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REPRODUCTIVE PERFORMANCE OF HOLSTEIN AND BROWN SWISS COWS UNDER INTENSIVE GRAZING IN A HUMID SUBTROPICAL CLIMATE

[COMPORTAMIENTO REPRODUCTIVO DE VACAS HOLSTEIN Y SUIZO AMERICANO EN PASTOREO INTENSIVO EN CLIMA SUBTROPICAL HÚMEDO]

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SUMMARY

The objective of the study was to determine days to first postpartum estrus (DFPE), days to first service (DFS), days open (DO), services per conception (SPC) and calving interval (CI) in Holstein (HO) and Brown Swiss (BS) cows grazing in an Af(c) climate, during three seasons of the year: windy, dry and rainy. A factorial design that included the effects of breed (BR), calving year (CY), calving season (CS) and the interaction BR*CY was used. Breed did not affect DFPE, DFS, DO and CI ($P > 0.05$), but it affected SPC ($P < 0.01$), being higher for HO (1.95±0.05) than for BS (1.74±0.05). The CY affected all variables studied ($P < 0.05$). The CS affected DFPE, DFS, DO and CI ($P<0.05$), but it did not affect SPC ($P > 0.05$). The BR*CY interaction did not affect any of the variables analyzed ($P > 0.05$). The CI was 390.7±4.01 and 397.8±4.32 d for HO and BS, respectively. During the windy, dry and rainy seasons the DFPE were 63.0±2.26, 69.3±2.1 and 61.7±2.0 d; the DFS 67.3±2.2, 73.8±2.1 and 66.4±2.0 d; the DO 100.5±4.1, 111.2±3.8 and 103.1±3.6 d; and the CI 391.3±4.3, 402.4±4.2 and 389.1±3.8 d, respectively. In conclusion, the HO and BS cows had a similar reproductive performance under humid subtropical conditions, but the BS required fewer SPC.

Key words: Reproduction; tropics; calving interval; Holstein; Brown Swiss.

RESUMEN

Se determinaron los días a primer estro posparto (DFPE), días a primer servicio (DFS), días abiertos (DO), servicios por concepción (SPC) e intervalo entre partos (CI) en vacas Holstein (HO) y Suizo Pardo (BS) en pastoreo en clima Af(c), durante tres épocas del año: nortes, secas y lluvias. Se utilizó un diseño factorial que incluyó efectos de raza (BR), año de parto (CY), época de parto (CS) y la interacción BR*CY. La BR no afectó ($P > 0.05$) los DFEP, DFS, DO y CI, pero sí afectó los SPC ($P < 0.01$), siendo mayor para HO (1.95±0.05) que para BS (1.74±0.05). El CY afectó todas las variables estudiadas ($P < 0.05$). La CS afectó ($P < 0.05$) los DFPE, DFS, DO y CI, pero no los SPC ($P > 0.05$). La interacción BR*CY no afectó ($P > 0.05$) ninguna variable analizada. El CI fue 390.7±4.01 y 397.8±4.32 d para HO y BS, respectivamente. En época de nortes, secas y lluvias los DFPE fueron 63.0±2.26, 69.3±2.1 y 61.7±2.0 d; los DFS 67.3±2.2, 73.8±2.1 y 66.4±2.0 d; los DO 100.5±4.1, 111.2±3.8 y 103.1±3.6 d; y el CI 391.3±4.3, 402.4±4.2 y 389.1±3.8 d, respectivamente. Las vacas HO y BS tuvieron un desempeño reproductivo similar en el subtrópico húmedo, pero las BS requirieron menos SPC.

Palabras Clave: Reproducción; trópico; periodo interparto; Holstein; Suizo Americano.

INTRODUCTION

Cow's milk is an important food for humans, particularly children, because of its high nutritional value (Rodríguez *et al*., 1973). One alternative for milk production is the use of grazing systems, since cattle take the forage directly from the plants, reducing the cost productions. Due to their high forage potential, the tropical regions are a good alternative for cow's milk production (Améndola *et al*., 2005). In Mexico, the tropical area includes 51.7 million ha, representing more than 28 % of the total area of the country, of which 25.7 million ha are dedicated to livestock production (González-Padilla, 2002). In the Mexican tropics, cattle production is characterized by traditional management systems with low productive efficiency, old age at first calving and prolonged intercalving periods (Calderón, 1997).

Cattle systems dedicated to milk production in the tropics are mainly dual-purpose systems that have cattle with some proportion of *Bos indicus* genotype, maintain 76 % of the animals in traditional extensive systems that combine calf rearing with milk production, and contribute with 18 % of the total milk production in Mexico (SAGARPA, 2004). Even though in a low percentage, the specialized tropical dairy system also exists, with breeds such as Holstein (HO) and Brown Swiss (BS) (García, 2002). Despite the contribution of the dual-purpose production system, its productive indices are low, with average milk production of 700 kg in 170 days, calving interval of 550 days, age at first calving of 43 months, and weight at weaning and first year of age of 130 and 150 kg, respectively (Koppel *et al*., 2002).

One alternative to increase milk production in tropical areas is the introduction of breeds with a higher genetic potential for milk production, such as HO and BS. Some authors have suggested that if appropriate management and feeding techniques are used, these breeds, both as purebred and as crosses with Zebu cattle, could increase milk production in the tropics (Covarrubias *et al*., 1992; Calderón *et al.*, 2007).

The specialized tropical dairy system can be defined as a system in the tropics in which milk is produced from specialized purebreds, such as HO, BS and Jersey; this system is characterized by grasslands that are planted with improved grasses, and by feeding concentrates to cows during milking. This system can be of several types depending on the region where the production units are located: total confinement in pens, confinement with availability of forage during daytime and night grazing, and total intensive rotational grazing, where milking of the cows is carried out without the presence of the calf, unlike the dual-purpose system. Nevertheless, the studies on the reproductive performance of female cattle in integral production systems are scarce in the tropics, and have been carried out mainly under a disciplinary approach (Cavestany *et al*., 2001).

Even though the European purebreds reach productive indices much higher than the dual-purpose cattle, their utilization in tropical regions is not affordable, due to the problems caused by the fertility, and calf weight and mortality (Pearson-Vaccaro, 2007). However, since the 1960's purebreds specialized in milk production have been introduced in the Mexican tropics with encouraging results (Falcón, 1984).

Therefore, the objective of the present study was to evaluate the reproductive performance of HO and BS cows maintained under intensive rotational grazing in a humid subtropical climate in Mexico.

MATERIALS AND METHODS

The study was carried out using the information provided by the specialized tropical dairy production unit Santa Elena owned by the Experimental Station "Las Margaritas", located in Hueytamalco, Puebla, Mexico (Lat. 19° 20' N and Long. 97° 20' W, at 500 m altitude). Climate is Af(c) (García (1988), with mean annual temperature of 21 °C (minimum 6 °C in winter and maximum 31 °C in summer), relative humidity of 90 % and mean annual rainfall of 3000 mm.

The information used included the years 1990 to 2007, and was obtained from individual records of 151 BS and 171 HO cows.

The cows were separated from their calves at the third day after calving, and hence they were managed in three groups: 1) cows from calving to the fifth month of lactation, 2) cows from the fifth month of lactation until drying off, and 3) dry cows. In the two first groups cows were mechanically milked twice a day. In the three groups the stocking rate was 2.5 A.U. ha^{-1}, under intensive rotational grazing of African Star (*Cynodon plectostachyus*) grass, with grazing periods of 2 and 3 days, and rest periods of 30 and 45 days during spring-summer and autumn-winter, respectively. Additionally, cows received 3.5 kg $animal^{-1}$ day^{-1} of a feed concentrate (70 % total digestible nutrients and 18 % crude protein), and *ad libitum* minerals and water. From November to March, cows received 10 to 15 kg $animal^{-1}$ day^{-1} of fresh and chopped Japanese cane (*Saccharum sinense*).

In the first group of cows, estrus detection was performed twice a day, and the cows were given the opportunity of three artificial insemination services and two natural services to achieve conception; the cows that required more services to get pregnant were culled from the herd. From drying off until calving, the cows were kept in a pasture and were given 2 kg animal^{-1} day^{-1} of the same feed concentrate that had received before.

All the cows were vaccinated against clostridial diseases (*Clostridium* spp.) three times a year, and against rabies once a year, and were dewormed at calving and at drying off. Each month, the cows received a tick treatment bath and were also weighed. Three calving seasons were defined in the study: windy (November to February), dry (March to June) and rainy (July to October).

The cows were subjected to a selection process based on their milk production; those cows that during their first lactation produced less than 2500 kg or that on their second lactation produced less than 3000 kg were culled from the herd.

The preliminary statistical model to analyze the characteristics that were studied included the breed (BR), calving year (CY), and calving season (CS) as fixed effects, the simple interactions derived from these main effects, the age of the cow as covariable, and the sire nested in the breed of the cow as a random effect. The analyses were carried out with the Mixed procedure from the SAS (Littell *et al*., 1996). The response variables evaluated were: days at first postpartum estrus (DFPE), days at first service (DFS), days open (DO), services per conception (SPC) and calving interval (CI). The definitive statistical model was obtained eliminating the interactions and covariables that were not significant ($P > 0.05$) according to the preliminary analyses. The final model for DFPE, DFS and SPC included the effects of BR, CY and CS. For DO and CI, in addition to the main effects, the interaction BR*CY was included. The criteria used for the edition of the information were: 15 to 180 days for DFPE, 28 to 180 days for DFS, 28 to 260 days for DO, 300 to 550 days for CI and 1 to 5 SPC.

RESULTS

The BR of the cows only affected the SPC ($P < 0.01$; Table 1). The CY affected ($P < 0.05$) all the variables studied. The CS affected DFPE ($P < 0.01$), DFS ($P < 0.01$), DO ($P < 0.05$) and CI ($P < 0.05$), but it did not affect SPC ($P > 0.05$). The interaction BR by CY had no effect ($P > 0.01$) on any of the response variables that were studied.

The BR only affected SPC (Table 2), and fewer SPC ($P < 0.01$) were needed by the BS cows than by the HO cows to become pregnant.

The CS had an effect on CI ($P < 0.05$), DO ($P < 0.05$), DFS ($P < 0.01$) and DFPE ($P < 0.01$; Table 3). There was no difference in SPC ($P > 0.05$). The CI and the DO were greater ($P < 0.05$) in the dry season, compared with the windy and rainy seasons. The DFS and DFPE were also greater ($P < 0.01$) in the dry season than in the windy and rainy seasons. No difference was found between the windy and rainy seasons ($P > 0.05$).

DISCUSSION

There was no effect of BR in DFPE, averaging 64 days in HO and 65 days in BS cows. These results were similar to those reported by Castillo (1972) in dry tropical climate, and by Jiménez and De los Santos (1984) in Tamaulipas Mexico, but were grater than the 50 days indicated by Galavíz *et al*. (1987) in BS cows, and lower than those obtained by Salazar *et al*. (1970), of 73 to 93 days in three herds of HO cows in Colombia. It is likely that the values reported by Castillo (1972) were lower because the cows received special feed and remained confined into a pen to counteract the heat stress. However, in the case of Galavíz *et al*. (1987), the lower number of observations included in their study might have influenced the results. Other authors (Inostroza and Sepúlveda, 1999; Cavestany *et al*., 2001) have indicated intervals of 70 to 89 days in grazing HO cows, in Chile and Uruguay, respectively. The difference among the studies reviewed is 30 days, which indicates that despite the tropical environment conditions, the pure dairy breeds resume ovarian activity in an acceptable period of time after calving.

In the present study, the DFS were 68 days in HO and 70 in BS cows. These results were similar to the 67 days reported by the Ministry of Culture of Cuba (1982) in HO cows maintained in an intensive system, but were lower than the 83 days obtained by Ramírez and Segura (1992) in a HO herd in Tamaulipas Mexico, in a dry tropical climate. These latter results were likely due to the extreme climate, since in that region temperature fluctuates between 2 and 45 °C. Inostroza and Sepúlveda (1999), under different climatic conditions but also in a grazing system, obtained 79 days in HO cows. Cavestany *et al*. (2001) indicated 90 days in multiparous and 112 days in primiparous HO cows. In BS cows managed in a dual-purpose system, Gleaves *et al*. (1986) reported 165 days; this result was probably due to the influence of suckling and the presence of the calf because the cows remained with their calves at foot, different to the dairy cows managed under specialized systems, which do not need the suckling stimulus of the calf to be milked. As a consequence of DFPE there is no variation among studies for DFS postpartum, since according to what was previously mentioned, the interval is 67 to 83 days in the specialized dairy systems.

Table 1. Significance levels (P) of the analysis of variance for days to first postpartum estrus (DFPE), days to first service (DFS), services per conception (SPC), days open (DO) and calving interval (CI) in Holstein and Brown Swiss cows under intensive grazing in a humid subtropical climate.

Variation source	DFPE	DFS	SPC	DO	CI
Breed (BR)	0.7819	0.401	0.0015	0.5931	0.2358
Calving year (CY)	< 0.0001	0.0039	< 0.0001	< 0.0001	< 0.0001
Calving season	0.0077	0.0069	0.8243	0.0406	0.0145
BR*CY				0.0482	0.2811

Table 2. Means of least squares and standard errors for days to first postpartum estrus (DFPE), days to first service (DFS), services per conception (SPC), days open (DO) and calving interval (CI) in Holstein and Brown Swiss cows under intensive grazing in a humid subtropical climate.

Breed	DFPE	DFS	SPC	DO	CI
Holstein	64.3±1.9[a]	68.0±1.9[a]	1.95±0.05[a]	103.4±3.6[a]	390.7±4.0[a]
Brown Swiss	65.0±2.1[a]	70.3±2.0[a]	1.74±0.05[b]	106.5±4.5[a]	397.8±4.3[a]

[a,b]Means with a different superscript by column are statistically different (P < 0.01).

Table 3. Means of least squares and standard errors, by calving season, for days at first postpartum estrus (DFPE), days at first service (DFS), services per conception (SPC), days open (DO) and calving interval (CI) in Holstein and Brown Swiss cows under intensive grazing in a humid subtropical climate.

Calving season	DFPE	DFS	SPC	DO	CI
Windy	63.0±2.3[a]	67.3±2.2[a]	1.88±.07	100.5±4.1[a]	391.3±4.3[a]
Dry	69.2±2.1[b]	73.8±2.1[b]	1.84±.06	111.2±3.8[b]	402.3± 4.2[b]
Rainy	61.7±2.0[a]	66.4±2.0[a]	1.83±.06	103.1±3.6[a]	389.1±3.8[a]

[a,b]Means with different superscript by column are statistically different (P < 0.05).

For the variable SPC, the HO cows received 1.95 services, whereas the BS cows received 1.74 services, fewer than the 2.0 services reported by Ortiz and Robles (1983) in BS cows in a humid subtropical climate, and by Jiménez and De los Santos (1984), who also reported 2.0 SPC in HO cows and 1.8 SPC in BS cows. Gleaves *et al*. (1986) and Anta (1989) indicated similar results in dual-purpose cattle in the Mexican tropics, of 1.7 to 1.9 SPC. The Ministry of Culture of Cuba (1982) reported 2.6 SPC in HO cows, greater than the result of the present study. Likewise, Marini *et al*. (2007) in Argentina mentioned that grazing HO cows required 2.2 to 2.4 services to become pregnant. The SPC were affected by the BR, and in all the cases the number was greater in HO cows. However, these results are within a range that does not exceed 2.0 services indicated as an acceptable goal, considering that these are multiparous and not nulliparous cows, which are more fertile and require fewer SPC. The variation that existed among studies (1.74 to 2.6 SPC) might have been due to the environment in which the animals were raised, as well as the effect of the artificial insemination technician, calving number, feeding, and milk yield, among other factors.

The mean for DO was 103 days for HO and 106 days for BS cows. These results are lower than those reported by Yifat *et al*. (2009), of 130 to 140 days in crosses of European dairy by Zebu cattle in tropical conditions, as well as the results by Castillo (1972), of 160 days for HO cows and 118 for BS cows in a dry tropical climate. On the other hand, Ortiz and Robles (1983) reported 112 days in BS cows, whereas Galavíz *et al*. (1987) indicated 84 days in BS cows in a humid subtropical climate. Jiménez and De los Santos (1984) obtained 121 days for HO cows and 116 days for BS cows. The Ministry of Culture of Cuba (1982) reported 140 days in HO cows. Ramírez and Segura (1992) indicated 132 days for HO cows raised in Tamaulipas, Mexico. In Uruguay, Cavestany *et al.* (2001) obtained 125 days in grazing HO cows. Marini *et al.* (2007) reported an interval of 121 to 140 days in Argentina. According to the studies previously mentioned, the variation for DO is much more noticeable, since it ranges from 84 to 160 days, which indicates that this variable can be influenced by many factors, such as climate, feeding, reproductive management (mainly estrus detection) and presence of infections in the reproductive tract, that can affect fertility. In general, most of the studies state that HO cows take longer to become pregnant than BS cows, which could be due to the fact that the HO cows are more susceptible to heat stress (Hernández, 2005).

For CI, the mean was 390.7 days in HO cows and 397.7 days in BS cows. These results were greater than the 374 days reported by Galavíz *et al*. (1987) in BS cows in a humid subtropical climate, but were lower than the 490 days obtained by Jiménez and De los Santos (1984) in HO cows in a semi-intensive system in Tamaulipas Mexico. These latter authors indicated 401 days for BS cows, which were similar to the results obtained in the present study. Also similar to those of the present study are the 392 days indicated by Castillo (1972) in BS cows, but were shorter than the 452 days obtained in HO cows by this same author. Ortiz (1979) reported 436 days in HO cows in the humid subtropic of Guerrero Mexico, whereas the Ministry of Culture of Cuba (1982) indicated 417 days in HO cows, and Urbano *et al*. (2000) obtained 432 days in HO cows in a dry tropical climate in Merida, Venezuela, all these results greater than that obtained in the present study. Under tropical conditions, Yifat *et al.* (2009) recorded 406 to 418 days in dairy European by Zebu crosses.

The results reported by the different authors above mentioned range between 374 to 490 days, and it is evident that the variation for the CI is more marked. This is a logical consequence of DO, since this variable had a similar behavior. It is worth mentioning that CI and DO might have been influenced by factors such as climate, feeding, reproductive management, etc. The HO cows are high-producing animals, and somehow this affects their reproductive performance, resulting in longer DO and CI.

The CS did not affect the number of SPC. Ramírez and Segura (1992) mentioned that in each year evaluated, the CS was different only with respect to the response variable DFPE.

The values obtained for all the response variables studied were greater during the dry season, compared with the windy and rainy seasons. One explanation for this could be that in the dry season there is less forage available and days are hotter than in the two other seasons, when temperature decreases, which affects positively the cows by reducing heat stress (Hernández, 2005) and making their environment more comfortable.

The CI is an event that is dependent on DO, which in turn depends on DFPE and DFS. Therefore, during the postpartum period it is advisable to reduce DO. One likely explanation for the longer CI in the present study is that the cows that give birth in the dry season take longer to resume ovarian activity due to the lower availability of forage in the pasture, whereas the females that give birth during the rainy and windy season recover faster, because in the rainy season there is enough forage available for the cows, and in the windy season the lack of forage is compensated with the Japanese cane, which is given fresh and chopped to the cows. Nevertheless, to support this statement, it is necessary to conduct studies on the dry matter availability during the above mentioned seasons of the year.

CONCLUSION

The HO and BS cows had similar reproductive performance under humid subtropical climate conditions. However, the BS cows required fewer SPC than the HO cows. As was expected, the CY affected all the variables studied. In addition, the dry season was the least favorable season for cows to calve. The results indicate that it is feasible to establish milk production systems with specialized dairy breeds in the tropics. However, it is necessary to evaluate the production indicators and to determine their profitability.

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