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Indicators of Efficiency in Four Milky Genotypes in Outdoor Pasture Conditions in the Ecuadorian Amazonia

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Abstract

The aim of this work was the evaluation of four milky genotypes at first lactation in outdoor pasture conditions through indicators of biological efficiency in the Canton Arosemena Tola, Province of Napo- Ecuador. 36 milky cows at first deliver crossbreeds of different genotypes (Bos Indicus x each genotype used): Bos Indicus x Gyr (Gyr), Bos Indicus x Brown Swiss (BS), Bos Indicus x Jersey (J) and Bos Indicus Sahiwal (S). For the productive variables studied there were no significant differences ($p \geq 0.05$) among the four genotypes. For the reproductive variables analyzed there were significant differences ($p \leq 0.001$) among the four genotypes studied as regards the age at first delivery. Concerning the rest of the variables there were no significant differences ($p \geq 0.05$). Neither were there significant differences ($p \geq 0.05$) of weight at delivery among the four genotypes; however differences appeared 90 days after the delivery ($p \leq 0.01$) and at healing ($p \leq 0.01$). It is concluded that the four genotypes studied behave in a similar way, in agreement with the region of study. None of the milky genotypes studied stands out from the others, showing a similarity in this aspect.

Keywords: genotypes, production, reproduction, pasture system

1. Introduction

The huge increase in the productive performance and the size of the modern high production cows has been possible due to the repeated and asymmetric use of a selection exclusively based on milk production. Even though this process has been accompanied with modifications on the nutritional ground, these have not been enough to avoid the deterioration of vital functions, such as reproduction and survival (Camargo, 2012). The consequences of such a statement clash with the proposals declared in a more general vision of milk production (Molinuevo, et al., 2005) which emphasizes on the adjustment there must be between the genetic potential of a certain productive species and the characteristics of the environment where such a species must show that potential. Low supply pasture systems have advantages that should be considered. The litres of milk a cow produces do not represent the most appropriate indicator in order to make a complex variable like productive operational efficiency and should therefore be replaced by other types of indicators which constitute a more comprehensive measure of production. Considering indicators of this kind would contribute to avoid the overvaluation of one of the characters involved in the characterization of a good milky cow and would allow the identification of biotypes better adapted to the Amazonia. The crossing of milky cattle has become a point of real interest as an answer to the worries of milk producers as regards fertility, health and survival of specialized cows. In the crossings producers mean to exploit the favourable characteristics of alternative races, to eliminate the negative effects associated to inbreeding and to take advantage of a phenomenon known as heterosis. Recent results of investigations clearly show higher fertility and survival range in cross breeding cows (Buckley, 2014). However, when it comes to deciding on what cattle breeds to cross for the Ecuadorian Amazonia, only few productive variables are used; and variables of biological efficiency - which would contribute to make a better decision - are not implemented. The aim of this work was the evaluation of four milky genotypes at first lactation in outdoor pasture conditions through indicators of biological efficiency in the Canton Arosemena Tola, Province of Napo-Ecuador.

2. Materials and Methods

2.1 Design and Population of Study

It was evaluated the productive and reproductive behaviour of 36 cows of four milky crossbreed genotypes at first lactation during 2014-2015 Brahman x Gyr (Gyr), Brahman x Brown Swiss (BS), Brahman x Jersey (J) y Brahman x Sahiwal (S) belonging to the milky rodeo of the Postgraduate Investigation Centre and Conservation of the Amazonian Biodiversity (CIPCA). This centre is located in the canton Arosemena Tola in the province of Napo (Ecuador), at kilometer 44 in the Puyo-Tena way (coordenates: S 01 °14.325 ´;W077 °53.134 ´). It has a surface of 42 hectares of pastures used for the milk industry. It has tropical climate with 4000 annual mm of rainfall, a relative humidity of 80% and temperatures between 15 and 25 °C. Its topography consists of mainly lowlands with no steep slopes, distributed in huge natural plateaus. Its altitude varies from 580 to 990 metres above sea level. Even though the soil presents a highly heterogeneous composition, most of it is originated in fluvial sediments which come from the Andes region of the country. The cows which were evaluated were all raised under the same environmental, nutritional and handling conditions. These entered the CIPCA premises at 15-17 months of age and with an average weight (average ± EE) of 204 ± 7.7 kg (Gyr); 276 ± 11.0 kg (BS); 204 ± 8.7 kg (J) y 186 ± 6.0 kg (S).

2.2 Handling

Productive data was obtained from their own milky control every fortnight the first 60 days and every month afterwards. Cows were milked once a day at 7:00 am, with the assistance of its calf in order to stimulate milk ejection. During the process, all cows were handled in the same milking premises. All cows were inseminated with semen from proofed bulls. Cows were weighed at delivery, 90 days afterwards and at healing. This procedure was carried out at the same time (after milking), and the three times with the same calibrated mechanical scale. The physical and chemical analysis of the milk was carried out during the milk control, collecting 200 ml of milk per cow, these samples were placed in glass jars properly labeled with the number of the animal and the genotype they belonged to; they were later transported and stored at 4 ℃ till its processing, in order to determine: density, fat percentage, total solids percentage, non-fatty solids percentage and protein percentage using an ultrasonic milk analyzer LACTOSCAN® previously calibrated and compared with standard methods.

2.3 Food and Sanity

The bovine herd under study was fed on outdoor pasture, with a base of 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%). The sanitary management was the one that is habitually used in the bovine rodeo of CIPCA, which includes: deparasite treatments, baths against mites and flies, vaccinations against food and mouth disease, bovine rabies and vesicular stomatitis plus vitamins and minerals injections.

2.4 Variables Used

- Milk production at first lactancy (pl_{150}) in litres: $\sum l_{c1}$ x 30.5 where lc are litres produced in the j-th milk control of first lactancy, 30.5 the average number of days a month till the 150 days of lactancy.
- Consumption of dry matter (CMS_{150}) in kg: Kilograms of dry matter consumed to the 150 days of lactancy.
- Production of proteins in kilograms (KP_{150}): Kilograms of total protein at 150 days of lactancy.
- Weight (P): individual average weight in kg.
- Consumption of dry matter per milk production (CMS_{150} / PL_{150}) in kg: kilograms of dry matter per daily litre of milk.
- Consumption of Dry Matter per Production of Protein (CMS_{150} / KP_{150}) in kg: Kilograms of Dry Matter per kilograms of daily protein.
- Milk index, defined as the daily milk production of cows and calculated as the quotient between the total milk production (PL_{150}) of each cow throughout its first lactancy and the number of days required in order to produce that from its birth. (PL_{150} / days between birth and healing) in litres: litres of milk per day.

2.5 Data Analysis

Averages and standard errors were estimated for the variables mentioned. The analysis of variability was carried out through a classifying criteria and tests of multiple comparisons HSD of Turkey-Kramer HSD among the genotypes in order to prove whether there were significant differences ($p \leq 0.05$). The final production was related to the production of each genotype, through a dispersion graph IL and PL_{150}, and a curve was adjusted from the estimation of parameters of the model. All statistical analyses were carried out using the programme JMP in its version 5.0 for Windows (JMP®, 2003).

3. Results

Chart 1 shows that there are significant differences ($p \leq 0.05$) as regards CMS_{150} y CMS per day, and this is mainly due to the cows' weights. In relation to PL_{150} there were no significant differences ($p \geq 0.05$) among the four genotypes under study.

Chart 1. Averages and standard errors of indicators for the four genotypes

Genotype	CMS_{150} (kg)	CMS/day (kg)	PL_{150} (litres)
BS	1304.4 ± 77.8 a	8.7 ± 0.51 a	1010.5 ± 26 a
J	1096.3 ± 73.5 ab	7.3 ± 0.48 ab	998.7 ± 44 a
S	1072.7 ± 53.0 ab	7.2 ± 0.35 ab	1003.8 ± 52 a
Gyr	975.1 ± 53.0 b	6.5 ± 0.35 b	983 ± 42 a

Note: different letters in a same column ($p \leq 0.05$)

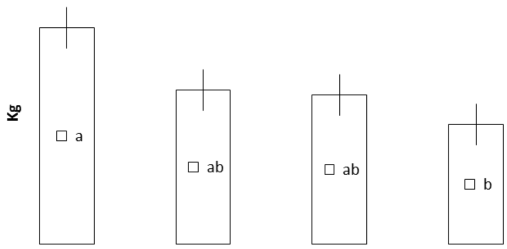

Figure 1. Averages and standard errors of indicators for the four genotypes

In Figure 1 significant differences ($p \geq 0.05$) can be seen in the weights among the four genotypes, being BS the heaviest (381 ±11), J (344 ±12) and S (341 ±13) the intermediate ones and Gyr (323 ±16) the lightest.

Chart 2. Averages and standard errors of indicators for the four genotypes

Genotype	CMS_{150}/PL_{150}	Pr_{150} (kg)	CMS_{150}/Pr_{150}	IL (litres)
BS	1.29 ± 0.07 a	33 ± 1 a	40 ± 3 b	0.80 ± 0.03 a
J	1.11 ± 0.03 a	33 ± 1 a	34 ± 2 ab	0.76 ± 0.02 a
S	1.09 ± 0.09 a	33 ± 2 a	33 ± 3 ab	0.71 ± 0.04 a
Gyr	0.99 ± 0.06 a	33 ± 2 a	30 ± 2 b	0.72 ± 0.03 a

Note: different letters in a same column ($p \leq 0.05$)

Chart 2 shows there are no significant differences ($p \geq 0.05$) as regards CMS_{150}/PL_{150}, Pr_{150} (kg) y IL. However, there are significant differences ($p \leq 0.05$) as regards CMS_{150}/Pr_{150} among the four genotypes.

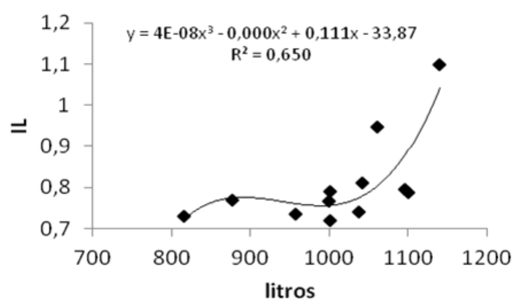

Figure 2. Relation between milk index and first lactancy production adjusted for Brown Swiss

Figure 2 shows the relation between milk index and production adjusted at 150 days for Brown Swiss, where the best adjustment was achieved with a polynomial regression of third order (R^2=0.65). There is a group with low production and low IL, another with medium production and low IL and a third group with high production and high IL. This shows there are cows with different biological efficiency.

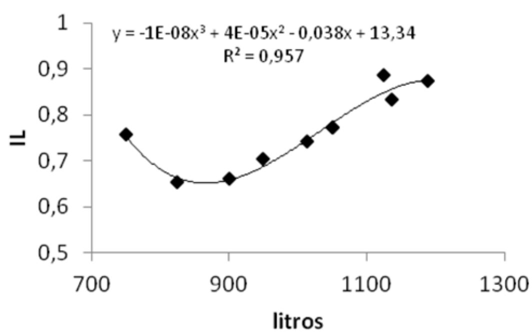

Figure 3. Relation between milk index and first lactancy production adjusted for Jersey

Figure 3 shows the relation between milk index and production adjusted at 150 days for Jersey cows; where the best adjustment was achieved with a polynomial regression of third order (R^2=0.95). There is a group with low production and high IL, another with medium production and low IL and a third one with high production and high

IL. This shows there are cows with different biological efficiency.

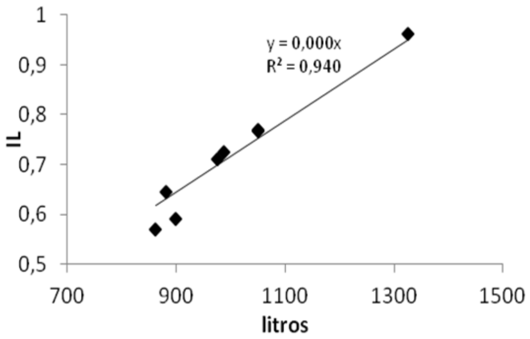

Figure 4. Relation between milk index and first lactancy production adjusted for Sahiwal

Figure 4 shows the relation between the milk index and production adjusted at 150 days for Jersey cows, where the best adjustment was achieved with lineal regression (R^2=0.94). The higher the production, the higher the biological efficiency as IL.

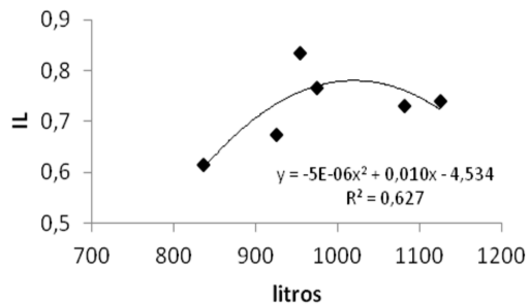

Figure 5. Relation between milk index and first lactancy production adjusted for Gyr

Figure 5 shows the relation between the milk index and the production adjusted at 150 days for Jersey cows, where the best adjustment was achieved with a polynomial regression of second order (R^2=0.63). There is a growth and then a decay, where the most productive is not the most biologically effective.

4. Discussion

Focusing on production lets aside other important components of pasture systems and low supplies. Therefore, other selection criteria should be used taking these into account, which would let cows adapt better to conditions of limited resources, with lower production level, long lasting, at lower costs and mainly with a really high reproductive capacity. Milk production at first lactancy can be used as an estimator for the future productive behavior, incorporating concepts of *performance* (giving value to a cow through indicators of biological or economical productivity) and efficiency (keeping the relation product-supply cost stable in long periods of time) (Camargo, 2012). The real efficiency of milk production, according to, is the proportion of nutrients in the diet which turns into milk (and its solid components) leaving aside the nutrients which come with the catabolism of tissues or will become part of them and the maintenance requirements, claims that the efficiency in the use of protein and energy in the diet diminishes as milk production increases because marginal efficiency is not constant per unit of milk produced; the question that arouses is whether this principle applies to both high genetic merit cows as well as cows with lower potential of milk production, since a lower milk production would imply higher efficiency in the use of food. Being that so, those who focus on selection by milk production would be obliged to measure and quantify that possible loss of efficiency (biological and economical) so as to protect their genetic position. The efficient use of pasture in low supply systems is a determining point in order to guarantee a higher productivity and a reduction in production costs, and therefore using indicators of efficiency would become highly important. The results of CMS per breed (2% to 2.3%) are within the normal values for the region and coincide with the ranges cited by (Ramírez-Cerdas, 2013), who found consumptions which go from 2.3% till 3.2% of the PV, and are above those reported by (Berchielli et al., 2000) , of 1.59% of the PV. Milk production is maintained within the results obtained by other authors who analyzed the tropic area (Román-Ponce et al., 2013). Feeding costs make up for almost 80% of the total cost of operation and about 50% of the total cost of milk production (USDA-NASS, 2011). Therefore, the strategies which reduce food requirements of rodeos could have important implications for the sustainability of milk producers. Live weight (PV) is the basis for evaluating growth rates, the answer of animals to different diets and to the environmental conditions and for determining the food requirements. Knowing the animals' weight and its changes is also important in determining the answers to genetic selection (Lukuyu et al., 2016), and is a key management tool (Dingwell et al., 2012; Bretschneirder et al., 2014; Ozkaya et al., 2009; Lukuyu et al., 2016) The values corresponding to the weights at delivery of the four genotypes are below those presented by (Martínez-Tinajero et al., 2006; Osorio-Arce et al., 2008; Holgado et al., 2014), and that can be explained because of a low weight gain obtained during recria: Gyr (0.190±0.03), J (0.230±0.01), BS (0.240±0.02) y S (0.220±0.01) grams. Considering Chart 2, we can take the values of BS and Gyr to analyze and we can see how Gyr consumes 32 % MS less than the BS, which is the biggest consumer, and needs 25% less CMS to produce one kilogram of Protein than the BS and needs 30 % less MS to produce one litre of milk. That shows that incorporating the indicators of efficiency helps to understand more widely the behavior of the genotypes, showing the advantages that lighter and smaller animals have in pasture systems; while J and S show an intermediate behavior as regards the indicators analyzed. Figures 1 to 4 show three different behaviours as regards Milk Index, Figure 1 and 2, show that genotypes BS and J behave similarly, showing that within the breed there are three groups of cows: those which produce low PL_{150} and have a low IL, those with low IL and intermediate PL_{150} and lastly those with high PL_{150} and high PL. Figure 3, shows that in S cows, the higher the PL_{150}, the higher the IL. Lastly Figure 4 shows a particular behavior for Gyr cows, where a higher individual production does not necessarily indicates a higher IL. Although there is a tendency-the higher the production, the higher IL- this tendency tends to decrease and annul in the category of highest production (Figure 4). At least for this genotype, a greater individual production does not guarantee a higher production (PL_{150}) or a higher productive efficiency when considering the time implied for producing a certain quantity of litres IL.

5. Conclussion

It is concluded that the four genotypes studied behave in a similar way with some indicators, and with others the Gyr outstands the others.

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