentioned in determination of age at puberty in this study, puberty was reached at 18 months of age, so winter born heifers reached puberty in the autumn of the next year and conceived at the following winter when the temperature was, to some extent, cold and suitable for breeding. While summer born heifers reached puberty during winter of the next year and, passed the hot summer season to conceive during autumn (wet summer). The same was true for autumn bornheifers that reached puberty during their second summer and passed autumn to conceive in winter.

Although cattle are not seasonal breeders, these results demonstrated that season of birth an season of attainment of puberty influence the age at conception in heifers. The effect of season of birth on age and weight at sexual maturity is equivocal; some studies

showed that spring-born heifers mature faster than autumn-born heifers[22]. Other studies have shown the opposite results[16]. In contrast with age and weight at conception were not significantly different between dry and wet summer born heifers. This result agreed with Honaramooz *et al.*[21] in that the age and weight did not differ between the three groups of heifers. The disagreement with the result recorded by Schillo *et al.*[22] may be due to the different environment where each study had been carried out.

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