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Effects of early weaning and progesterone-estradiol treatments on postpartum reproductive efficiency of grazing anestrous beef cows

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Abstract

To study the effects of early weaning (EW) and progesterone-estradiol treatment on the postpartum reproductive efficiency of beef cows, 110 anestrous Aberdeen Angus and Hereford cows with a mean body condition score of 3.5 ± 0.04 (1-8 scale) were used. At 70 d postpartum, cows were randomly assigned to one of four treatment groups: 1) S (n = 28), cows suckled throughout the experiment; S+C (n = 28), cows suckled throughout the experiment and treated with a CIDR-B (1.38 g progesterone; InterAg, New Zealand) for 7 d plus 2 mg of estradiol benzoate (EB, Dispert, Uruguay) at CIDR insertion and 1 mg EB 24 h after CIDR withdrawal (D0); 3) EW (n = 27), cows with calves weaned (D0); 4) EW+C (n = 27), cows with calves weaned and received the same CIDR-EB treatment as group S+C 7 d before weaning. After treatments, cows were mated by natural service for a period of 60 d and weekly serum P4 concentrations were measured. A greater proportion of EW+C cows had serum P4 concentrations ≥1 ng/ml one week after treatments (64, 32, 23 and 0% for EW+C, S+C, EW, and S, respectively; $P < 0.05$). The interval from treatment to resumption of postpartum estrous cycles was influenced by treatment (12.9 ± 1.8, 18.6 ± 1.9, 31.3 ± 3.6, and 41.5 ± 2.2 d for EW+C, EW, S+C, and S, respectively; $P < 0.04$). Early weaned cows had greater pregnancy rates compared to suckled cows (88.9, 88.9, 35.7, and 28.6% for EW+C, EW, S+C, and S, respectively; $P < 0.05$). Early weaning and progesterone-EB treatments were both effective means to induce an earlier onset of estrous cycles and enhance postpartum rebreeding efficiency in anestrous beef cows.

Keywords: postpartum anestrous, CIDR-B, suckling, body condition score.

Introduction

Prolonged postpartum anestrus in suckled cows is a major cause of poor reproductive efficiency in beef herds. Suckling and malnutrition are the most important factors effecting the length of postpartum anestrus, and primiparous cows are the group that have the longest postpartum anestrous interval and reduced pregnancy rates (Randel, 1990; Stagg *et al*., 1998; Williams, 1990; Yavas and Walton, 2000b).

To reduce the postpartum anestrous interval in grazing cows, alternatives such as calf-suckling manipulation strategies and hormonal treatments are available. Bonding of maternal offspring is an essential component in inhibiting episodic LH release and thus in extending the postpartum anestrous interval (Williams, 1990; Williams and Griffith, 1995; Stagg *et al*., 1998). Reducing the suckling stimulus by calf isolation results in increased episodic LH release, which results in the onset of estrous cycles and enhancement of pregnancy rates in anestrous beef cows (Stagg *et al*., 1998; Williams, 1990); therefore, early weaning before the breeding season has been used to enhance postpartum rebreeding efficiency in beef herds (Laster *et al*., 1973; Lusby *et al*., 1981; Arthington and Kalmbacher 2003). Treatment with progesterone (P4) and estradiol enhances dominant ovarian follicle turnover and ovulation of new healthy follicles in cows that have initiated estrous cycles following calving (Bo *et al*., 1995) and is being recommended for the application of fixed-time artificial insemination (FTAI) in suckled cows (Baruselli *et al*., 2004; Bo *et al*., 2005). Although P4-estradiol treatments have been widely used to induce and synchronize estrus and ovulation in suckled beef cows (Grimard *et al*., 1997; Mackey *et al*., 2000; Yavas and Walton, 2000a; Baruselli *et al*., 2004; 2005), results are highly variable. The inclusion of early weaning to P4-estradiol based treatments could increase ovulatory response to these treatments (Mackey *et al*., 2000); however, field trials with cows in marginal body condition score (BCS) are few.

In beef production systems in Uruguay, where cattle husbandry occurs under extensive rangeland conditions, cows usually calve with a less desirable BCS and forage during the summer (breeding season) is often sparse; therefore, the development of reproductive management strategies to enhance pregnancy rates during the subsequent breeding season is very valuable. The objectives of the present study were to determine whether early weaning, progesterone-estradiol treatments,

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and these treatment combinations are effective at inducing the onset of estrous cycles and enhancing postpartum rebreeding efficiency of anestrous beef cows with a marginal BCS.

Materials and Methods

The present study was conducted at UTU La Carolina farm, Flores, Uruguay (34°S) from December to February, using 110 Aberdeen Angus and Hereford cows (39 primiparous and 71 multiparous). All cows had calved between September 17^{th} and November 17^{th} and were kept together grazing on rangeland. The study included all animals from the herd that were at least 52 d postpartum at the beginning of the experiment. The BCS was assessed biweekly during the experimental period using a scale of 1-8 (1 is severe emaciation and 8 is obese; Vizcarra *et al*., 1986); this scale was adapted for beef cows from the scale described by Earle (1976) for dairy cattle. Anovulation was confirmed in all cows by the absence of a corpus luteum (CL) at two repeated ultrasonographic examinations 14 d apart before starting treatments (D -14 and 0) using a real-time, B-mode scanner equipped with a 5-7.5 MHz linear-array transducer (Scanner 480, Pie Medical, Maastricht, Netherlands) and palpation of uterine tone.

Treatments

At mean of 70 d postpartum, cows were randomly assigned to one of four treatment groups according to parity, breed, days postpartum, and BCS. Day 0 (76.9 ± 2.0 d postpartum, mean ± SEM; range, 52 - 100 d) was the predetermined day of the beginning of the breeding period and the day when either early weaning was applied and/or progesterone devices were withdrawn for all animals. Treatments were as follows: 1) Group S (n = 28), cows were suckled throughout the experiment; 2) Group S+C (n = 28), cows suckled throughout the experiment and treated with an intravaginal progesterone device (CIDR-B; 1.38 g progesterone; InterAg, New Zealand) for 7 d plus 2 mg of estradiol benzoate i.m. (EB; Dispert, Uruguay) at CIDR insertion and 1 mg EB was administered 24 h after CIDR withdrawal (D0); 3) Group EW (n = 27), cows with calves weaned at D 77 postpartum (D0); 4) EW+C group (n = 27), cows with calves weaned at D77 postpartum that received the same CIDR-EB treatment as group S+C 7 d before weaning. After treatments (D0), cows were mated by natural service for 60 d using bulls of proven fertility. The first week after treatments, a 1:9 bull:cow ratio was used, and a 1:20 bull:cow ratio was used for the remaining of the breeding period. Pregnancy diagnosis was performed using ultrasonography 50 d after the end of the breeding period.

Blood collection and RIA

Blood samples were collected weekly by tail venipuncture on D7, 14, 21, 28, 35, 42, and 49. Samples were immediately refrigerated and centrifuged within 4 h after collection (de Castro *et al*., 2004a). Serum was separated and stored at –20°C until assayed for P4. Serum P4 concentrations were measured using a solid-phase, I^{125} radioimmunoassay kit (Diagnostic Product Co, Los Angeles, CA, USA). The detection limit of the assay was 0.1 ng/ml and the intra- and inter-assay coefficients of variation were 6.4 and 8.0%, respectively. Progesterone concentrations ≥ 1 ng/ml for at least two consecutive weekly samples were considered indicative of resumption of ovarian activity associated with ovulation (McSweeney *et al*., 1993; Silveira *et al*., 1993).

Statistical analysis

The interval from treatment to the onset of estrus was analyzed using ANOVA. The model included the effects of treatment, BCS, parity, and breed (Stata, 2003). Chi-square analysis was used to compare frequencies. Logistic regression was used to analyze effects of treatments, BCS, parity, and breed on final pregnancy rates (Stata, 2003). Effects of group, time, and the group by time interaction on BCS were analyzed using the Mixed Model of the Statistical Analysis System (SAS, 1999/2000). Differences were considered significant at $P < 0.05$. Results are expressed as the mean ± SEM.

Results

The effects of calf isolation and progesterone-estradiol treatments on resumption of estrous cycles are depicted in Fig. 1. The association of early weaning with P4-EB treatment resulted in a greater proportion of cows that had initiated estrous cycles at the beginning of the breeding period. Few suckled cows (9 of 28) had luteal-phase P4 concentrations within the first week in response to P4-EB treatment. Five weeks after treatments, 90 to 100% of the early weaned cows (EW and EW+C) had initiated estrous cycles, but only about 50% of suckled cows (S and S+C) did so by the end of the breeding period.

Data for intervals from treatment to resumption of estrous cycles and pregnancy rates (number of cows pregnant divided by total cows mated) after 2 mo of the breeding period are shown on Table 1. The interval from treatment to resumption of postpartum estrous cycles was influenced by treatment ($P < 0.001$). The combination of P4-EB treatment with EW resulted in a shorter interval to resumption of estrous cycles. An effect of BCS at the beginning of the experiment on interval from treatment to resumption of estrous cycles was found ($P < 0.006$). Cows with BCS ≤ 3 had longer intervals to resumption of estrous cycles ($P = 0.02$) compared to cows with a BCS ≥ 3.5. Although P4-EB treated cows that were suckling calves initiated estrous cycles during the postpartum period 10 d earlier than suckled cows, this had no effect on final pregnancy rates compared to untreated suckled cows (Table 1). Both groups of early weaned cows (EW and EW+C) had greater pregnancy rates compared to suckled cows ($P < 0.001$). There was also an effect of BCS at the beginning of the experiment on final pregnancy rate ($P < 0.03$). Cows with a BCS ≤ 3 had lesser pregnancy rates compared to cows with a BCS ≥ 3.5. There was no effect of parity on reproductive responses.

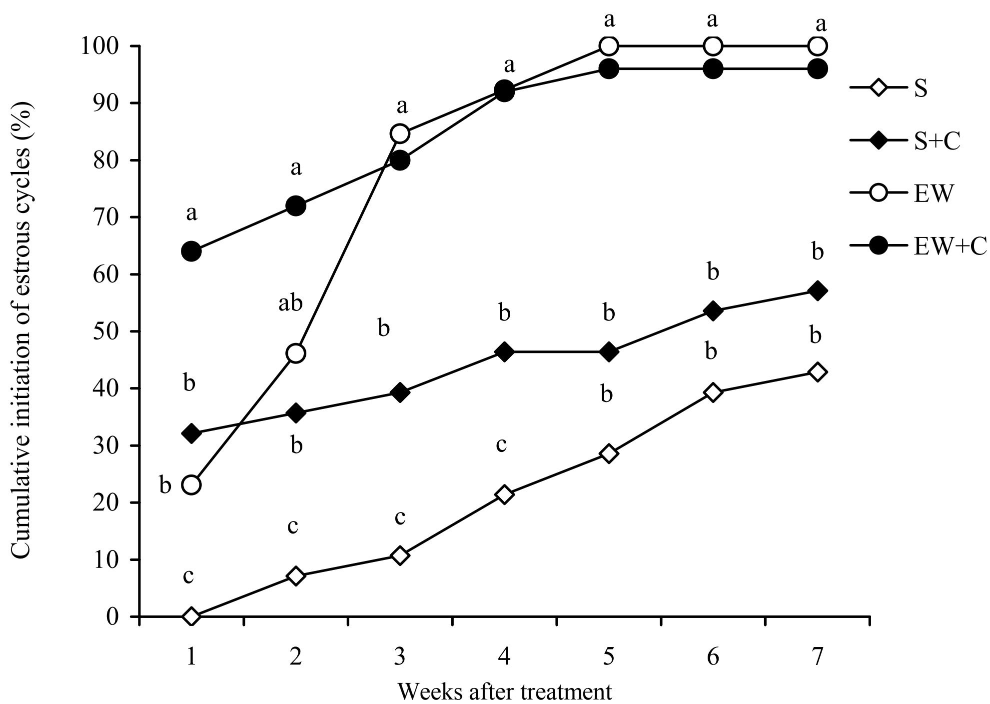

Figure 1. Cumulative percentage of cows resuming estrous cycles (progesterone concentrations >1 ng/ml in 2 consecutive weekly samples) that were either suckled (S); suckled and received a 7-d progesterone-estradiol treatment (S+C), early weaned (EW), or early weaned and received a 7-d progesterone-estradiol treatment (EW+C). Within week, different superscripts differ ($P < 0.05$).

Table 1. Interval (d) from treatment to resumption of luteal function (mean ± SEM) and pregnancy rates in beef cows that were either suckled (S); suckled and received a 7-d progesterone-estradiol treatment (S+C), early weaned (EW), or early weaned and received a 7-d progesterone-estradiol treatment (EW+C) at 77 d postpartum.

Group	Interval from treatment to resumption of luteal function (d)	Pregnancy rate (%)
S	41.5 ± 2.2 [a]	28.6[a]
S+C	31.3 ± 3.6 [b]	35.7 [a]
EW	18.6 ± 1.9 [c]	88.9 [b]
EW+C	12.9 ± 1.8 [d]	88.9 [b]

Within a column, different superscripts differ ($P < 0.04$).

Cows used in the study had a mean BCS of 3.5 ± 0.04 at the beginning of the experiment. Data for BCS change after treatments in cows kept together grazing on rangeland are shown on Fig. 2. There were effects of group ($P < 0.0001$), time ($P < 0.0001$), and a group by time interaction ($P < 0.0001$) on BCS. Early weaned cows had a greater BCS than suckled cows at 1 and 2.5 mo after treatment by 0.5 and 1 point, respectively (Fig. 2; $P < 0.05$).

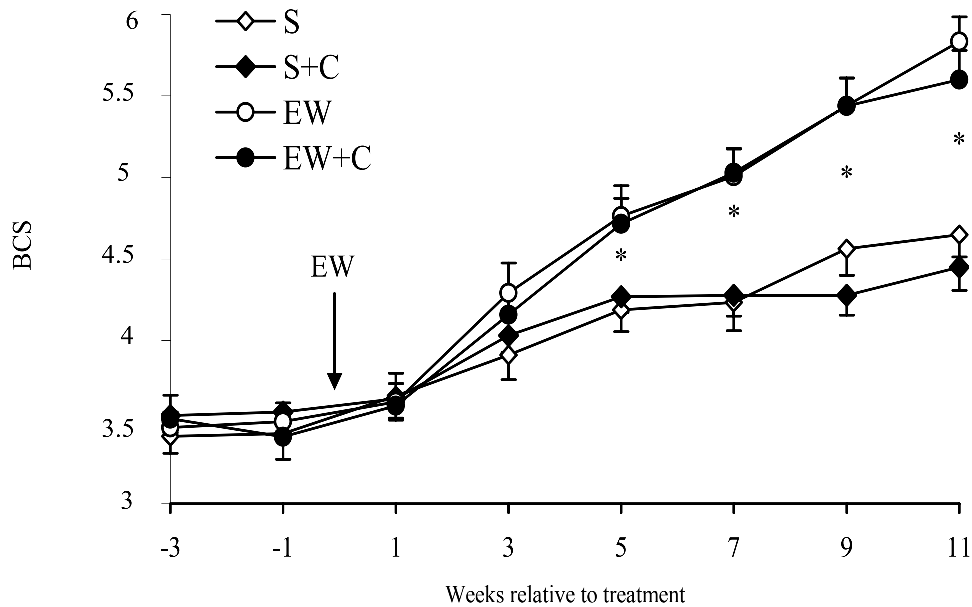

Figure 2. Body condition score evolution in beef cows kept together grazing on rangeland and were either suckled (S); suckled and received a 7-d progesterone-estradiol treatment (S+C), early weaned (EW), or early weaned and received a 7-d progesterone-estradiol treatment (EW+C). * Within week, differences between groups are significant ($P < 0.05$).

Discussion

Present results indicate that early weaning induced resumption of estrous cycles; 100% of the cows had initiated estrous cycles within the first month of the breeding period. This is consistent with previous reports that showed that weaning shortly after parturition shortened the period of postpartum anovulation by 20 to 50 d (Williams, 1990; Hoffman *et al*., 1996), and weaning before the breeding season had the same effect by shortening the period 17 d (Lusby *et al*., 1981). In the present study, early weaning increased final pregnancy rates by 60% points; this is in agreement with earlier studies (Williams, 1990; Williams and Griffith, 1995). Using primiparous cows with marginal BCS, Lusby *et al*. (1981) reported that estrous cycles were initiated by 85 d postpartum in 90% of the EW cows compared to 34% of the suckled cows, and weaning increased pregnancy rates by 38%. Furthermore, when calves were isolated and suckling was restricted to once a day, 50% of the anestrous cows had ovulations within 10 d after treatments compared to 3% of the suckled cows (Stagg *et al*., 1998). All the cows in the present study were in anestrus at the beginning of the breeding period (mean, 77 ± 2.0 d postpartum) and only around 50% of suckled cows had initiated estrous cycles by the end of the breeding period, which explains the lesser pregnancy rates obtained in this group and confirms that postpartum anestrous duration is one of the major causes of poor reproductive efficiency in beef herds (Short *et al*., 1990; Stagg *et al*., 1998).

Association of P4-EB treatment with early weaning resulted in 64% of anestrous cows having luteal-phase P4 concentrations within the first week of the breeding period and consequently shortened the interval from treatment to resumption of estrous cycles. Mackey *et al*. (2000) found that most cows had ovulations after calf isolation and 6 d of P4 treatment in cows with a greater BCS than those used in the present study. Cows in the present study had a lesser BCS and none had initiated estrous cycles before treatment initiation. Considering that early weaning and P4-EB treatment increases labor costs and costs of application, some alternatives should be studied so that results can justify the implementation of this program by beef cattle producers. Initiating early weaning before starting progesterone treatment could be an interesting alternative to increase LH pulsatility during progesterone treatment (Mackey *et al*., 2000) and allow follicles to reach larger diameter and subsequently obtain a better ovulation response. Moreover, this could allow cows to recover energy status before inducing ovulation.

Early weaning exerted a positive effect on BCS recovery. Cows with weaned calves had a 0.5 and a 1 unit increase in BCS at 1 and 2.5 mo after weaning respectively compared to suckled cows when grazing under the same conditions. This confirms that suckled cows require more nutrients than non-suckled cows (Hoffman *et al*., 1996). Similarly, Lusby *et al*. (1981) reported that cows with early-weaned calves gained on average 0.5 kg/day during a 2 mo breeding period. This has important practical implications because these cows will have greater stores of fat at the beginning of the subsequent winter and will probably have an enhanced BCS by the following calving.

Early weaning has been associated with increased labor and reduced growth rate of calves (Yavas and Walton, 2000b); therefore, this technique has had limited implementation by beef producers. In previous studies however, early-weaned male (Rubianes *et al*., 2002) and female (de Castro *et al*., 2004b) beef calves had less body weight after weaning compared to controls, but when the feed supply there was a compensatory growth within 10 mo after birth. Moreover, puberty was attained at similar age and live weight in heifers (de Castro *et al*., 2004b) and bulls (Rubianes *et al*., 2002). These findings suggest that early weaning has obvious benefits in rangeland systems when forage is sparse or cows have marginal BCS to the extent that rebreeding performance is compromised.

When suckled cows were treated with P4-EB in the present study, only 32% responded with luteal-phase P4 concentrations indicative of estrous cycle initiation within the first week after treatment; however, these cows resumed estrous cycles 10 d earlier than suckled, non-treated cows. Although there was not a large number of animals, results of the present study indicate a lesser response in the onset of estrous cycles than that reported by Fike *et al*. (1997) who found that 71% of anestrous cows responded to a similar treatment, but those cows had a greater BCS. Pregnancy rates after an estrus-induction treatment were less in cows with greater energy mobilization from body energy stores although BCS and body weight were not different between cows with greater or lesser pregnancy rates (Grimard *et al*., 1997). In the present study, no differences were detected in BCS between cows with and without ovulations in response to the P4-EB treatment. Although these treatments have been used in postpartum *B. taurus* and *B. indicus* beef cows and resulted in approximately 50% pregnancy rates after FTAI (Bo *et al*., 2005), using a large number of animals (13,500), there is a clear correlation between BCS and pregnancy rates following FTAI. In a previous study (de Castro *et al*., 2001), primiparous cows with a marginal BCS (mean 2.6 ± 0.1, 1-8 scale) treated with P4-EB failed to have ovulations although signs of behavioral estrus were induced pharmacologically by the treatment. Thus, the lesser BCS in the present study could be the cause of the lesser ovulation response to P4-EB treatment in suckled cows. Bo *et al*. (1995) clearly showed that treatment with P4 and estradiol induced ovulation of new, healthy follicles in cattle having initiated estrous cycles following parturition; however, it is not clear if this mechanism is operative in anestrous cows, probably due to a different sensitivity of the LH secretory system to estradiol negative feedback (Rhodes *et al*., 2002). Treatments of small doses of P4 in anestrous Jersey cows did not stimulate sufficient pituitary release of LH to increase the size of the dominant follicle, and the association with EB treatment delayed subsequent follicular development (Rhodes *et al*., 2002). In addition, Baruselli *et al*. (2005) showed that when prostaglandin-F2α was administered to Zebu heifers at the beginning of a P4-EB treatment to reduce P4 concentrations, a greater ovulation response was observed because the dominant follicle was allowed to reach a larger diameter. Thus, maybe P4-EB treatments applied to low-BCS anestrous cows are exerting greater negative feedback on LH release resulting in a smaller dominant follicle and a reduced ovulation response. On the other hand, the use of eCG stimulates follicular growth and has been shown to increase cyclicity and pregnancy rates in cows with nutritional stress (Roche *et al*., 1992; Macmillan and Burke, 1996; Bo *et al*., 2003). The administration of eCG at P4 device removal in suckled cows with a low BCS and/or in the absence of large follicles (≤ 8 mm) increased pregnancy rates after FTAI (Bo *et al*., 2003; 2005). Therefore, these low-BCS, suckled cows may require the addition of eCG to assure final follicular development and ovulation to enhance pregnancy rates. The marginal response confirms results of previous studies (Grimard *et al*., 1997) where lesser pregnancy rates after estrus synchronization/induction treatments in postpartum cows are mainly due to a lesser ovulation rate.

Considering that conception should occur by approximately 85 d postpartum to obtain 1 calf/cow/year, early weaning at the beginning of the breeding season in anestrous beef cows with a marginal BCS appears to be an acceptable alternative to enhance pregnancy rates in beef herds grazing under rangeland conditions. The association of P4-EB treatment with early weaning induced a greater percentage of cows to initiate estrous cycles within the first week of mating. This program would be useful to concentrate and advance the onset of the subsequent calving season, thus yielding a more uniform calf crop with heavier calf weights and also allowing cows to have more time to restore for subsequent breeding season. The lesser proportion of suckled cows responding to P4-EB suggests that these treatments should not be used for cows with a marginal BCS.

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