FACTORS THAT AFFECT THE RESUMPTION OF THE POSTPARTUM OVARIAN ACTIVITY AND PREGNANCY RATE IN DUAL-PURPOSE COWS IN SOUTHEAST OF MEXICO †

[FACTORES QUE AFECTAN EL REINICIO DE LA ACTIVIDAD OVÁRICA POSPARTO Y TASA DE GESTACIÓN EN VACAS DE DOBLE PROPÓSITO EN EL SURESTE DE MÉXICO]

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SUMMARY

Background. The resumption of ovarian activity after parturition is related to reproductive efficiency. **Objective.** To determine the effect of breed group and some non-genetic factor on resumption of ovarian activity and pregnancy rate of dual-purpose cows. **Methodology.** In study 1, 37 cows were sampled biweekly, from the day 15 to 150 postpartum or until a corpus luteum (CL) was detected. Follicular population (FP), maximum follicle diameter (MFD) and maximum CL diameter (MCLD) were also measured. In study 2, 71 cows were pregnancy diagnosed. Chi^2 tests and analyses of variance were performed to determine the effects of breed group, parity number, body condition score (BCS), BCS change (BCSC) and body weight change (BWC) on the dependent variables. **Results.** In study 1, aproximately, 84% of cows resumed ovarian activity at 68.3 days. More CL were found in multiparous cows (92.59%) and those with BCS ≥3.0 (95.83%). No differences were found in the FP and MFD. F1 cows had the largest MCLD (19.51 mm). In study 2, pregnancy rate was higher in cows with 2-3 (47.83%) and ≥4 parities (54.55%), F1 (54.29%) cows, those gaining BCS (64.29%) and high body weight (66.67%). **Implications.** Results suggest that primiparous cows and those with BCS ≤2.5 require better management; therefore, strategies must be established to improve reproductive efficiency. **Conclusion.** Primiparous and cows with BCS ≤2.5 delayed the first ovulation. Multiparous, F1 cows, those gaining BCS and body weight after calving had the highest pregnancy rate.
Key words: body condition; breed group; corpus luteum; follicular population; parity number.

RESUMEN

Antecedentes. El reinicio de la actividad ovárica posparto está relacionado con la eficiencia reproductiva. **Objetivo.** Determinar el efecto del grupo racial y algunos factores no genético sobre el reinicio de la actividad ovárica y tasa de gestación (TG) de vacas de doble propósito. **Metodología.** En el estudio 1, se evaluaron 37 vacas cada dos semanas, desde el día 15 hasta 150 posparto o hasta que se detectó un cuerpo lúteo (CL). También se midió la población folicular (PF), el diámetro folicular máximo (DFM) y el diámetro máximo del cuerpo lúteo (DMCL). En el estudio 2, se diagnosticó la gestación a 71 vacas. Se realizaron pruebas de Chi^2 y análisis de varianza para determinar los efectos del grupo racial, número de parto, condición corporal (CC), cambios de CC (CCC) y cambios de peso corporal (CPC) sobre las variables de respuesta. **Resultados.** En el estudio 1, el 84% de las vacas reiniciaron actividad ovárica a los

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68.3 días. Se encontraron más CL en vacas multíparas (92.59%) y aquellas con CC ≥3.0 (95.83%). No se encontraron diferencias en PF y DFM. Las vacas F1 tuvieron DMCL más grandes (19.51 mm). En el estudio 2, la TG fue mayor en vacas con 2-3 (47.83%) y ≥4 (54.55%), vacas F1 (54.29%), aquellas que ganaron CC (64.29%) y peso corporal (66.67%). **Implicaciones.** Los resultados sugieren que las vacas primíparas y con CC ≤2.5 requieren mayor manejo, por lo cual, se deben establecer estrategias para mejorar la eficiencia reproductiva. **Conclusión.** Las vacas primíparas y con CC ≤2.5 tardaron más en alcanzar la primera ovulación. Las vacas multíparas, F1, aquellas que ganaron CC y peso corporal posparto, tuvieron la TG más alta.
Palabras claves: condición corporal; grupo racial; cuerpo lúteo; población folicular; número de parto.

INTRODUCTION

Dual-purpose systems predominate in the tropics and particularly in Latin America, characterized by the production of meat and milk, using different grades of *Bos taurus* × *Bos indicus* cattle (Aguilar-Pérez *et al*., 2009a). In dual-purpose systems, cattle is normally fed in grass paddocks, which are generally of low quality and different vegetative growth, throughout the year. Grass in tropical regions of Mexico generally do not meet the energy and protein requirements of lactating cows, causing prolonged calving intervals due to long postpartum anestrus. Anestrus are regulated by different factors that reduce herd productive and reproductive efficiency.

The causes of postpartum anestrus have been reported in dairy (Chen *et al*., 2015, Roche *et al*., 2015) and beef (Mondragón *et al*., 2016, Joner *et al*., 2018) production systems. The anestrus is mainly regulated by nutrition, which causes changes in weight and body condition score (BCS) of cows that affect estrous duration (Mulliniks *et al*., 2012). Other factors that affect the duration of anestrus are management, climatic conditions (De Rensis *et al*., 2017), parity number of the cow (Meikle *et al*., 2004), breed group used (Gautam *et al*., 2010), type of suckling and the length of lactation (Aguilar-Pérez *et al*., 2009a, Díaz *et al*., 2017). At the start of lactation, dairy cows experience a negative energy balance (NEB), associated to an inadequate feed consumption of nutrients for milk production (Chen *et al*., 2015). This NEB affects the follicular dynamics, reduce the growth of the dominant follicle, lengthens the duration of estrus, and diminish the ovulation rate. This is due to the reduction of LH pulses (Wiltbank *et al*., 2006), which compromises the development of the subsequent corpus luteum (CL) and pregnancy (Gautam *et al*., 2010, Bruinjé *et al*., 2017).

In Mexico, most of the studies on ovarian activity and pregnancy rate in cows have been carried out under sub-humid tropical conditions (800 to 1200 mm of rainfall per year), which are conditions different to those prevailing in the humid tropics, where the annual pluvial precipitation ranges from 2,000 to 3,000 mm. This indicates important differences in environmental and herd management in those two environments that may influence herd productivity. Some studies have evaluated the effect of body weight change, postpartum BCS (Aguilar-Pérez *et al*., 2009a, Tinoco-Magaña *et al*., 2012), age of the cow, BCS at calving and breed group under subhumid tropical conditions of Mexico (Aban *et al*., 2008, Magaña-Monforte *et al*., 2014). However, there are no studies of genetic and non-genetic factors affecting the resumption of the postpartum ovarian activity, in dual-purpose cattle systems of production, under Mexican humid tropical conditions. Therefore, it is necessary to determine the main factors that affect the resumption of postpartum ovarian activity and pregnancy rate in dual-purpose cows in the humid tropics. These will allow us to make better decisions to improve those characteristics, and to increase the productive and reproductive efficiency of the herd. The objective of this study was to determine the effect of parity number, breed group and BCS on the resumption of postpartum ovarian activity and pregnancy rate in dual-purpose cows under humid tropical conditions of Mexico.

MATERIALS AND METHODS

Study area and period

The study was carried out from May 2018 to June 2019 in a livestock production unit located on the Juárez-Reforma kilometer 10 highway, Ría. Aldama, Juárez, Chiapas, between 17°33’19.8” and 17°50’44.88” N and 93°23’25.8” and 93°0’42.84” W, at 140 m above sea level. The climate is hot-humid with average temperature and rainfall of 26°C and 3,000 mm, respectively (INEGI 2022).

Experimental design

The research was divided in two studies dealing with the resumption of postpartum ovarian activity and pregnancy rate of dual-purpose cows.

Study 1

Animals characteristics and management

Thirty-seven clinically healthy cows classified according to parity number (primiparous and multiparous), breed group (F1 and other crosses; 0.25 to 0.75 Holstein × Gir) and BCS (≤ 2.5 and ≥ 3.0) were used. The number of animals per level of each factor

Table 1. Least squares means and standard errors of the mean (SEM) by factor for follicle sizes of dual-purpose cows, under humid tropical conditions.

Factor	N	**Small** Mean±SEM	**Medium** Mean±SEM	**Large** Mean±SEM
Parity number				
Primiparous	10 (55)	18.69±1.60[a]	8.05±1.14[a]	1.68±0.21[a]
Multiparous	27 (106)	20.87±1.26[a]	9.61±0.75[a]	1.67±0.14[a]
Breed group				
F1	25 (116)	19.51±1.18[a]	8.54±0.77[a]	1.57±0.14[a]
Other crosses	12 (45)	20.05±1.62[a]	9.13±1.06[a]	1.78±0.20[a]
BCS†				
≤ 2.5	13 (63)	21.35±1.57[a]	9.84±1.09[a]	1.59±0.20[a]
≥ 3.0	24 (98)	18.21±1.19[a]	7.83±0.73[a]	1.76±0.14[a]

Different letters between categories of a factor, indicates significant differences (P<0.05).
F1 = 1/2 Holstein × 1/2 Gir; †BCS = Body condition score; n = number of cows; ( ) = number of evaluations.

are shown in Table 1. The BCS at calving of the cows ranged from 1 = emaciated to 5 = obese (O'Hara *et al*., 2016). The cows were managed in rotational grazing of *Pennisetum purpureum*, *Panicum maximun*, *Brachiaria decumbens* and *Brachiaria brizantha*, and given 1 kg of a commercial feed with 18 % crude protein (CP; during milking), mineral salt and water *ad libitum*. The cows were milked with a mechanical milking machine once a day and with the calf at the foot of the cow.

Resumption of postpartum ovarian activity

Cows were sampled from day 15 postpartum, at intervals of 14 days, until the presence of a CL was observed (confirmed the next visit) or until 150 days postpartum. The follicles and CL per cow were determined by real-time ultrasound (Mindray® DP-10Vet, USA) with a 7.5 MHz linear transrectal transducer.

Variables measured

Follicular population (FP): the number of follicles by cow (both ovaries), at each day of evaluation were counted and classified as small (≤4 mm), medium (4.1-8 mm) and large (≥8.1 mm), according to the scale of Bó *et al*. (2003).

Maximum follicular diameter (MFD): the diameter of the dominant follicle observed in a cow.

Maximum corpus luteum diameter (MCLD): the diameter of the largest CL recorded in a cow.

Study 2

Animals and management

In this study, 71 cows (the 37 cows evaluated in study 1) and 34 more with similar characteristics were used. The change in body condition score (BCSC) was calculated as the gain or loss of BCS, measured every 30 days from calving up to 150 days postpartum. Similarly, the body weight change (BWC) was the weight gain or loss measured every 30 days from calving up to 150 days postpartum, with a digital scale (Wim-Systems®). The number of animals per level of each factor are shown in Table 2.

Pregnancy rate

Estrous was detected from day 15 to 150 postpartum, twice a day (06:00-07:00 and 18:00-19:00) by visual observation. Cows in estrous were identified and according to their milk yield, they were classified as apt for natural mating by a bull or artificial inseminated (12 hour after estrous detection). Pregnancy diagnosis

Table 2. Percentage of pregnant cows by factor for dual purpose cows under humid tropical conditions.

Factor	N	Pregnancy rate (%)
Parity number		
Primiparous	1/15	6.67[a]
Multiparous	29/56	51.78[b]
Breed group		
F1	19/35	54.29[a]
Other crosses	11/36	30.56[b]
BCS†		
≤ 2.5	5/19	26.32[a]
≥ 3.0	25/52	48.08[a]
Change in BCS		
Gained	18/28	64.29[a]
Lost	12/43	27.91[b]
Change in LW‡		
Gained	22/33	66.67[a]
Lost	8/38	21.05[b]

Different letters between categories of a factor, indicate significant differences (P<0.05).
N = number of cows pregnant/total number of cows
† Body condition score ‡Live weight

was carried out by ultrasound 45 days after the service was registered. A cow was considered pregnant when a cow given service got pregnant up to 150 postpartum days.

Statistical analysis

Chi-square or Fisher´s exact tests were carried out to determine the effect of parity number, breed group, and BCS on the presence of a CL (yes or not) and the previous factors plus BCSC and BWC on pregnancy status (yes or not). The analysis of variance for FP, MFD and MCLD included the effects of parity number, breed group and BCS. All statistical analyzes were done using the SAS package (2015).

RESULTS

Resumption of postpartum ovarian activity

Overall, 83.78% of the cows resumed postpartum ovarian activity at 68.3±34.8 days. The presence of a CL was significantly (P=0.0317) higher in multiparous cows (92.59%) than in primiparous cows (60%). The 95.83% of cows with BCS ≥ 3.0 resumed ovarian activity compared to 61.54% for those with BCS ≤ 2.5 (P=0.0133). The resumption of ovarian activity was similar between breed groups. The factors here studied did not have effect on FP (Table 1). The small, medium and large follicles means were 19.7, 8.8 and 1.6 mm, respectively. The results for MFD and MCLD are shown in Table 3. No difference was found for MFD, being on average 12.6 mm. The F1 cows showed the highest MCLD (19.51 mm) in comparison with cows classified as other crosses (P<0.05).

Pregnancy rate

Regarding the pregnancy rate, 42.25% of the cows got pregnant at 114.8±31.75 days postpartum. Pregnancy rate was significantly higher (P=0.0063) for 2-3 (47.83%, 11/23), and ≥ 4 (54.55%, 18/33) cows than in primiparous cows (6.67%, 1/15). Pregnancy rate in F1 cows was 54.29% compared to 30.56% of the other breed group (Table 2).

Cows with BCS ≥ 3.0 had higher (P=0.0579) pregnancy rate (48.08%) compared to cows with BCS ≤ 2.5 (26.32%). Likewise, the pregnancy rate was significantly (P=0.0021) higher in the cows that gained BCS (64.29%) than in those that lost BCS (27.91%). Pregnancy rate was also higher (P=0.0001) in cows that gained body weight (66.67%) compared to those that lost weight (21.05%) in the postpartum period (Table 2).

DISCUSSION

Resumption of postpartum ovarian activity

The cows here evaluated resumed ovarian activity (83.78%) at 68.3 days, which differs from the value found by Kawashima *et al*. (2007) in Japan, who indicated that approximately 50% of Holstein cows ovulated, the first time, at 21 days postpartum. However, Aguilar-Pérez *et al*. (2009a) in sub-humid tropical conditions observed that 58 and 30% of the cows ovulated at 68.5 and 66.6 days after calving, in dual-purpose cows with and without feed supplementation, respectively. Breed, management, diet, and other factors, whose effects vary from region to region, cause differences in the time and the proportion of ovulating cows.

The lower ovulation rate of primiparous cows (60%) *vs* multiparous (92.59%), disagree with Meikle *et al*. (2004) results, in Holstein cows in Uruguay. They found no statistical difference in the proportion of cows that ovulated according to parity number, finding that the first postpartum ovulation took more days (P=0.0001) in primiparous than in multiparous cows 45 *vs* 21 days, respectively. Similarly, Delgado *et al*.

Table 3. Least squares means and standard errors of the mean (SEM) by parity number, breed group and body conditions score (BCS) for maximum follicular diameter (MFD) and maximum corpus luteum diameter (MCLD) in dual-purpose cows.

Factor	N	MFD Mean±SEM	N	MCLD Mean±SEM
Parity number				
Primiparous	10 (45)	12.73±0.84[a]	10 (6)	18.60±1.65[a]
Multiparous	27 (100)	12.52±0.54[a]	27 (25)	17.17±0.88[a]
Breed group				
F1	25 (109)	13.14±0.56[a]	25 (20)	19.51±1.16[a]
Other crosses	12 (36)	12.11±0.78[a]	12 (11)	16.25±1.27[b]
BCS				
≤ 2.5	13 (54)	12.25±0.79[a]	13 (8)	17.39±1.62[a]
≥ 3.0	24 (91)	13.01±0.05[a]	24 (23)	18.38±0.89[a]

Different letters between categories of a factor, mean significant differences (P<0.05).
F1 = 1/2 Holstein × 1/2 Gir; n = number of cows; ( ) = number of evaluations.

(2004) indicated that primiparous Zebu cows under sub-humid tropical conditions had poor cyclicality (first postpartum ovulation) compared to multiparous cows. The delay of the first postpartum ovulation is generally associated with a pronounced NEB probably related to the increase in growth and development needs in primiparous cows that occurs simultaneously with the demands of lactation and its lower capacity for food consumption. Cows calving with BCS ≥ 3.0 had a shorter resumption of the postpartum ovarian activity compared to those cows that calved with BCS ≤ 2.5. Roche (2006) indicates that Holstein cows calving with BCS ≤ 2.5 are more likely to have prolonged anestrus, under high temperatures. This agrees with the observations of Aguilar-Pérez (2007) and Salgado *et al*. (2008), who indicated a positive correlation between weight loss and BCS in early lactation. Furthermore, in that study, the cows showed a NEB (when using their body reserves) with a prolonged postpartum anestrus (>150 days), which compromised follicular development by suppressing or showing low plasma concentrations of IGF-1, T3, estradiol and pituitary LH (Meikle *et al*., 2004), making ovulation inefficient.

Regarding ovarian activity, none of the factors studied affected FP, MFD, except breed group on MCLD, whose average was higher in F1 cows. These results agree to those reported by Tinoco-Magaña *et al*. (2012) and Bottini-Luzardo *et al*. (2015) in sub-humid tropic conditions, who also found no difference in FP in dual-purpose cows. The difference recorded in the present study for MCLD of F1 cows *vs* the other crosses was probably due to a higher expected hybrid vigor in F1 cows, which allowed them to better withstand humid tropical conditions. The size of CL is of great importance to produce adequate levels of progesterone and the establishment of pregnancy.

Pregnancy rate

Approximately, 42% of the cows got pregnant at 115 days postpartum, which represents 50% of the cows that resumed postpartum ovarian activity. This rate is like that reported by Aguilar-Pérez *et al*. (2009b), who found 33.3 *vs* 41.7% pregnant cows with and without feed supplementation, respectively, at 90 days postpartum, in sub-humid tropical conditions. Differences in pregnancy rate are influenced by diet, environment and management, among other factors. In this study, multiparous and F1 cows had the highest pregnancy rate probably due to a positive energy balance, associated with BCS and body weight gain. However, although the overall percentage of cows that reinitiated postpartum ovarian activity was high and had good BCS, the overall pregnancy rate was regular. This could be associated with the reproductive management in the ranch, probably because some cows showed silent estrous or showed it at night and were not detected to give them service (natural mating or artificial insemination).

The pregnancy rate (51%) found in the multiparous and primiparous (6.67%) cows disagree with what is commonly reported in other latitudes such as the USA, Spain and Canada, where in Holstein cows is reported that primiparous cows have better fertility than multiparous cows (Santos and Rutigliano, 2009, Garcia-Ispierto and López-Gatius, 2017, Bruinjé *et al*., 2017). However, the present study agrees with the results of Aban *et al*. (2008) who in a previous study under sub-humid tropical conditions observed a lower pregnancy rate in primiparous cows (20%) compared to multiparous cows (54%), at 120 days postpartum. It is important to mention that the animals here evaluated were under grazing conditions, where animal hierarchy exist in the herd, which could in part, influenced primiparous cow results, since they depend on the availability of food for growth and production.

The pregnancy rate of the F1 cows found here found (54.29%) differs from the value reported by Magaña-Monforte *et al*. (2014), who mention 30% pregnancy rate at 120 days postpartum, and lack of differences between breed groups However, Osorio-Arce and Segura-Correa (2002) and Aban *et al*. (2008) indicated high pregnancy rates for the F1 cows (48.51 and 58.00%, respectively). The superiority of F1 cows in the present study could be attributed to the effect of the hybrid vigor (100%) expressed on fertility, because these cows are expected to be better adapted to tropical conditions (rusticity and productivity) compared to other crosses with higher grade of *Bos taurus* blood. Therefore, this factor should be considered to establish management practices according to the requirements of each breed group and thereby improve ovarian activity and pregnancy rate.

The favorable effect of BCS (≥ 3.0) at calving on pregnancy rate could be because the cows here evaluated, showed a positive energy balance, as indicated by the BCSC and BWC (48.08, 64.29 and 66.67%, respectively). Better pregnancy rates are generally associated to good physical condition (at calving and postpartum), which reduces the period of physiological recovery and thus the calving interval (Mulliniks *et al*., 2012). In addition, the availability of forage, promotes weight gain and body fat deposition, and consequently, the formation of adipocytes, which triggers leptin synthesis that act on the network of metabolic hormones (insulin, GH, IGF- I and II) to increase the frequency and pulse of LH (Souza *et al*., 2009). Finally, the effect of the factors here studied, on the resumption of postpartum ovarian activity and pregnancy rate, indicates that a strategic feeding management should be established during prepartum

and postpartum periods, classifying the cows by parity number and breed group, so that they could express their maximum productive and reproductive potential.

CONCLUSIONS

The primiparous cows and those with BCS ≤ 2.5 at calving, prolonged the time to the first postpartum ovulation. However, BCS and parity did not affect follicle size. F1 multiparous cows and those gaining BCS and body weight after calving had higher pregnancy rates.

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Compliance with ethical standards. All the authors declare that the animals were managed in accordance with the Mexican Official Standard guideline 051-ZOO-1995 and the Mexican Official Standard of technical specifications for production, care and use of experimental animals. The Ethics Committee of the Universidad Juárez Autónoma de Tabasco approved the project (approval number: 0240).

Data availability. Data are available with Jorge Alonso Peralta-Torres, japt83@hotmail.com upon request.

Authors contribution statement (CRediT). **Y. Izquierdo-Camacho** - Data curation, Formal analysis, Writing - original draft., **J.C. Segura-Correa** - Formal analysis, Investigation, Methodology, Writing - review & editing., **N.F. Ojeda-Robertos** - Supervision, Validation, Writing - review & editing., **A.J. Chay-Canul** - Conceptualization, Methodology, Validation., **V.H. Severino-Lendechy** - Methodology, Validation, Writing - review & editing., **J.A. Peralta-Torres** - Conceptualization, Formal Analysis, Methodology, Project administration, Supervision, Validation, Writing - review & editing.

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