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The Relationship Between Pregnant Cows' Behavior, Calf Birth Weight and Postpartum Levels of Progesterone

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Abstract: The objective was to evaluate pregnant bovine dominance in 2 genetic types of cows and its relation to weight and sex of calves, as well as the ovarian function 70 days after postpartum of the cows. Twelve cows were used, Brahman×Simmental (n = 5, Br) and Brown Swiss×Brahman (n = 7, F1) between 550-610 k, 4-5 years old, having experienced parturition 2-3 times and being 6-7 months pregnant. Twelve observations were made every other day, using a displacement and success index, behavior samples and scanning the data every four hours with five minute intervals between each sample. The weight and sex of calves at birth were also recorded. Ten samples were used to determine the progesterone levels in blood serum using the PROC MIXED procedure for sample 3 and 8 ($p < 0.01$ and 0.05), respectively. In order to determine dominance a Mann Whitney test was used, dominance was measured at U = 38 and U = 33 for F1 and Br, respectively. The Spearman test correlated with the Weight at Birth (WB) with the displacement and success index, at 0.58, 0.26 for F1 and 0.64, 0.57 for Br, respectively, we observed greater correlation between weight at birth and the displacement index for both genetic types. Correlation between progesterone level's in blood serum and displacement and the success index was 0.84 and 0.07. The only samples that were significant were samples 3 and 8 where correlations of 0.75 and 0.11 were made for F1; 0.28 and 0.61 for Br, respectively which indicates that genetic type F1 had short luteal cycles and genetic type Br had no ovarian activity.

Key words: Genetic type, dominance, progesterone, Ovarian activity, WB, spearman test

INTRODUCTION

Seventy five percent of Bovine meat production is carried out under tropical pasturing conditions (SAGARPA, 2000) where predominant native cattle races are a mixture of European and East Indian breeds live under critical environmental conditions (Beal *et al*., 1990). These cattle (Bos Taurus X Bos Indicus) are characterized by high resistance to humidity, temperature and parasites (Pineheiro *et al*., 1998).

In the Mexican tropics, the main livestock activity is meat production, for which rapid growth livestock breeding is important.

Most common environmental behavioral patterns are asynchronal at today's cattle ranch, for example, the fact that grass availability is directly connected with parturition (Lindsay, 1996). Because of this situation, behavioral and environmental destaging produce economic loss in the humid tropics (Peters, 1996). Increase in long periods of dioestrus are due to suckling, these are some of the circumstances preventing optimum production (Browing *et al*., 1994).

During handling in the corral, bovine suffer stress confronting diverse environments and when mixed with other animals better adapted to said environments this can affect the health, well being and some reproductive aspects of the animals (Solano *et al*., 2004; Fraser and Broom 1998; Hasegawa *et al*., 1997; Arave and Albright, 1981) since they must compete for food and a resting place, they experience stress when separated from familiar animals in the pasture and when introduced into a new cattle ranch for the first time (Wierenga, 1990). Inadequate handling causes stress and unnecessary interaction between animals, causing fights that in turn diminished fertility and increase animal handler risk (Solano *et al*., 2004; Boleman *et al*., 1998; Scanga *et al*., 1998).

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In a study made to determine the gender of calves born to dairy cattle in a range of three-dominant, intermediate and subordinate with a male: female ratio of 13:05 for dominant, intermediate 17:17 and 8:20 for subordinate (Yunes *et al*., 2001).

Among factors that increase postpartum dioestrus and effective maintenance of ovarian cyclicity are the nutritional state and suckling (Galina *et al*., 2001; Bell *et al*., 1998; Browing *et al*., 1994) or the presence of short luteal periods that on occasion are the preamble or regulation of the postpartum oestrous cycle (Ramirez-Godinez *et al*. 1982).

Studies related to plasma progesterone behavior and levels during open days are limited. Individual studies have shown levels greater than 1 ng of progesterone more than 100 days postpartum in humid tropical areas (Gutierrez *et al*., 1996; Galina and Arthur, 1989). Investigations have also been made where the main objective is to find adequate Progesterone dosages (P_4) during oestrous cycle synchronization in treated meat production livestock and in witness groups without treatment, registering an average concentration of 5 ng mL^{-1} in 8 days. (Callejas *et al*., 2006).

Values less than 1 nmol L^{-1} in Zebu cows are related to the follicular or dioestrus phase and values equal to (or greater than) 2.8 nmol L^{-1} during the luteal period. Concentrations of P_4 above 1 ng mL^{-1} have been reported from the 7 to the 17th day and when conception occurs with progesterone levels greater than 9 ng mL^{-1} during 5 consecutive weeks (McLeod and Williams, 1991). The short luteal periods in Zebu crossbred with Bos Taurus have values less than 9 ng mL^{-1} and the normal cycle values over 9 ng mL^{-1} (Cavestany *et al*., 2001).

The objective of this study was to evaluate maternal behavior of dominant cows confined in a dry tropical setting using two different genetic types, its relation to the sex and weight of newborn calves as well as ovarian function 70 days after postpartum.

MATERIALS AND METHODS

The investigation took place at the Faculty of Veterinary Medicine and Zootecnia, Universidad Autonoma de Nayarit at 21° 17' 18'' north latitude and 104° 54' west longitude, 800 m above sea level, predominant climate of the region according to the Köeppen classification (Garcia, 1989) is warm-humid (awz), with an average rainfall of 1000.4 mm and with a average temperature of 22 °C per year.

Twelve cows were used in this study, with two different genetic types: Brahman crossed with Simmental or Charolais, (n = 5, Br) and Brown Swiss×Brahman (n=7, F1), with two to three parturitions, five to six years old, 70 days after postpartum, with a body condition measuring 4 to 6, the scale being 1 to 9 with 1 = emaciated and 9 = obese (Houghton *et al*., 1990). The cows were numbered on there flanks with oil based paint contrasting to the color of there fur for easy identification. The investigation took place in a handling corral, with four divisions and an earthen floor with 150 square meters of space in each division. The reason for these divisions was to allow for ease in animal interaction and observation, the animals could move from one of the four divisions to another freely, there was an elevated platform used for interaction observation. A chute 40 m long by 0.90 cm wide was constructed, each animal had 2.8 meters of space, divided by a wooden post in front and back of the animal so that blood samples could be taken as well as measure ovarian activity with progesterone concentration in serum. The animals were given a diet of corn silage and supplements fed to them in block form, these blocks were made up of 35% molasses, 14% corn flour 1.5% ureal, 17% fish (in powdered form), 11.5% lime, 20% minerals and 1% sulfur. Food and water was supplied Ad libitum, in a 1.5 by 6.5 m feeder in each division.

Table 1: Postpartum cow behavior in the corral catalog

Agonists	Non-agonists
Butting head to head	Threatening to butt head to head
Butting head to neck	Threatening butting head to neck
Butting head to flank	Threatening butting head to flank
Butting head to rear of cow	Threatening butting head to rear of cow
Displacement with body	Threatening at a distance

Note: A successful result is when one animal displaces another

Physical control measures and behavioral observation: The animal behavior was observed for 24 days, with 12 observations every other day, the animals were observed and notes were taken 4 h each day, using cognitive sampling for 5 consecutive minutes and another sweep sampling, with continuous interaction observation of the animals taken in 5 min intervals (Martin and Bateson, 1999) this study was made when the cows were 6-7 months pregnant.

A one week preliminary study was taken in order to define which events were important for inclusion in the behavior catalog data (Table 1). Agonists behavioral, total contact and Non-agonists interaction as well as displacement and success rate index frequencies were calculated by the hour.

Displacement determination index and success: Displacement and success indexes were established with the following formulas (Galindo and Orihuela, 2004; Solano *et al*., 2004; Gonzalez *et al*., 2003; Lehner, 2000).

$$DI = \frac{\text{Number of times an animal was displaced}}{\text{Number of times displacing another animal} + \text{The number of times it was displaced}}$$

$$SI = \frac{\text{Number of animals capable of displacing another}}{\text{Number of animals capable of displacing another} + \text{The number of animals that displace it}}$$

Where: DI = Displacement Index and SI = Success Index.

Calf data: When calves were born, weight and sex was registered for both genetic types.

Ovarian activity test: Before starting the test the animals were given an adaptation period, putting them through the shoot, 3 times a week so that all cows would have the same opportunity to get to know the area. The study was carried out in February before the behavior test and started 70 days after parturition.

Ten blood samples were taken during a 19 day period every 48 h in order to determine progesterone concentration. At the same time restricted suckling was carried out for 18 h periods every seven days.

Progesterone concentration determination: The blood samples were collected from the jugular vein and kept on ice until it was centrifugated for 10 min at 5500 rpm, the serum was decanted in 2 mL flasks and stored at - 20°C till they were analyzed. The progesterone concentration was analyzed by Radioimmunoassay (RIA), using a commercial kit (Coat-a-Count, DPC) with 50 μL of sample aliquot then measured in a gamma counter. The intra- and inter-assay coefficients of variation were 3.2 and 11.4 %, respectively (Bolanos *et al*., 1997; Collier *et al*., 1982).

STATISTICAL ANALYSIS

The Mann Whitney test was used (Lehner, 2000) in order to determine dominance of the two genetic types for data that was not normally distributed, the results from the displacement and success index were used to establish differences between race, the numerical frequency for Agonists behavior was calculated and finally Agonists and Non-agonists interaction frequency was analyzed.

In order to analyze the calf data, weight correlation was used at birth against the displacement and success index as well as a description of the sex of the calf in relation to dominance.

Progesterone concentration data was analyzed by PROC MIXED (SAS, 2000) according to a completely random repetition measurement design, the factors involved were the genetic type of animal and the 10 samples, the animal was included as a randomized effect.

In order to determine the significance of the genetic type interaction by sample the adjusted Tukey test (LSMEANS option) was used (Litell *et al*., 1998). A measurement comparison was used for the number of long and short duration interactions. So that we could establish correlation between ovarian activity and the dominance and success index, the Spearman correlation was used (Lehner, 2000).

RESULTS

Significant differences were found ($p < 0.05$) between genetic types in the displacement and success index, of 0.54±0.13, 0.66±0.13 for F1 and 0.17±0.36, 0.36±0.30 for Br, respectively. Dominance (U) was of U = 38 for F1 and U = 33 for Br.

During there stay in the handling corral the animals showed much short term interactive behavior (497) little behavior longer than 5 sec (37), difference found ($p < 0.01$) (Fig. 5).

The Agonists and Non-agonists interaction numerical frequencies were obtained by the hour and in absolute form for both genetic types (Fig. 1-4).

We observed that genetic type Br had a greater number of Agonists interaction and less Non-agonists interactions, per hour, therefore F1 had more Non-agonists interactions (Fig. 1).

There is more homogeneity in genetic type Br in reference to the non-agonists interaction presentation, concerning genetic type F1 Agonists interactions prevailed (Fig. 2 and 3).

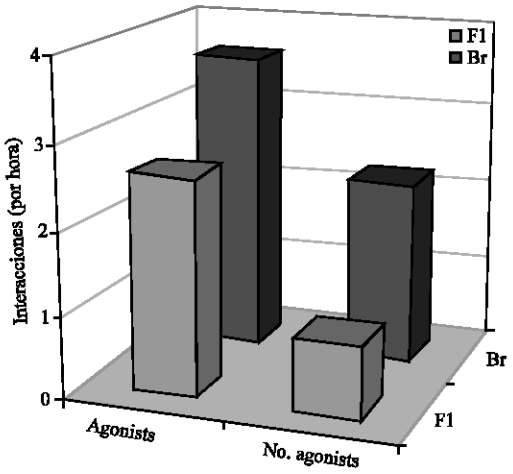

Fig. 1: Frequency of Agonists and non-agonists interaction per hour by two genetic types

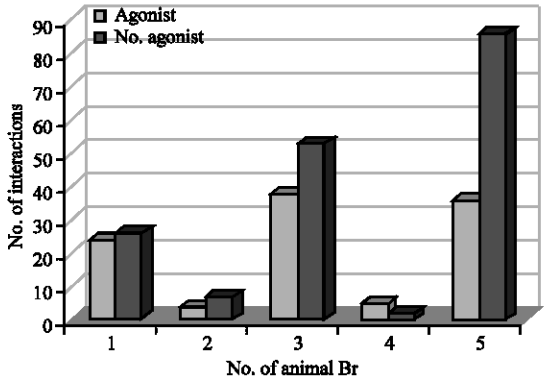

Fig. 2: Absolute interaction frequency of genetic type Br

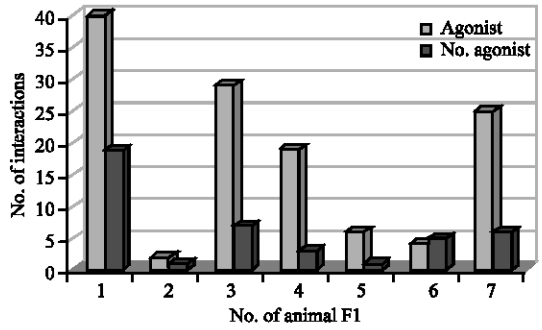

Fig. 3: Absolute interaction frequency of genetic type F1

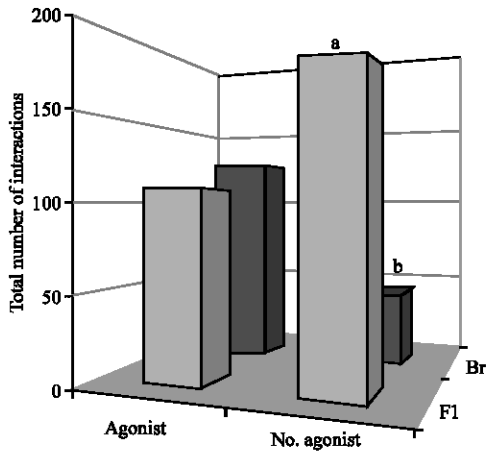

Fig. 4: Absolute interaction frequency of both genetic types

We found a difference ($p < 0.05$) in the means for the Agonists and Non-agonists interactions for genetic type F1, non existent in Br nor in interactions between the two types of genetic types (Fig. 4).

There was a difference in the Spearman correlations ($p<0.05$) between Weight at Birth (WB) and the displacement and success index (DI and SI) as shown in Table 2.

Table 2: Spearman correlations for weight at birth with displacement and success index

Spearman correlation		F1	Br
WB	DI	0.58	0.64
WB	SI	0.26	0.57

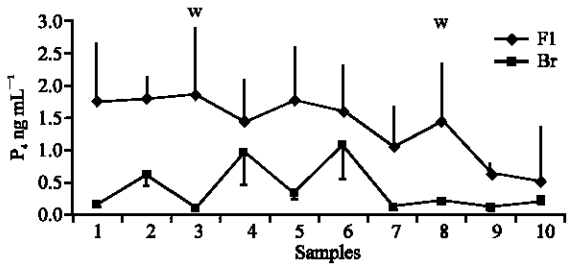

Fig. 5: Progesterone concentration (means±EE) in both genetic types ($p<0.05$)

Regarding genetic type F1 six female calves were born and one male, for genetic type Br 3 females and two males were born, statistic analysis was not for the number of animals for each genetic type in this case.

Ovarian activity and progesterone concentrations: There were P_4 concentrations in genetic type F1 that indicate lutea activity, with short luteal periods. In this group we only saw differences in samples 3 and 8 (Fig. 5), ($p<0.01$, 1.8 ng mL^{-1}; $p<0.05$, 1.4 ng mL^{-1}), respectively. On the other hand genetic type Br had concentrations less than 1 ng mL^{-1} in most samples without finding differences between them from 0.01 to 0.07 ng mL^{-1} ($p<0.05$).

Regarding the restricted suckling carried out every 7 days for 18 h periods, ovarian activity initiation was not observed in the genetic type Br; although genetic type F1 showed short luteal periods.

Values registered between ovarian activity correlation and progesterone concentrations in F1 animals obtained from the 10 samples in regard to the displacement and success index were $R_s = 0.84$, $R_s = 0.07$, $p<0.05$, regarding sample 3, $R_s = 0.75$, $R_s = 0.11$, $p<0.01$ and sample 8 $R_s = 0.28$, $R_s = 0.61$, $p<0.05$ (Fig. 5). Genetic type Br was not considered for the correlation test because progesterone concentrations were below 1 ng.

DISCUSSION

The social behavior of both genetic types evaluated were different, we found a greater number of Agonists behavior in genetic type F1 and non-agonists behavior in genetic type Br, this behavior corroborated with values obtained from the Mann Whitney test determining dominance, where F1 was greater than Br.

Dominant behavior of F1 cows could be due to a compensatory effect for the lack of horns, for which in the case of the Br animals we observed less agonists behavior because they do have horns, as well as for being an animal with a more nervous temperament (Galina *et al*., 2001).

The dominant behavioral study in each group showed diverse behavior for each animal, with the Brahman animals showing anywhere from 2 to 85 non-agonists interactions while the F1 animals showed anywhere from 2 to 40 agonists interactions. We have found that this type of behavior is counterproductive in animal production, which has been widely studied by various investigators using different types of bovine (Gonzalez *et al*., 2003; Fraser and Broom, 1998; Hasegawa *et al*., 1997; Grandin, 1983; Arave and Albright, 1981).

Dominant behavior is an activity that establishes hierarchy in bovine herds (Solano *et al*., 2004; Hasegawa *et al*., 1997; Fraser and Broom, 1998), this causes interactions between animals that can lead to health problems for the same, which is why it is important to determine dominance by observing short term interaction, less than five seconds, as we have done in this research.

Animals with herd instinct used for zootechnical production, have interactive behavior that could be due to handling, the installations also play a fundamental role in the number of interactions that are intimately linked to stress and ultimately influencing ovarian activity in cows not producing calves, this effects a larger proportion of cows after parturition, which increases open days, affecting reproductive efficiency and production in bovines with dual purpose (Scanga *et al*., 1998 and Wierenga, 1990).

The Brahman calf genetic types had greater correlation between weight at birth and the displacement index, registering at 0.64, the success index for the same was 0.57. While F1 was 0.58 and 0.26. The sex of the calves for genetic type F1 was 6 female and 1 male, with Brahaman genetic type registering 3 females and two males, finding a greater number of females in both genetic types. Weight at birth for genetic type Br had a greater correlation in weight at birth due to genetics of the breed.

On the other hand, considering dominance of protocol synchronization in oestrus synchronization for artificial or natural insemination programs, dominance of animals that must compete for food resources and bedding can affect response to treatment as described by Gonzalez *et al*. (2003) and Grandin (1983).

Progesterone levels found in this investigation at 1.8 ng mL^{-1} for close to 8 days show short luteal periods posterior to animal parturition in genetic group F1, which differs from what was reported by Callejas *et al*. (2006) with concentrations of P_4 (5 ng mL^{-1}) during an 8 day period for Bos Taurus cattle without synchronization treatment using progestagene. However, Ramirez-Godinez *et al*. (1982) coincide with what was found in this work regarding the short luteal phase that refer to progesterone concentrations above one ng in a period of 8 days. Other investigators (Galina *et al*., 2001; Bell *et al*., 1998; Browing *et al*., 1994) mention that some other factors that lengthen postpartum dioestrus and affects restarting ovarian activity are body condition and calf suckling.

Restricted suckling carried out in 18 hour periods every 7 days in this investigation, did not have an effect starting ovarian activity in any of the genetic types studied.

Comparing the grade of ovarian activity against the displacement index in the 10 F1 animals, we found them to be positive, except for sample 3 in the displacement index and sample 8 in the success index. However correlation of the displacement index with calf suckling was not positive, due to low progesterone concentration that activates the hypothalamus-pituitar-gonadal axis needed to have a positive effect in the normalization of the oestrus (Hadley, 2000).

CONCLUSION

Dominant behavior is influenced by the genetic type. We observed that F1 was dominant, under the confinement system and conditions of this investigation. We found no ovarian activity at 90 days postpartum due to short luteal periods, which do not represent physiological normalization of the oestrus. On the other hand the restricted calf suckling carried out for 18 h every 7 days was not effective in order to normalize ovarian activity. We found that the Brahman genetic type had greater correlation with weight at birth in regard to the displacement and success index; we also observed greater correlation to dominant behavior and ovarian activity in genetic type F1.

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