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Growth pattern during the first gestation of heifers crosses with Brahman father and different maternal genotype

Patrón de crecimiento durante la primera gestación de vaquillonas cruza con padre Brahman y diferente genotipo materno

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Resumen

El objetivo del presente trabajo fue evaluar el patrón de crecimiento durante la primera gestación de vaquillonas cruza con padre Brahman y diferente genotipo materno, en la Amazonía Ecuatoriana. Se utilizaron datos retrospectivos de 2304 pesos individuales de 48 vacas cruzas lecheras. Con ello, se evaluó el comportamiento dinámico del peso corporal de cuatro genotipos: Brahman x Gyr (Gyr) (n=12), Brahman x Brown Swiss (BS) (n=12), Brahman x Jersey (J) (n=12) y Brahman x Sahiwal (S) (n=12), pertenecientes al rodeo lechero del Centro de Investigación, Posgrado y Conservación de la Biodiversidad Amazónica (CIPCA) – Ecuador. Las diferencias entre genotipos en el peso corporal a la preñez y al primer parto no fueron estadísticamente significativas. Se observaron diferencias en la edad a la primera preñez correspondiendo la mayor precocidad a la cruza con madre Brown Swiss y la menor precocidad a las cruzas con Gyr y Sahiwal. Las hembras producto del cruzamiento con Jersey presentaron un comportamiento intermedio. Se observó que, durante su primera gestación, las vaquillonas F1 con padre Brahman y diferente genotipo materno, presentan similar patrón de crecimiento en las condiciones limitantes de la Amazonía Ecuatoriana, respuesta interpretable en términos de interacción genotipo-ambiente negativa.
Palabras clave: Biogás, metano, relleno sanitario, estimación teórica.

Abstract

The objective of the present work was to evaluate the growth pattern during the first gestation of heifers crossed with Brahman father and different maternal genotype in the Ecuadorian Amazon. Retrospective data of 2304 individual weights of 48 dairy cows were used. The dynamic behavior of the body weight of four genotypes was evaluated: Brahman x Gyr (Gyr) (n=12), Brahman x Brown Swiss (BS) (n=12), Brahman x Jersey (J) (n=12) and Brahman x Sahiwal (S) (n=12) belonging to the dairy herd of the Research Center, Postgraduate studies and Preservation of the Amazonia Biodiversity (CIPCA) – Ecuador. The differences between genotypes in body weight at pregnancy and at first birth were not statistically significant. Differences in age at the first pregnancy were observed, with the highest precocity at crossing with Brown Swiss mother and the lower precocity at crosses with Gyr and Sahiwal. The females produced by crossing with Jersey showed intermediate behavior. It was observed that, during their first gestation, F1 heifers with Brahman father and different maternal genotype have a similar growth pattern under the conditions of the Ecuadorian Amazon, response in terms of negative genotype-environment interaction.
Keywords: Landfill gas, methane, landfill, theoretical estimation.

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1 Introduction

Calderón et al. (1993); Abeygunawardena and Dematawewa (2004), reported that females from crossbreeds between zebu and European breeds begin puberty at a younger age compared to pure breeds in wet tropic conditions, with values of 15 and 19 months, respectively. The genetic variability existing within and between breeds results in differences in age and body weight to the presentation of the first estrus, affecting subsequent reproductive events that end up being global productive (Navarrete, 1995; Nogueira, 2004). For this reason, it is important to have different breeds adapted to these particular conditions, able to overcome the productive limits that *Bos taurus* breeds present in these regions. In this sense, it has been observed that cows from Brahman x *Bos taurus* crosses have higher fertility, higher milk production and greater longevity than those of pure *Bos taurus* genotype (Grajales et al., 2006; Zambrano-Sepúlveda et al., 2014).

However, by increasing the proportion of indica genes, females tend to delay age at puberty and this impacts negatively their subsequent reproductive behavior. In this sense, it has been found (Rocha and Lobato, 2002; Zambrano and Contreras, 2014) the inability of cows to cross Brahman x *Bos taurus* to produce a replacing cow that maintains its same productivity characteristics, as a result of the loss of heterosis with respect to that expressed by F1. The live weight record of cattle is a strategy that allows to monitor the behavior in their natural environment, and this information is specifically used for a variety of purposes, including determining the appropriate feeding level and the nutritional status of animals, monitoring the growth rate and responses to the genetic selection (Marulanda, 1996; Lesosky et al., 2013; Lukuyu et al., 2016).

The assessment of the live weight of animals in livestock production systems is essential if wanting to implement good grassland management practices aimed at achieving sustainable production in the Amazon. In this context, the aim of this research is to evaluate the growth pattern during the first gestation of heifers crossed with Brahman father and different maternal genotype in the Ecuadorian Amazon.

Table 1. Age and body weight at the first pregnancy in four F1 heifer groups with Brahman father and different mother genotype.

Variable	Mother genotype				Contrastes
	Gyr	Brown Swiss	Jersey	Sahiwal	
Age (days)	$1148^{c} \pm 57{,}7$	$852^{a,b} \pm 38{,}3$	$994^{b,c} \pm 49{,}5$	$1135^{c} \pm 54{,}4$	F = 7,619 p = 0,0003
Pregnancy weight (kg)	319 ± 17,3	350± 9,5	308± 13,6	324± 8,6	F = 1,239p = 0,307
Calving weight (kg)	392± 15,8	414± 18,8	399± 14,0	399± 11,0	F = 1,239p = 0,307

All values correspond to an arithmetic mean ± standard error.
Sample size: n = 12 individuals per group.
a, b, c Values with different letters differ in at least 0.05.

2 Materials and methods

Retrospective data were used from 2304 individual body weight records of 48 dairy cross cows belonging to four genotypes: Brahman x Gyr (Gyr) (n=12), Brahman x Brown Swiss (BS) (n=12), Brahman x Jersey (J) (n=12) and Brahman x Sahiwal (S) (n=12) belonging to the Research Center, Postgraduate studies and Preservation of the Amazonia Biodiversity (CIPCA). This center is located in Carlos Julio Arosemena Tola, Napo province (Ecuador), at kilometer 44 of Puyo-Tena (coordinates: S 01° 14.325; W077° 53.134) and has 42 ha of pasture for breeding. Heifers came from the same establishment and had been bred under the same environmental, nutritional and management conditions, and entered in CIPCA at 15-17 months of age and with body weights (average EE) of 204 x 7.7 kg (G); 276 x 11.0 kg (BS); 204 x 8.7 kg (J) and 186 x 6.0 kg (S). In order to assess the dynamic behavior of the body weight, all animals were weighed individually between December 2012 and December 2016, every 30 days. The feeding of the bovine herd under study was free grazing, with grasslands based on Brachiaria decumbens (17 585 kg MS/ha/year, Protein: 10.6% Phosphorus: 0.18%; DIV: 44.4%), Brachiaria brizantha (26 970 kg MS/ha/year; Protein: 10.1%; Phosphorus: 0.18 %; DIV: 44.1%), Arachis pintoi (6 212 kg MS/ha/year; Protein: 19.4%; Phosphorus: 0.21%; DIV: 59.2%), Desmodium ovalifolium (5 890 kg MS/ha/year; Protein: 16.3%; Phosphorus: 0.16%; DIV: 39.6%) and Stylosanthes guianensis (15 237 kg MS/ha/year; Protein: 21.4%; Phosphorus: 0.4%; DIV: 48.7%) (Leonard, 2015).

The health management applied was commonly used for CIPCA, which includes deworming, claw stools and

flies, vaccinations for foot-and-mouth disease, bovine rabies and vesicular stomatitis and the injectable application of vitamins and minerals. The body weight (kg) was recorded individually at the first pregnancy, the age (days) to the first pregnancy and the body weight (kg) at the first calve. The normal distribution of each of these variables was evaluated with the D'Agostino Pearson test (D'Agostino and Pearson, 1973) and the homogeneity of its variances with Brown-Forsythe test (Brown and Forsythe, 1974). For each genotype, the average body weight during the first gestation was calculated at monthly intervals. The average data calculated were organized according to the months of gestation, in all cases identifying behavior similar to a linear model found with a cycle test. The effect of the genetic group on the values of the estimators of linear function parameters was assessed with a covariance analysis.

3 Results

Table 1 shows the effect of the genetic group on the three response variables, all of them presenting normal distribution and homogeneous variations. The observed differences between genotypes in body weight at pregnancy and early calving were not statistically significant. Differences in age to the first pregnancy were observed, being the highest precocity the crosses with Mother Brown Swiss and the lowest precocity the crosses with Gyr and Sahiwal. Females with Jersey crossing presented intermediate behavior.

On adjusting the average body weight vs gestation months, a non-significant deviation from linearity was observed for the four genetic groups [Mother Gyr (p = 0.833), Mother Brown Swiss (p = 0.283), Mother Jersey (p = 0.881) and Mother Sahiwal (p = 0.405)]. The values of the linear determination coefficient (R^2) and the residual variances (S_{yx}) showed an adequate goodness of the adjustments [mother Gyr (R^2 = 0.773; S_{yx} = 9.88), mother Brown Swiss (R^2 = 0.958; S_{yx} = 6.00), Mother Jersey (R^2 x 0.967; S_{yx} = 5.54) and Sahiwal mother (R^2 = 0.975; S_{yx} = 3.85)]. Regression equations corresponding to the different groups are listed in Table 2.

Table 2. Regression of the different groups of different mother genotype.

Mother Gyr	Y= 5,676 * X + 321,2
Mother Pardo suizo	Y= 8,884 * X + 342,5
Mother Jersey	Y= 9,347 * X + 307,5
Mother Sahiwal	Y= 7,488 * X + 321,7

Table 3. Ordinates of regressions of groups of different mother genotype.

Genotype	Ordinate	Registered weight
Mother Gyr	a= 321,2 Kg	319Kg
Mother Pardo suizo	a=342,5 Kg	350 Kg
Mother Jersey	a=307,5 Kg	308 Kg
Mother Sahiwal	a=321,7 Kg	324 Kg

Ordinate values at origin (body weight estimators at the beginning of gestation) showed no differences (p >0.05) with the observed values (Table 3). All the slopes were statistically different to zero (Table 4).

The analysis of covariance revealed a statistically significant difference in the value of the slopes (F = 5.018; p = 0.0058) of the different genetic groups, which prevented the comparison of the differences in height. Since the slopes are estimators of the daily weight gain rate throughout gestation, the observed difference between them highlighted a particular behavior of females resulting from Brahman x Gyr crossbreeding, showing lower weight gain in the period. When excluding this group from the analysis, the differences between the slopes of the three remaining genotypes were statistically non-significant (F = 2.845; p = 0.078), which allowed to calcu-

Table 4. Slopes of regressions of groups of different mother genotype.

Genotype	Regression	Significance
Mother Gyr	b $\pm$ S_b = 5,676 $\pm$ 1,088 kg/mes	F = 27, 2 p = 0,0008
Mother Pardo suizo	b $\pm$ S_b = 8,884 $\pm$ 0,661 kg/mes	F = 181 p <0,0001
Mother Jersey	b $\pm$ S_b = 9,347 $\pm$ 0,610 kg/mes	F = 235 p <0,0001
Mother Sahiwal	b $\pm$ S_b = 7,488 $\pm$ 0,423 kg/mes	F = 313 p <0,0001

late a slope common to all of them (bc = 8.573 kg/month) and compare the heights, which are statistically different (F = 99.4; p <0.0001).

4 Discusion

In Ecuador, as in other countries of the tropics and subtropics of Latin America, there has been a strong tendency to replace local breeds with exotic breeds in order to increase milk production levels. These breeds introduced in the area for breeding purposes come from regions where climatic and nutritional conditions are generally more favorable compared to those prevailing in the destination area, so their productive performance is negatively affected. Because of this, a genetic management strategy that local producers have resorted to is the use of crossbreeding between zebu breeds (*Bos indicus*) and European breeds (*Bos taurus*) in an attempt to minimize the adaptation problems (Tewolde, 1993; Madalena, 2012).

Despite their differences in the body size, all the genotypes evaluated in this work showed similar behavior in terms of growth pattern during their first gestation. This result agrees with the fact that weight increases during the breeding to the first milking of the four cross dairy genotypes analyzed were 0.201 kg/day, according to the region under study. None of the dairy crossings stood out above the other, all were similar (Quinteros et al., 2015).

The fact that the heifers under study do not differ in their weight gains during the first gestation regardless their genetic formation can be interpreted in terms of a negative genotype-environment correlation. According to this, the best genotype in terms of potential growth rate-crosses with Brown Swiss-receives the worst environment. This claim is based on the fact that, if the weight to pregnancy accounted for 65% of the adult weight of each maternal genotype, the calve weight should be 90% of the adult weight, with theoretical values for Brahman x Gyr of 441 kg, for Brahman x Brown Swiss of 538 kg, for Brahman x Jersey of 473 kg and for Brahman x Sahiwal of 498 kg.

This prediction differs from the results reported in this work, with observed body weights lower than the expected under this hypothesis (Table 1), and is in line with the limited atmosphere of the area. The high relative humidity and the high temperatures typical of the Ecuadorian Amazon are factors that negatively impact the cows, and according to Sánchez (2010); Arias et al. (2008), animals will produce to the extent that environmental conditions allow them to show their productive potential. The low yield value reflects the values resulting from the assessment of productive and reproductive variables used as indicators of their rate or level of economic profit and adaptation of animals, expressed as averages of age at first calve, interval between calves and postpartum estrum and milk production (Morales, 2009; Motta et al., 2012; Quinteros-Pozo and Marini, 2017).

The genotype with maternal Brown Swiss begins pregnancy at an earlier age (higher precocity), and these are maintained throughout pregnancy although the differences did not reach statistical significance with higher body weight. Most likely, an improvement in quality and in the amount of diet offered could increase the average daily weight gain. The reality indicates that this option is not always possible, hence, alternatives of using the elements available in the Amazon should be thought. In this regard, there are findings that show that weight gain values ranging from 600 to 750 grams per day would be optimal for future dairy cows, while lower values could cause a delay in puberty (Wathes et al., 2014; González-Stagnaro et al., 2007). However, these are works that have not been carried out in environments such as the Amazon, so the transfer of the results derived from them is not always possible.

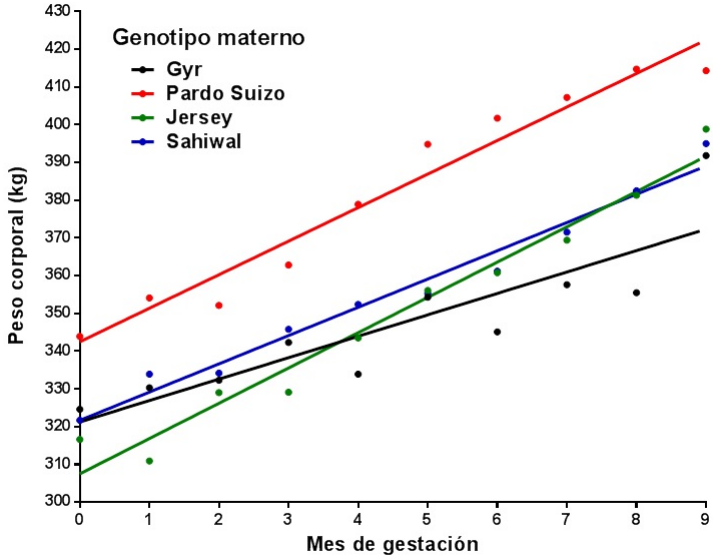

Figure 1. Linear growth pattern during the first gestation of cows crossed with Brahman paternal genotype and different maternal genotype in grazing conditions in the Ecuadorian Amazon.

5 Conclusion

The results confirm that the limiting environmental conditions in the Ecuadorian Amazon prevent the expression of the different genetic potentials of F1 heifers with Brahman father and different maternal genotype during their first gestation, resulting in a similar growth pattern in all of them. Considering that what is measured in animals is a phenotype resulting from the action of its genetic composition in the environment in which it is to express itself, the choice of a particular cross will be determined by the feasibility of offering an ambition nutritional status more in line with the requirements. The presence of a negative-genotype environment interaction indicates that it makes no sense to generate a population by crossbreeding whose growth potential and its correlation at the reproductive level cannot be expressed by limitations attributable to the environment.

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