Live Body Weight Evaluation of Four Genotypes of Dairy Heifers under Free Grazing Conditions in Ecuador

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ABSTRACT----

Objective: The aim of this study was to evaluate the evolution of body weight of four dairy genotypes under free grazing conditions in Canton Arosemena Tola, Napo Province, Ecuador.

Materials and methods: The individual body weight of 48 dairy heifers (12 per genetic group) derived from crossing Brahman bulls x Gyr (G), Brown Swiss (BS), Jersey (J) or Sahiwal (S) cows were recorded every 30 days between 15-17 months (December 2012) and 31-33 months (March 2014) of age.

Results: The Brown Swiss cross was the heaviest at beginning of the trial and maintained a significant weight difference (P≤0,001) until the last body weight record. No statistically significant differences between genotypes in daily weight gain (P> 0.05) were observed, showing the four genetic groups similar values for this trait (0.265 grams per day on average for the period analyzed).

Conclusions: The four genotypes showed monthly body weight gains values similar to those commonly observed in the region. They are insufficient to ensure a good start of the reproductive activity of females and impact negatively on the value of the same. None of them showed peculiarities related to this character that allows differentiating it from any of the other groups.

Keywords--- growth curves, development, tropical zones (*Source: CAB*)
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1. INTRODUCTION

In Ecuador, the same as in other Latin American tropical and subtropical countries, there has always been a tendency to replace local or native dairy cattle by exotic ones in order to increase milk production. Those breeds which have been introduced into the region for production improvement come from regions where weather and nutritional conditions are generally better in comparison to those of the zones of destination. Due to this, their yield is negatively affected. For this reason, the local farmers have implemented crossbreeding of Zebu cattle (*Bos indicus*) and European breeds (*Bos taurus*) in an attempt to reduce adaptation problems of the latter [8].

One of the most outstanding effects of inadequate adaptation is related to reproductive problems. Reproductive deficiency depends on a variable set of factors (physiological, nutritional, genetic, biological, sanitary and management among others), being visible especially after first parturition. For young heifers at their first breeding, the previous growth rate is particularly important, as it affects the beginning of sexual maturity and consequently determines the age for the first parturition. The beginning of the reproductive cycle depends more on body weight than age [7].

Considering the close relation between weight increase during the end of the heifers´ growth cycle and their age at the first service, a higher growth rate in the pre-reproductive phase is likely to enable breeding at lower age as well as reduce the cost of replacing females [7, 14]. On the other hand, a delayed puberty even partially related to insufficient weight during the growing-finishing phase, might have a negative impact on the economic value of the females as it diminishes the number of descendents they would normally produce during their reproductive life.

Tropical systems offer some comparative advantages. In such environments, productive strategies are based on using the abundant solar energy available for efficient photosynthesis by the fast-growing C4 forage species as water availability as well. The management systems, fodder quality and availability, as well as differential adaptation of some particular crossbreeding to these environmental specific conditions, play a crucial role in this productive context. High individual production which is actually the real objective of the genetic plans implemented in those systems with better intensification prospect, has become harmful to these environments in which those high-yield breeds health and fertility have been particularly affected [8].

The information referring to the behavior of productive and reproductive indicators for dairy cows in hot and/or humid climates in the tropical zone is not abundant [5] in particular, if compared to the profuse bibliography generated for similar products in temperate regions. As a rule, the existing works are limited to the use of Indian breeds (*Bos indicus*), especially American Brahman [1], being very rare the comparative studies of behavior with adequate nutritional control, the type of crossbreeding, the management mode and the monitoring of weather conditions likely to provide credible evidence of physiological answers from the animals under different tropical environmental situations [11, 4].

It is common that heifers at the end of their growth cycle, under low-tropical weather conditions with high rates of environmental temperature, variable humidity and solar radiation, would show metabolic and physiological changes linked related to late age and low body weight at the beginning of the reproductive activity, with difficult cyclical regularity and changes in the duration and intensity of oestrus and low bearing and fertility rate [4, 6].

Zárate-Martínez [18] registered weight increase around 0, 351 kg in dairy heifers Holstein/Cebú in tropical forage conditions, which are quite inferior to the 0, 850 kg per day registered in similar crossbreeding and forage conditions but in temperate zones [15]. The authors think the difference is due to the climate and low nutritional quality of the tropical fodder.

According to [2], under wet tropical conditions, female from Zebu and European crossbreeding start puberty at an earlier age than pure breeds, in a proportion of 15 and 19 months, respectively. The genetic variability within and between breeds result in differences in aging and body weight at the presentation of the first heat; such differences affect further reproductive events which end up being crucial for productivity [11,12]. For this reason, it is important to work with breeds adapted to these particular conditions, being able to overcome the productive limitations existing in *Bos taurus* in these zones. As a matter of fact, it has been revealed that cows resulting from Brahman /*Bos taurus* crossbreeding, present higher fertility, milk production and longevity other than those of pure *Bos taurus* genotype. However, with the increase of breeds with Indian blood, they tend to delay puberty age and furtherly this cause a negative impact on their reproductive behavior. It has been observed [16] that cows produced from Brahman/*Bos taurus* crossbreeding are unable to produce a replacing female which would keep their own productive performances, as a consequence of the loss of heterosis regarding to the one expressed in F1.Taking into account the impact of the heifers growth rate on their future productivity and the search for a strategy that would make possible the combination of adaptation and productivity efficiency, the aim of this study is to evaluate the evolution of the body weight of four dairy heifers genotypes kept under the same free range grazing tropical conditions.

2. MATERIALS AND METHODS

Design and study target population.

The dynamic behavior of the body weight of four crossbred dairy heifers' genotypes has been evaluated: *Brahman x* Gyr (G), *Brahman x* Brown Swiss (BS), *Brahman x* jersey (J) and *Brahman x* Sahiwal (S) belonging to the dairy herds of the Center for researching, postgrade and Amazon biodiversity conservation. (CIPCA in Spanish). The center is located in the canton of Arosemena Tola, in the province of Napo (Ecuador), Km 44 via Puyo-Tena (coordinates: S 01° 14.325´; W077° 53.134´) and has an area of 42 hectares of fodder devoted to growing-finishing phase. The environment is tropical with rainfall level of 400 mm, average humidity of 80% and temperatures ranges from 15 and 25 °C. Its topography is characterized by slightly waved reliefs with no steep hills, distributed over wide natural plateaux (uplands). The altitude ranges between 580m and 990m above sea level. The soils show a very heterogeneous composition, being most of them originated from the Andean river sediments The evaluated heifers came from the similar ranches and had been reared under the same environmental, nutritional and management conditions; they were introduced to CIPCA at the age of 15 to 17 months with body weights as follows: (average +_ EE) of 204

+_7,7 Kg (G); 276 +_ 11,0 Kg (BS); 204 +_ 8,7 Kg (J) and 186 +_ 6,0 Kg (S). All the animals have been weighed individually every 30 days, between December 2012 and March 2014.

Feeding and care.

The cow herd has been fed on free grazing with *Brachiaria decumbens* fodder (17,585 kg/MS /ha/year, Protein: 10% Phosphore: 0,18; DIV: 44,4%), *Brachiaria brizantha* (26,970 Kg MS/ha/year, Protein: 10,1%; Phosphore: 0,18%; DIV: 44,1%), , *Arachis pintoi* (6,212 Kg MS/ha/year; Protein: 19,4%; Phosphore: 0,21%; DIV: 59,2%), *Desmodium ovalifolium* (5.890 Kg MS/ha/year; Protein: 16,3%; Phosphore: 0,16%; DIV: 39,6%) y *Stylosanthes guianensis* (15.237 Kg Ms/ha/year; Protein: 21,4%; Phosphore: 0,4%; DIV: 48,7%). It has been applied the health management commonly used for the cattle herd of CIPCA. It includes de-worming, ticks and mosquitoes, foot-and-mouth vaccine, cattle rabies and vesicular stomatitis and injectable administration of vitamins and minerals.

Data Analysis

Performance of the average body weight.

The body weight registration for all the four groups of animals started at the age of 16 weeks or 480 days aprox. And from that moment, it has been taken 17 times at a 30-day constant interval up to 32 weeks.

The transversal data body weight average –age have been represented on an Orthogonal Cartesian coordinate system (Y: average body weight in Kg; X: chronological age in weeks) and they showed a behavior fully compatible with a linear model which has been tested through a Runs test.

The pairs of values average weight-age have been adjusted according to a linear regression adjustment and the resulting regression lines have been compared through an analysis of covariance.

3. RESULTS

The experimental data showed a linear behavior with age. None of the four groups omitted the linearity hypothesis (mother Genotype – Swiss duns; P =0,413; Gyr : P= 0,646; Jersey; P= 0, 821 and Sahiwal: p= 0, 791).

All the gradients were positive and significantly different from zero (0) (P<0,0001). (Mother Genotype – Swiss duns: b = 0,2083 different 0,00956; Gry; b = 0,1865 different 0,00671; Jersey: b = 0, 2080 different 0,00629 and Sahiwal: b = 0, 2010 different 0,00744).

The comparison of the regression lines showed no statistically significant differences between the gradients (F= 1,815; P= 0,157) which made possible the calculation of common gradient for the four genetic groups 8b common = 0,201 Kg/day and also the comparison of heights (intercepts). These latter showed statistically significant differences 8F= 1214; P<0,0001) due to the behavior of the mother genotype –Swiss duns crossbreeding which started the test with a weight that was significantly higher. (analysis of variance at one classification criterion: f= 21,3; P<0,001 – Tukey's multiple comparison test. BS > G = J = S) maintaining this difference along the probationary period (Chart 1)

4. DISCUSSION

The data sequence showed an anormality in weights after 720, 750 and 780 days with a common behavior to the four genotypes (the average weight decreases after 720 days, reaching a minimum after 750 days and started a recovery increasing at 780 days and retakes the previous tendency after 810 days). The elimination of those points (Chart 2) did not affect the result of the analysis which has been kept going in the final calculation

The livestock production has contributed to the regional development of many Latin American countries and thus influenced the possibilities to adopt new productive strategies. In Ecuadorian Amazon, 82% of the farming area is destined to pasture land, which put in evidence the importance of livestock activity into the rural economy. The low inputs grazing systems are prevailing for the ruminants in this region with three methods of livestock production: outfield grazing, electric fence grazing and rope grazing. During the last decades many an aspect has been improved such as forage species, fertilizers, rational management of pastures, production patterns and forage conservation, artificial irrigation, animal feed on new agricultural byproducts, use of concentrates and mineral supplement, vaccination and healthcare. As far as the purpose of animal Breeding production is to obtain better phenotypes whereas scientific progress involves only the environmental component of the referred phenotype, it is necessary to better the process by using more efficient genotypes and better adapted to these new circumstances [8].

The system that has been analyzed in this study is the electric fence grazing. The results obtained coincide with those found by other authors [3], which registered an average increase in weight of 0, 278 gr/day.

All the genotypes evaluated showed a similar behavior, in spite of their differences in size. The fact that the heifers under study showed no differences in daily weight increase against their genetic constitution can be interpreted in terms of negative genotype-environment correlation. According to the best genotype in terms of growth rate – Swiss buns breeding,

All the genotypes evaluated showed a similar behavior, in spite of their differences in size. The fact that the heifers under study did not show any difference regarding their daily weight gain in spite of their genetic constitution can be interpreted as a negative genotype-environment correlation.

According to this, the best genotype in terms of Swiss crossbreeding growth rate corresponds to the worst environment comparatively. The nutritional environment (direct grazing) might impose a limit on the heifer's growth rate, generating thus kind of uniformity in the referred variable (equal gradients) as it reduces the ability of each genotype to express its own potentiality.

Probably, an improvement in the diet quality offered could increase the average daily weight gain. The truth is that this option is not always possible, so other alternatives should be considered through the use of the elements that are available in the Amazon region. Regarding this, it has been previously proved that the weight gain values ranged between 600 and 750 grams per day would be right for the future milk cows and that lower values might delay puberty [17]. However, it refers to works which have been performed in zones different from the Amazon; therefore the transfer of the results derived from them is not always possible.

Although the grazing heifers could select the fodder they use as the grass used does not always provide their requirements for nutrients, especially those energetic (temperate fodder with a 2,5 Mcal/Kg/ MS average digestible energy and tropical fodder with a 1,4 Mcal/Kg/MS digestible energy. The high competitiveness of this system is related to the forage species growth seasonal pattern in use, which basically depends on appropriate humidity, rain and soil fertility. This was observed about the discontinuity in average weight increasing values during the analyzed period. Reaffirming the specific features of the free range grazing systems in which an increasing daily weight gain is hard to reach as it depends on environmental factors and fodder quality. The months of July and August, corresponding to weighing 8 and 9, showed the best weight values which were negative as they corresponded the driest months of the region. On the opposite, September and October which corresponded to weighing 10 and 11, showed the higher weight gains with values amounting to 20 Kg (650 gr/per day).

It is not strange that the information generated under confinement conditions in temperate zones, cannot be applied properly to animal on direct grazing in tropical meadows. In these conditions, grazing animals have an additional expense of energy, compared to house indoors animals directly connected to the full impact of the environmental variables.

According to studies carried out in the humid tropical zone in Costa Rica, an increase from 5,5% to 13% of the protein amount in the heifers´ food supplement, increased the number of corpus luteum animals, whereas no effect was registered on weight gain and corporal condition either [10]. However, other studies showed that the protein supplement in tropical forage improve the daily average weight gain and tend to increase the number of ovulating animals within a synchronization program [13].

The milk production in low-cost grazing is grounded on the use of the prairies growing with low utilization of supplies and labour, in other words, through the exploitation of grass as a basic food supply and a high number of cows per person in charge [10]. The key components for productivity in a grazing system are the dry matter production per area unit, its energy and digestible protein content, and growth pattern as well. Thus, in order to raise farming net profits, it is necessary to reach high efficiency in the utilization of the forage animals are fed on, and a genotype adapted to the system.

In conclusion, the monthly weight increase of the dairy genotypes considered fits our expectations for the region under the existing environmental and nutritional limitations. Under usual management conditions, the latter might be inadequate to ensure a good start of the female reproductive process as they negatively impact their values. None of the milk crossbreeding performed were clearly better, all of them showing parity in this aspect.

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Table 1. Initial body weight, weight body end and crosses daily gain of body weight (mean ± standard error) of four genetic groups of heifers grazing in the Ecuadorian Amazon

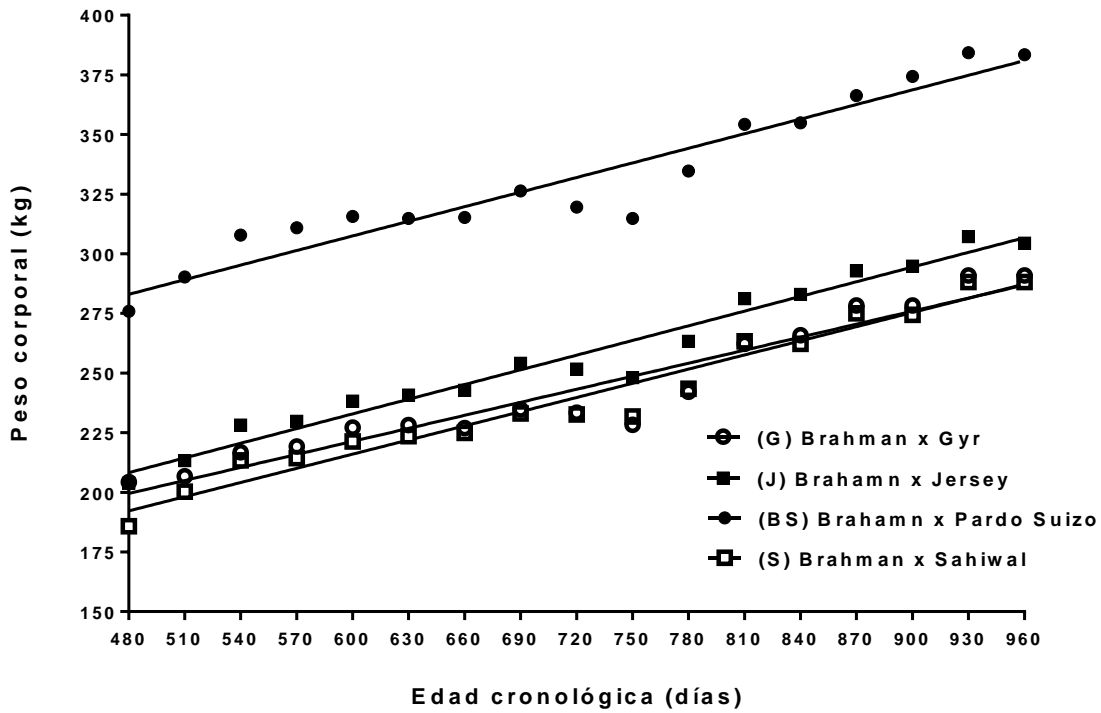| Genotype	Initial body weight (kg)	Final body weight (kg)	Daily gain (kg/day)
G	204 ± 7,7 a	291 ± 11,6 a	0,190 ± 0,030 a
J	204 ± 8,8 a	307 ± 13,2 a	0,230 ± 0,011 a
BS	276 ± 11.0 b	384 ± 10,7 b	0,240 ± 0,020 a
S	186 ± 6,4 a	288 ± 7,0 a	0,220 ± 0,010 a
G: Brahman x Gyrolando; J: Brahman x Jersey; BS: Brahman x Brown Swiss; S: Brahman x Sahiwal a,b Values with different letter differ at least 0.05 for comparisons between genotypes			

Figure 1 - Modification of body weight as a function of chronological age (linear setting) of four genetic groups of heifers grazing in the Ecuadorian Amazon crosses
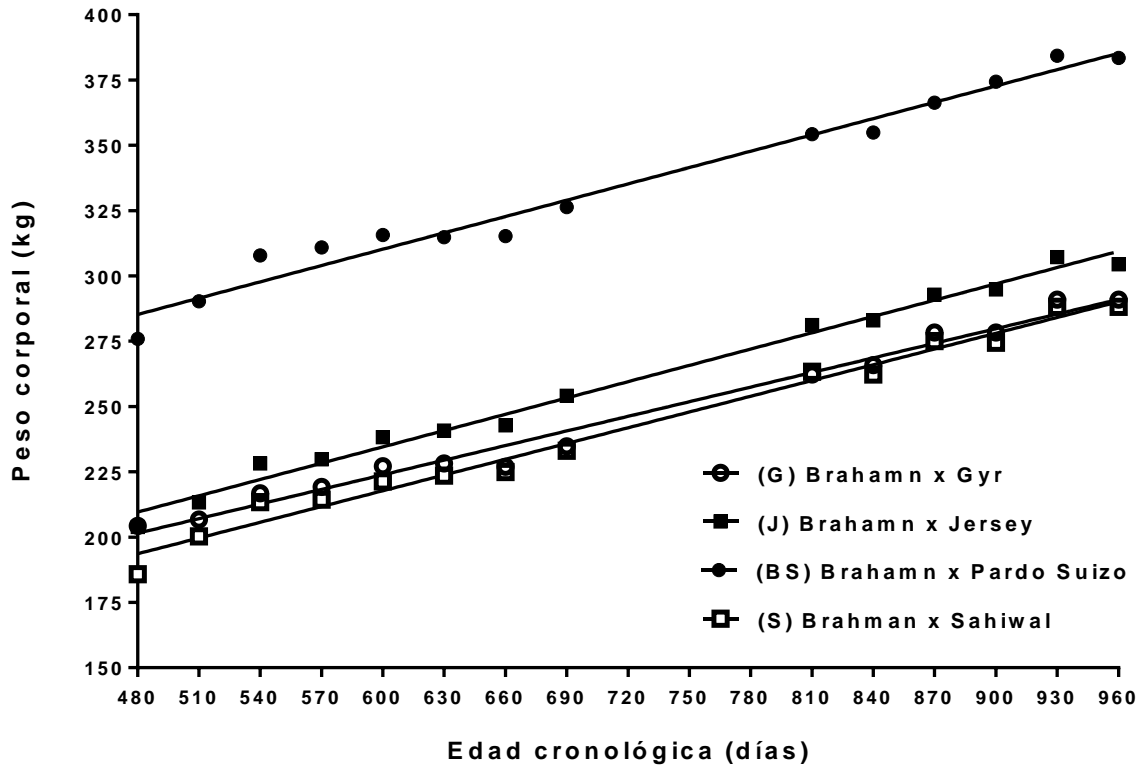
Figure 2 - Change of body weight as a function of chronological age (linear fit without considering the records corresponding to the months of August, September and October 2013) of four genetic groups of heifers grazing in the Ecuadorian Amazon crosses