Follicular dynamics during postpartum anestrus and the first estrous cycle in suckled or non-suckled Brahman (Bos indicus) cows

G. Henao a,1, M. Olivera-Ángel b,*, J.G. Maldonado-Estrada b,c,2

a Departamento de Producción Animal, Universidad Nacional de Colombia, Medellín, Colombia
b Biogenesis-Biotechnology Group, Universidad de Antioquia, AA 1226 Medellín, Colombia
c Facultad de Medicina Veterinaria y de Zootecnia, Universidad de Antioquia, AA 1226 Medellín, Colombia

Received 19 August 1999; received in revised form 16 May 2000; accepted 18 May 2000

Abstract

Brahman (Bos indicus) cows, were selected at 28±10 days after calving and analyzed by real time rectal ultrasonography three times a week, in order to evaluate and compare follicular and corpus luteum development during postpartum (PP) anestrus and the first PP estrous cycle under sylvopastoril conditions. Suckling (S, n=11) or non-suckling (NS, n=5) cows were evaluated in a zone of tropical dry forest (450 m of altitude, mean temperature=27°C, annual rainfall=1000 mm). Estrous detection was performed twice daily by direct observation. Progesterone was quantified using RIA. From 28±10 days postcalving to resumption of estrous cycles, there were no differences (P>0.05) between NS and S cows for diameter of the dominant or first subordinate follicle, follicular growth rate, or interdominance interval. Silent ovulation, corpus luteum formation and subsequent progesterone concentrations ranging from 0.3 to 9.7 ng/ml, were found in both groups. The first calving to ovulation and calving to standing estrus intervals were shorter (P<0.01) in NS (34.8±4.82 and 41.2±9.03 days) than in S (65±4.82 and 81±6.21 days) cows. Follicular development and progesterone concentrations during the first PP estrous cycle did not differ (P>0.05) between NS and S cows. These results suggest that Brahman cows could have an early PP resumption of follicular recruitment if fed under sylvopastoril system conditions. However, non-suckled cows did have an earlier standing estrus and ovulation than did suckled cows. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Progesterone; Ultrasound; Sylvopastoril conditions

* Corresponding author. Tel.: +574-4259110; fax: +574-4259111.
E-mail addresses: ghenao@yahoo.com (G. Henao), molivera@catios.udea.edu.co (M. Olivera-Ángel), jungmal@catios.udea.edu.co (J.G. Maldonado-Estrada).
1 Tel.: +574-2607333/ext. 158; fax: +574-2300380.
2 Tel.: +574-4259130; fax: +574-4259104.
1. Introduction

Zebu (*Bos indicus*) cattle exhibit a low reproductive efficiency because of a prolonged postpartum (PP) anestrus (García et al., 1990), which under extensive conditions on native pastures may last until weaning 8–10 months after calving (Ruiz-Cortés and Olivera-Ángel, 1999). Suckled rather than non-suckled cows exhibited a prolonged PP anestrus (Escobar et al., 1984). In suckled Zebu cows fed under a wet Colombian tropical environment, the PP anestrus was characterized by a pronounced delay of the development of dominant follicles and first ovulation (Ruiz-Cortés and Olivera-Ángel, 1999), preceded or not by standing estrus. In contrast, Toribio et al. (1995) reported that non-suckled Zebu cows developed dominant follicles between the first and second week after calving. The first estrous cycle is often atypical, characterized by ‘silent estrus’: ovulation not preceded by standing estrus, reduction of the interovulatory interval, early lysis of the corpus luteum and reduced progesterone concentrations (Toribio et al., 1995). The re-establishment of PP follicular development and estrous cycles in suckled Brahman cows has been evaluated (Ruiz-Cortés and Olivera-Ángel, 1999). The aim of this work was to describe and to compare follicular and CL development between suckled and non-suckled Brahman cows fed under silvopastoral system conditions, during PP anestrus and the first PP estrous cycle.

2. Materials and methods

This study was performed with the Brahman (commercial type) herd at the Investigation, Teaching, and Extension Center ‘Cotové’ of the Universidad Nacional de Colombia, located at an altitude of 450 m, with a mean temperature of 27°C, an annual rainfall of 1000 mm, and two well defined periods of drought (December–March and June–September) which corresponds to the Holdridge zone of tropical dry forest (Espinal and Montenegro, 1963). During the period of study (July–December 1997) the drought was extended due to the meteorological phenomenon of the Pacific.

Cows were maintained in a silvopastoral extensive production system were grazed pastures containing *Dichanthium aristatum*, *Panicum maximum* and *Brachiaria mutica* grasses and low growing legumes (*Centrosema* spp., *Desmodium intortum*, *Stilozantes capitata*), and shrub legumes (*Enterolobium cyclocarpum*, *Cassia grandis*, *Hymenaea acoubaril*, *Guazuma ulmifolia*, *Pithecellobium saman*, *Cescentia cujete*, *Glicidica sepium*). During periods of forage shortage the cows were supplemented with 1 kg per cow per day of *Dichanthium aristatum* hay. Cows had access to a standard commercial mineralized salt and water ad libitum.

2.1. Animals

Sixteen Brahman cows that had calved were selected to be bled and ovarian scanning via ultrasonography was done.  

1. Suckled cows (*n*=11) remained with their calf throughout the study period. The cows had an average parity of 3.1±0.6, an intercalving interval of 408±27 days, an age of 5.4±0.7 years, a body weight of 404±14 kg, a body condition score (BCS) of 3.2±0.2 and days after calving at first bleeding and scanned of 29.1±2.9.
2. Non-suckled cows (n=5) whose calf died within 24 h. The cows had an average parity of 2.4±0.4 (±SEM), an intercalving interval of 449±17.9 days, an age of 4.7±0.4 years, a body weight of 418±12.1 kg, a body condition score (BCS) of 3.6±0.1 and days after calving at first bled and scanned of 25±5.8.

Ultrasonography was performed on each cow three times a week until Day 140 PP, according to the protocol described by Pearson et al. (1988), using a real time B-mode linear array ultrasound scanner, with a 7.5 MHz rectal probe (Aloka SSD-500, Aloka, Tokyo, Japan). Images of dominant (DF), largest subordinate follicles (SF) and of corpus luteum (CL) were videotaped (Perry et al., 1991) for further analysis. Both the ultrasonographic examination and analysis of videotape were performed by a single operator.

The parameters included for the characterization of follicular development were: the presence of a dominant follicle (>8 mm), and its growth rate; the presence of the first subordinate follicle and its growth rate and the presence of a corpus luteum and its volume ($V=4/3\pi r^3$).

Follicular growth rate (GR) was established from maximum diameter (mm) reached by the dominant follicle, minus the diameter the day of its detection, divided by the number of days. The duration of each follicular wave was calculated by the interdominance interval (ID), interpreted as the time elapsed from the day previous to the beginning of the regression or ovulation of a DF and the day previous to the beginning of the regression or ovulation of the next DF (Rhodes et al., 1995). The ovulation of a DF was defined as the disappearance of the DF between two consecutive examinations with subsequent CL formation. The lifespan of the CL was defined as the time elapsed between two consecutive ovulation in which this structure was observed by ultrasound evaluation. The first estrous cycle length was considered to be the time between the first and the second PP standing estrus.

2.2. Blood samples

Bleedings were performed from coccygeal vessels on each cow three times a week until Day 140 PP using a Vacutainer (Becton-Dickinson). Serum was stored at −20°C until RIA for progesterone quantitation.

Progesterone concentrations were determined using a commercial solid phase RIA kit (Progesterone, Coat-A-Count, Diagnostic Products Corp., Los Angeles, CA, batch TKPG1-1418) validated for the bovine (Bergfelt et al., 1997). The sensitivity limit for the assay was 0.02 ng/ml of serum. Samples were evaluated in duplicate; the intra- and interassay coefficients of variation were 3.5 and 13.4%, respectively. Progesterone concentrations were quantified in samples taken during the two follicular waves that preceded the first PP standing estrus. In addition, samples corresponding to the beginning, middle and final phase of development of each follicular wave, during the first PP estrous cycle, were also evaluated.

2.3. Estrous detection

Cows were observed twice daily (6.00 and 17.00 h) from the first week after calving for a 30 min period each one with the aim of detecting any signs of estrus. In addition, an androgenized heifer equipped with a chin-ball was used in order to improve detection of estrus. Accordingly, neither NS nor S cows presented behavioral estrus before the start of the study.
2.4. Statistical analysis

Means and S.E.M. (Saunders and Trapp, 1993) were calculated for: (a) Calving-first ovulation period, (b) calving-first standing estrous period, (c) DF and SF diameters, (d) DF and SF growth rate, (e) ID, (f) CL lifespan and volume, (g) maximum progesterone concentrations before the first standing estrus and during the first estrous cycle, and (h) persistence of progesterone concentrations >2 ng/ml. Progesterone concentrations were correlated with CL volume. To establish the difference between means, the Student’s t test (Statsoft, 1995) was used.

3. Results

Cows were evaluated through Day 140 after calving when all NS (5) and 7 out of 11 S cows had exhibited at least two standing estrus. The remaining S cows (n=4) were excluded from the analysis, because the PP anestrus lasted beyond the period of study. At the first standing estrus suckled and non-suckled cows had an average BCS of 3.4±0.2 and 3.5±0.2 (1–5 scale), respectively. At Day 140 after calving the four suckled cows that were in anestrus during the experimental period had an average BCS of 2.8.

3.1. Characteristics of follicular development during the PP anestrus

Follicular development recorded from the day of inclusion until the resumption of cyclicity, was characterized by formation of follicular waves, with development of a DF with a similar diameter (P>0.05) in the NS (Figs. 1 and 2) and S (Figs. 3 and 4) cows. Similarly,
Fig. 2. Follicular development of non-suckled Brahman cow number 86-2.

Fig. 3. Follicular development of suckled Brahman cow number 10-8.
neither the greatest SF, the ID interval, nor the DF or SF growth rates significantly differed ($P>0.05$) between NS or S cows (Table 1).

3.2. Calving to first ovulation and calving to first estrus interval

The calving to first ovulation interval was significantly shorter ($P<0.01$) in NS than in S cows. Similarly, the calving to first estrus interval was shorter ($P<0.01$) in NS than in S cows; however, the first interovulatory interval had a similar ($P>0.05$) duration in NS and S cows (Table 2).

Two out of five cows in the NS group had a first ovulation not preceded by standing estrus (Fig. 1), while the remaining three cows had a standing estrus followed by ovulation

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Non-suckled</th>
<th></th>
<th>Suckled</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n^a$</td>
<td>Mean±S.E.</td>
<td>Range</td>
<td>$n^a$</td>
</tr>
<tr>
<td>Number of follicular waves before first PP standing estrus</td>
<td>10</td>
<td>2.5±0.3*</td>
<td>1–3</td>
<td>41</td>
</tr>
<tr>
<td>Diameter of DF (mm)</td>
<td>10</td>
<td>10.9±0.5</td>
<td>8–13</td>
<td>41</td>
</tr>
<tr>
<td>Diameter of first SF (mm)</td>
<td>10</td>
<td>6.8±0.2</td>
<td>6–8</td>
<td>41</td>
</tr>
<tr>
<td>Interdominance interval (days)</td>
<td>7</td>
<td>9.9±1.1</td>
<td>1–14</td>
<td>33</td>
</tr>
<tr>
<td>DF growth rate (mm per day)</td>
<td>9</td>
<td>0.7±0.1</td>
<td>0.5–1.5</td>
<td>38</td>
</tr>
<tr>
<td>SF growth rate (mm per day)</td>
<td>5</td>
<td>0.5±0.1</td>
<td>0.3–1</td>
<td>22</td>
</tr>
</tbody>
</table>

*a Number of observations included for analysis of each characteristic.  
* $P<0.01$.  

Fig. 4. Follicular development of suckled Brahman cow number 90-2.
Table 2
Calving to first ovulation and calving to first postpartum standing estrus in suckled and non-suckled Brahman cows

<table>
<thead>
<tr>
<th>Interval</th>
<th>Non-suckled (n=5)</th>
<th>Suckled (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±S.E.</td>
<td>Range</td>
</tr>
<tr>
<td>Calving-first ovulation</td>
<td>34.8±5.8*</td>
<td>17–52</td>
</tr>
<tr>
<td>Calving-first standing estrus</td>
<td>41.2±9.0*</td>
<td>17–66</td>
</tr>
<tr>
<td>First interovulatory interval</td>
<td>15.4±2.0</td>
<td>8–21</td>
</tr>
</tbody>
</table>

* P<0.01.

(Fig. 2). Six out of seven cows (85.7%) from the S group had a first ovulation not preceded by standing estrus (Fig. 3) and the remaining cow ovulated following standing estrus. After the ovulation not preceded by standing estrus, neither the volume (2.3±0.7 cm³) nor the lifespan (10.5±1.12 days) of CL from NS cows significantly differed (P>0.05) with volume (2.4±1.0 cm³) or lifespan (10.3±1.18 days) of the CL from S cows.

3.3. Progesterone concentrations during PP anestrus

Progesterone concentrations during the PP anestrus increased from basal (<0.2 ng/ml) following the formation of corpus luteum after silent estrus. Maximum progesterone concentrations were not significantly different (P>0.05) between NS and S cows (Table 3). In addition, in NS cows maximum progesterone concentrations following silent estrus were similar to those following standing estrus (P>0.01) which were in contrast, different in S cows (P<0.01). Correlation between CL volume and progesterone concentrations was 0.33 and 0.75 (P<0.05) for S and NS cows, respectively.

3.4. Follicular development during the resumption of PP estrous cycles

During the first PP estrous cycle, NS Brahman cows had one (40%) or two (60%) follicular waves, whereas S cows had two (71.4%) or three (28.5%) follicular waves. Neither the DF or SF growth rates, nor their respective maximum diameters differed (P>0.05) between NS and S cows (Table 4). Similarly, neither the ID during the first estrous cycle, nor the average length of the first estrous cycle differed (P>0.05) between NS and S cows (Table 4).

Table 3
Maximum progesterone concentrations (ng/ml) following a silent estrus compared with progesterone concentrations following a standing estrus in suckled or non-suckled Brahman cows

<table>
<thead>
<tr>
<th>Group</th>
<th>Silent estrus</th>
<th>Standing estrus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n*</td>
<td>Mean±S.E.</td>
</tr>
<tr>
<td>Non-suckled</td>
<td>2</td>
<td>4±1.5</td>
</tr>
<tr>
<td>Suckled</td>
<td>6</td>
<td>2.8±1.2*</td>
</tr>
</tbody>
</table>

* Number of cows.

* P<0.01
Table 4
Follicular dynamics during the first postpartum estrous cycle in suckled and non-suckled Brahman cows

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Non-suckled</th>
<th>Suckled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n\textsuperscript{a}</td>
<td>Mean±S.E.</td>
</tr>
<tr>
<td>Estrous cycle length (days)</td>
<td>5</td>
<td>18±2.4</td>
</tr>
<tr>
<td>Interdominance interval (days)</td>
<td>8</td>
<td>11±1.1*</td>
</tr>
<tr>
<td>Diameter of DF (mm)</td>
<td>8</td>
<td>11±0.2</td>
</tr>
<tr>
<td>Diameter of first SF (mm)</td>
<td>8</td>
<td>7.6±0.3</td>
</tr>
<tr>
<td>CL volume (cm\textsuperscript{3})</td>
<td>5</td>
<td>2.8±1.0</td>
</tr>
<tr>
<td>Lifespan of CL (days)</td>
<td>5</td>
<td>11.6±1.6*</td>
</tr>
<tr>
<td>Growth rate of DF (mm per day)</td>
<td>8</td>
<td>0.8±0.04</td>
</tr>
<tr>
<td>Growth rate of SF (mm per day)</td>
<td>8</td>
<td>0.5±0.07</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Number of observations included for analysis of each characteristic.
\textsuperscript{*} P<0.01.

3.5. Corpus luteum volume and lifespan during the first PP estrous cycle

Neither the volume of the CL nor its lifespan differed (P>0.05) during the first PP estrous cycle between NS and S cows (Table 4).

3.6. Progesterone concentrations during the first estrous cycle

The maximum progesterone concentration during the first PP estrous cycle (Table 3) did not differ (P>0.05) between NS and S cows. Progesterone concentrations were similar (P>0.05) and were maintained above 2 ng/ml for 11.8±0.8 and 12.3±1.1 days in the NS and S cows, respectively. Correlation between CL volume and progesterone concentrations was 0.49 and 0.35 (P>0.05) for S and NS cows, respectively.

4. Discussion

Non-suckled cows had a greater BCS than suckled cows at the beginning of the experiment and they had an earlier first PP ovulation and first standing estrus than suckled cows. When suckled cows reached a BCS similar to that of the non-suckled at first standing estrus, they presented the first PP ovulation and their first standing estrus. Published information is limited regarding optimal BCS for B. indicus cattle, but since BCS is an expression of the energetic metabolism, its increase is the reflection of a positive energetic balance that is necessary for PP ovarian cyclicity. A desirable BCS (3.4–3.5) was required for suckled Zebu cows to resume ovarian cyclicity after calving (Castillo et al., 1997).

Under sylvopastoril conditions Brahman cows resume their PP ovarian follicular activity early following calving and suckling has only a small effect. The early resumption of follicular development in both NS and S cows suggests that neither sucking nor the presence of the calf affected the development of PP follicular waves, although suckling delayed the first PP ovulation and the first standing estrus, resulting in an extended PP
anestrus, as reported elsewhere (Peters, 1984; McVey and Williams, 1991; Ruiz-Cortés and Olivera-Ángel, 1999). In this sense Hinshelwood et al. (1985), Murphy et al. (1990) and Ruiz-Cortés et al. (1999) established that this phenomenon was due to defects in ovulation rather than to development of dominant follicles, because suckling reduces the frequency of LH pulses and prevents the maturation and ovulation of the dominant follicle.

The results found for the interval from calving to first standing estrus was less than that reported for suckled and non-suckled Zebu cows in a wet tropical environment in Mexico (Escobar et al., 1984) and a wet tropic in Colombia (Ruiz-Cortés and Olivera-Ángel, 1999), but similar to those reported by Castillo et al. (1997), which showed an early resumption of ovarian cyclicity, as measured by progesterone concentrations in suckled cows which were maintained with good body condition scores (3.4–3.5) after calving.

Interestingly, we found that three (60%) NS cows exhibited estrous signs associated with the first ovulation (Fig. 2), whereas six of the suckling cows (85.7%) did not (Figs. 3 and 4). The expression of estrous signs associated with the first ovulation require a previous increase in progesterone concentration (Lishman and Inskeep, 1991; Perry et al., 1991), nevertheless, two NS cows did not have increases in progesterone concentrations before the first PP estrus. Similarly, Dimmick et al. (1991) found no significant increase in progesterone concentrations before the first ovulation in two out of nine Angus cows evaluated by ultrasound, which indicate that such progesterone increases are not necessary for estrous expression.

After first ovulation, correlation between CL volume and progesterone concentration was greater in NS than in S cows, but during the first estrous cycle this correlation was similar, indicating a possible luteinizing deficiency in the first CL of the S cows.

The duration of the first PP estrous cycle is not affected by the calf presence because it is similar in both groups of cows. Our results for the average duration of the first estrous cycle in S cows, were similar to those of Rutter and Randel (1984).

Although most NS and S cows presented two follicular waves during the first PP estrous cycle, it is possible to find cows that presented one or three follicular waves. Similar results have been reported by Zeitoun et al. (1996) in estrous cycling Brahman cows and Figueiredo et al. (1997) in Nelore (B. indicus) cows.

These results do not add much to basic literature but do corroborate certain observations from other authors. The most important finding was that, under sylvopastoril conditions, Brahman cows gain 5–6 months in their calving interval, and suckling has only a small effect. This result may have practical implications for managing cattle under tropical conditions and call for further research to test the hypothesis that sylvopastoril conditions may be more sustainable not only for ecological grounds but also economically.

Acknowledgements

This work was supported by University of Antioquia, the Colombian Institute for scientific and technological development, Colciencias (Grant 149–95) and National University of Colombia, Site Medellín. We would like to thank LABCO Laboratories (Medellín, Colombia) for laboratory assistance. Special thanks to Dr. Christopher Price for critical reviewing the manuscript.
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