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FACTORS AFFECTING POSTPARTUM OVARIAN ACTIVITY IN CROSSBRED PRIMIPAROUS TROPICAL HEIFERS

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ABSTRACT

The relationship between postpartum ovarian activity and a total of 9 variables was studied in a dry tropical environment. Primiparous cows (n=61) that had shown no peripartum abnormalities, and were not suckled but milked twice daily, were used in the study. Independent variables included crossbreeding, sex of the calf, season, body condition, weight of cow at calving, age of dam at calving, uterine involution, calf weight and accumulated milk yield. Diet was a controlled variable. Dependent variables were first estrus postpartum and/or first milk progesterone elevation prior to first estrus. A bull fitted with a chin ball marker was used to detect first estrus postpartum, while ovarian structures were palpated per rectum once a week. Progesterone was measured by RIA in milk samples collected twice weekly. First postpartum estrus was detected at 56 ± 32 days postpartum, a first milk progesterone elevation was observed in 50.8% of cows at 42 ± 27 days. Cows calving in the dry season had longer intervals and those who calved males had shorter postpartum intervals. Accumulated milk yield affected both intervals significatly ($p < 0.01$). Weight, age and uterine involution were asociated with first milk progesterone elevation, while crossbreeding, weight at calving and weight postpartum change were associated with the dependent variables.

Key words: progesterone, postpartum, crossbred cows, ovarian activity

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INTRODUCTION

One of the most important problems affecting livestock reproduction is long calving intervals (1) and subsequent low reproductive efficiency. Making the interval between calving and the first postpartum estrus optimal is critical to achieving the goal of a 12-month calving interval (2). After calving, suckling and milking can inhibit follicular development by affecting hypothalamic hypophyseal or ovarian activity (3). The amount of milk production, both in the period prior to parturition and in the postpartum interval, can affect the calving to ovulation interval (4). Environmental factors may also alter ovarian function at the central nervous system level, at the ovarian level, or by affecting other organs (5).

Various factors have been shown to affect the onset of postpartum cyclic ovarian activity (ovulation): uterine involution (2,6,7), the season of the year (8,9), suckling and milking (10,11), breed and/or prevailing crossbreeding (3,6,8,9,12), milk yield and nutritional level (2,6,13), weight and body condition at calving (2,8,14,15), age at calving (6,9), and number of calvings (4,9,11,13,16,17). Some authors have reported that variations in the endocrine status of the dam during the periparturient period, are affected by the weight and/or sex of the calf (18,19). Periparturient abnormalities have also been found to affect reproductive activity during the postpartum period (6,20,21). The purpose of this study was 1) to determine the onset of postpartum ovulation in crossbred primiparous cows by estimating the amount of progesterone in skim milk and 2) to determine effects of age, weight and body conditions at calving, season of the year, crossbreeding, uterine involution, milk production, weight and sex of calf on the onset of postpartum ovarian activity.

MATERIALS AND METHODS

The research was conducted on a commercial farm owned by the Zulia University, located at 10°15' latitude North 71°25' longitude West and 100 m. above sea level. The region is classified as a dry tropical area, with a mean temperature of 29.5°C and an annual rainfall of 1,048 ± 180mm. Sixty-one primiparous crossbred (*Bos taurus: Bos indicus*, about 50:50%) cows were studied. Of these 32, 19 and 10 were prodominantly Brahman, Brown Swiss and Holstein, respectively. The cows had experienced no peripartum abnormalities, and the calves were removed 72h after parturition; the cows were subsequently milked twice daily (at 4 to 6 a.m. and 4 to 6 p.m.) Animals were grazed on Guinea (*Panicum maximun*) and Survenola (*Digitaria xunfolozi*) grass, except during the dry months of the year when they were given hay from the above mentioned grasses. During the milking period, concentrates that had 20% crude protein were supplied according to the milk production level as follows:

cows giving 5.9, 6 to 9.9, 10 to 13.9, 14 to 19.9, 18 to 21.9 and >22kg of milk per day received no supplement, 2, 4, 6, 8 and 10kg of supplement, respectively. For management convenience, animals of each group, were identified by colored collars. Each animal was observed daily until the first postpartum estrus, with exception of those cows that showed estrus prior to 20 days postpartum. The latter cows were kept under observation until the next detected estrus. At calving, weight and sex of calves were recorded. Initial weight of the dam was determined around the third day postpartum and then weighing was carried out after the morning milking, every 30 days, until the first postpartum estrus.

Ovarian activity and degree of uterine involution were monitored by palpation per rectum beginning at day 7 postpartum and continuing once weekly until the first estrus. Involution of the uterus was considered to be complete when the horn reached < 30mm in diameter. Estrus was detected by visual observations twice daily with the help of a bull fitted with a chin ball. Body condition evaluation was based on a scale (0=emaciated; 5=very fat). The milk yield of each cow was determined every 30 days, weighing milk during two consecutive milkings, once in the afternoon and once at subsequent morning milking. The mean weight was taken as average milk yield per day (Kg/d). Information regarding crossbreeding, birth date and other data was obtained from the general farm records. The seasons of the year were classified as dry (December to March), intermediate (April to July) and humid (August to November).

Progesterone (P_4) was measured on two milk samples from each cow, twice a week, taken in test tubes previously treated with sodium azide to obtain a 0.1% final concentration. The whole milk sample was centrifuged at 3000 rpm for 10 min and the skim milk was kept at -20°C until laboratory processing. Samples were taken from the right front quarter at the beginning of the first morning milking and sampling was continued for a minimum of 3 samples after onset of the first postpartum estrus. Defatted milk samples were assayed in duplicate for progesterone by radioimmunoassay using the RIA/KIT supplied by the International Atomic Energy Agency (FAO/IAEA). Each sample was processed twice according to instructions. Skim milk progesterone concentration at or above 0.5 ng/ml were considered to be an indication of luteal activity (22,23). Intra-and-inter-assay coefficients of variation,were 8.9 and 13.2 respectively, as determined by the Cekan Method (24).

Analyses of Variance-Covariance were performed by the minimun square method, using the General Liner Model (GLM) from Statiscal Analysis System (SAS, 25) where the independent factors were crossbreeding, sex of calf, season of the year,body condition of cow at calving,as well as weight and age of cow at calving, calf weight, uterine involution and accumulated milk yield. Dependent factors considered were calving to first postpartum progesterone elevation prior to first estrus, and calving to the first detected estrus interval. Statistical analyses (26) were performed according to the following linear model:

$$Yijklm = u + Ci + CSj + Sk + BCl + B_1 (Wijkl) + B_2 (Aijkl) + B_3 (UIijkl) + B_4 (CWijkl) + B_5 (AMYijkl) + Eijklm$$

where:

u	=	the general mean
Ci	=	crossbreeding;
CSi	=	calf sex;
Sk	=	season of the year
BCl	=	Body Condition
B_1, B_2, B_3, B_4, B_5	=	coefficient of linear regression for variables
(W)	=	weight of cow at calving
(A)	=	age
(UI)	=	uterine involution
(CW)	=	weight of calf
(AMY)	=	accumulated milk yield at first progesterone rise or first postpartum estrus
Eijklm	=	experimental error

Mean comparative tests for the described variables were performed using the LSMEAN (minimum square method). Correlations were made between weight at estrus and change of weight from calving to estrus with the calving-to-estrus interval.

RESULTS

Reproductive trends according to degree of crossbreeding are shown in Table 1, Holstein cows calved at 32 ± 0.9 months, weight at calving and at first estrus was 380 ± 12.7 Kg. and 385 ± 13.4 Kg respectively; the first progesterone rise prior to first overt postpartum estrus was seen in 46.8% (n = 15), 47.3% (n = 9) and 70% (n = 7) of Brahman, Brown Swiss and Holstein cows respectively. Silent ovarian activity was higher in the Holstein crossbreds which had a slightly lower body condition score than others breeds; uterine involution was significantly earlier (20 ± 08 dpp) in Brown Swiss; the interval from calving to first estrus and to first progesterone discharge were not significantly different; calves from Brown Swiss cows were also significantly heavier (35 ± 0.9 Kg). Accumulated milk yield at first estrus and first discharge postpartum was significantly higher in Holstein crossbreds (Table 2); daily milk production from the calving to first estrus interval was significantly higher for Holstein cows in relation to Brahman cows (Table 2).

Table 1. Reproductive data of primiparous crossbred cows in tropical area of Venezuela

Factors	Brahman (n=32)		Brown Swiss (n=19)		Holstein (n=10)	
	Mean	SEM	Mean	SEM	Mean	SEM
Age at calving (months)	33	± 0.5	33	± 0.6	32	± 0.9
Weight at calving (kg)	386	± 7.1	394	± 9.2	380	± 12.7
Weight at estrus (kg)	400	± 7.5	395	± 9.7	385	± 13.4
BC at calving	3	± 0.1	2.5	± 0.1	2.3	± 0.3
BC at estrus	3	± 0.1	2.5	± 2.5	2.5	± 0.2
Interval from calving (days) to:						
- Uterine involution	23[a]	± 0.6	20[b]	± 0.8	24[a]	± 1.1
-First postpartum estrus	57	± 5.6	48	± 7.3	69	± 10
-First discharge[c]	38	± 6.9	37	± 8.9	59	± 10.2
Calf weight (Kg)	33[a]	± 0.7	35[b]	± 0.9	33	± 1.3

a,b = Dissimilar superscripts within rows are significantly different ($P<0.05$)
c = First postpartum progesterone discharge prior to first estrus.
BC = Body Condition

Table 2. Milk production and reproductive data in crossbred primiparous cows in tropical area of Venezuela

Factors	Brahman (n=32)		Brown Swiss (n=19)		Holstein (n=10)	
	Mean	SEM	Mean	SEM	Mean	SEM
Milk production (kg) accumulated at:						
-30 days postpartum	297[a]	± 18.3	345[ab]	± 23.7	454[b]	± 32.6
-First postpartum estrus	590[a]	± 85	549[a]	± 110	998[b]	± 152
-First discharge[c]	355[a]	± 118.7	436[ab]	± 153.3	833[b]	± 173.8
Milk production (kg/d) at calving interval:						
-First postpartum estrus	9.9[a]	± 0.5	11[ab]	± 0.7	13.4[b]	± 0.9
-First discharge[c]	9.4[a]	± 0.5	11[a]	± 1.2	12[a]	± 1.3

a,b = Dissimilar superscripts within rows are significantly different ($p < 0.05$)
c = First postpartum progesterone discharge prior to first postpartum estrus.

Based on covariance analysis (Table 3), the factors included in the model account for most of the observed variance in interval between calving to first estrus (r^2 = 0.86, P < 0.0001). The greatest effect was accumulated milk yield at first estrus (P < 0.0001). Cow weight at calving, although not a significant factor for the interval to first estrus, was significant for the interval to first progesterone discharge. Crossbreeding, age at calving, uterine involution, calving season and calf weight did not have a significant effect in the model. A significant correlation between weight at estrus (r^2 = 0.33, P < 0.01) and change of weight calving-estrus (r^2 = 0.44, P < 0.01) with calving to estrus interval was found.

Table 3. Analysis of variance-covariance for the onset of postpartum ovarian activity in primiparous crossbred cows in a tropical area of Venezuela

Source of Variation	Calving Interval to First P_4 Discharge			First Estrus		
	df	MS	P	df	MS	P
Crossbreeding	2	100.6	.26	2	501.4	.06
Calf sex	1	84.8	.26	1	653.2	.05
Calving season	2	53.7	.48	2	492.4	.05
Body condition at calving	3	47.6	.58	3	36.5	.89
Weight at calving (cov)	1	399.9	.02	1	337	.17
Age at calving (cov)	1	144.5	.17	1	25.7	.70
Uterine involution (cov)	1	138.4	.18	1	20.5	.73
Calf weight (cov)	1	221	.09	1	112.3	.42
Accumulated milk yield: (cov)						
-At first postpartum estrus				1	41283.9	.001
-At first progesterone discharge	1	12087.9	.001			
Model	13	1648.7	.001	13	3885.8	.001
Error	17	69.9		46	172	
r^2		0.94			0.86	
CV		19.7			23.7	

df = Degrees of freedom. MS = Mean square. P_4 = Progesterone
cov = Covariable. P = Probability

A significant difference in the interval from calving to first estrus was found for cows that calved male calves (50 days) and female calves (57 days). Cows that calved in the humid (49 days) or intermediate (49 days) seasons showed a significantly shorter interval than those calving in the dry season (61 days).

DISCUSSION

The first calving in our study ocurred at an earlier age than that reported by other authors in Venezuela (27,28) but was similar to values reported for Siboney crossbreds in Cuba (29) and Holstein crossbreds in México (30). Holstein crossbreds calved at an earlier age and at less weight at calving than Brahman and Brown Swiss (1,29). This may be due to genetic characteristics of the breed. Weight at calving was lower than that reported for the same type of animal (Bos taurus; Bos indicus, about 50:50%) (28). Calf sex significantly affected onset of postpartum first estrus; the hormonal status of the dam at the end of pregnancy is affected by calf sex and weight (18,19); there is a possibility that the hormone status of the sex of the calf has some effect upon cows' postpartum cyclicity resumption. The significant effect of season at calving is similar to other reports (3,8,9,11,17). Differences in the onset of postpartum ovarian activity in relation with the calving season have been reported for temperate climates (3,8,11,17), a higher incidence of ovarian inactivity in our region has been reported in animals calving in the dry season (9). This postpartum reproductive behavior has been associated with environmental factors, such as feed supply and/or nutritional status (9).

The greatest number of animals at calving (46%) and at estrus (49%) were judged to be in the mean body condition scale 3, which is considered the best from the reproductive point of view (31); the body condition at calving did not significantly affect the interval from calving to first estrus; therefore it is assumed that weight, age and body condition reflecting the nutritional status of the cows at calving, favored the onset of sexual activity. The animals calved and showed signs of estrus with 80-85% 88-90% of their adult weight, respectively. In primiparous crossbred cows, a marked change in postpartum weight occurs upon calving to first estrus (14) and this finding coincides with our results. In this work a significant correlation between weight at estrus and change of weight from calving to estrus with calving to estrus interval was not similar to those reported by other authors (8,13), who reported that change in postpartum weight is apparently not related with the postpartum acyclic period. Some authors have reported age as an important factor upon postpartum reproductive behavior in cows (6,20). The interval between calving and complete uterine involution was shorter than those published for primiparous animals (7,12,32) and similar to those reported by other authors (6,15). These results suggest that the earlier the uterine involution process in completed, the more rapid will be the onset of postpartum ovarian activity. This tendency, seen in primiparous animals without abnormalities during the periparturient period, may be affected by calving problems (2), high milk production (6) and number of calvings (12). Uterine involution had no significant effect on ovarian activity. In contrast to results reported by Gonzàlez (1), accumulated milk production accounted for virtually all of the difference in calving to first estrus interval for the 3 breeds of cows evaluated. With this variable factored out of this model, there was no signicant difference between breeds.

According to the Analysis of Variance-Covariance Model, the interval from calving to progesterone rise was higher than reported by 3,4 and 13. This first discharge was seen only in 50.8% of the animals, similar to those reported by research workers that have found that this first progesterone discharge prior to first postpartum estrus is not seen in all animals (3,23,33,34). The most important factor affecting the interval from calving to first estrus was accumulated milk yield, and the weight at calving was also significant for the interval to first progesterone discharge. These results probably show that cows that are high producers lose weight and body condition in order to sustain production levels. Age al calving, calf weight and uterine involution had no significant effect on both intervals. As a result this first progesterone discharge may be related to the animal condition at calving, with a higher proportion of progesterone discharge prior to first estrus seen in animal with a lower nutritional status (33,35).

We conclude that: 1) In primiparous crossbred cows, nonsuckling and under acceptable nutritional conditions and management, the most important factor affecting onset of postpartum ovarian activity is accumulated milk yield; 2) Sex of calf, weight of cow at calving and calving season significantly affected the postpartum ovarian activity in crossbred primiparous tropical heifers. 3) Under these tropical conditions Holstein crossbreds had a tendency to have earlier and silent postpartum cyclicity.

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