Scientific Paper

Effect of biotype on the productive performance and beef quality of bulls under silvopastoral system conditions

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Abstract

Objective: To evaluate the effect of biotype on the productive performance and beef quality of bulls under silvopastoral system of *Leucaena leucocephala* (Lam) de Witt variety Perú.

Materials and Methods: Fifteen animals were used per treatment during 195 days of the dry season (October-May). Two treatments were designed: 1) genetic group *Zebu* under grazing *ad libitum* + energy complementation, 2) genetic group *Siboney de Cuba* under grazing *ad libitum* + energy complementation. A mixed linear model was applied, in which the biotype was included as fixed effect, and the system and residual error as random effects. The live weight, average daily gain, weight increase and yield per hectare were determined. On the samples taken from the *Longissimus dorsis* muscle, the beef color, as well as water holding capacity and acidity, were measured.

Results: Differences were found ($p < 0,05$) for the weight at slaughter, mean daily gain, weight increase and yield per hectare, in favor of the *Zebu* genotype. The acidity, luminosity, red and yellow pigmentation of the beef did not differ from one group to the other. Differences were found ($p < 0,001$) in the concentration of acids C18:0 and C18:1, with the highest values in the *Zebu* genotype. Significant differences were also observed ($p < 0,001$) in the concentration of myristic and palmitic acid (C14:0 and C16:0, respectively). However, the highest amount was obtained in *Siboney de Cuba*.

Conclusions: The *Zebu* group, under the conditions of this research, showed better productive performance, although between both groups there were instrumental values of beef quality which were close; nevertheless, in both genotypes, the percentage values of saturated, unsaturated and polyunsaturated fatty acids were similar.

Keywords: Bovinae, quality, beef, *Leucaena leucocephala*, animal production

Introduction

The introduction of *Leucaena leucocephala* (Lam) de Witt (leucaena) shrubs in grasslands to promote silvopastoral systems aimed at cattle fattening constitutes a feasible productively and economically technological variant, if it is compared with finishing in grasslands (Iglesias *et al.,* 2017; Yadav *et al*., 2019). Nevertheless, several studies conducted in Cuba with different combinations of *L. leucocephala* and grasses corroborate that in these systems the metabolic energy contribution limits animal productivity (Iraola *et al*., 2016).

Iraola *et al*. (2017) developed a study in which they used an energy complementation based on *Saccharum officinarum* L. (sugarcane), combined with different levels of beneficial microorganisms (MEBA), for finishing *Zebu* bulls in silvopastoral systems with *L. leucocephala* in the rainy season (June-September) and obtained an individual gain higher than 0,850 kg/day. However, reaching daily gains higher 0,700 kg, at the lowest possible cost, in silvopastoral systems in the dry season, with the prevailing genotypes in commercial animal husbandry in Cuba, is a technological variant that can contribute to the development of the animal husbandry sector aimed at beef production. The objective of this work was to evaluate the effect of biotype on the productive performance and beef quality of bulls under silvopastoral system conditions with *L. leucocephala* variety Perú.

Materials and Methods

Location and animal management. The research was conducted in experimental areas of the Institute of Animal Science (ICA, for its initials in Spanish), located at 22º 53' LN, and 82º 02' LW at 92 masl, in the San José de las Lajas municipality, Mayabeque, Cuba. The study was carried out in the dry season (October-May), with 195 days of duration, in the finishing of bulls under silvopastoral system conditions with *L. leucocephala*.

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Animals and treatments. Thirty whole male cattle, with 16 months of average age at the beginning of the experiment, were used. They were divided into two treatments of 15 animals, according to the genetic group: 1) *Zebu* (5/8 Holstein x 3/8 *Zebu*) in grazing *ad libitum* + energy complementation, 2) *Siboney de Cuba* in grazing *ad libitum* + energy complementation.

Experimental procedure. The animals from both groups did not need preventive medicines and were managed in a silvopastoral system of *Leucaena leucocephala* (Lam) de Witt cv. Peru, associated with cultivated pastures (*Cynodon nlemfuensis* Vanderyst), divided into eight paddocks each. The rotation was eight days of occupation and 56 days of resting. The animals had free access to the drinking troughs and salt deposits. They were supplied in grazing 80 g/animal/day of mineral salts and were complemented with 2 kg/animal/day of *Zea mays* L. meal and fresh *S. officinarum* (variety C86-12), at a rate of 6 g DM/100 kg/LW with 1 % urea, plus water at will. They were weighed every 28 days with a digital scale (CEMA model, made in Cuba, of 1 000 kg).

When the average age of 24 months was reached in the two treatments, the animals were transferred to the Experimental Center of Meat processing of ICA. They were kept without feed during 24 h, with access to water and shade. Afterwards, they were slaughtered according to the technical regulations established in this center. After slaughter, the carcasses were reserved for 24 h between 6 and 7 ºC. Later, they were transferred to a deboning room and *Longissimus dorsis* samples were taken to perform instrumental analyses on the beef.

Measurements. The live weight (initial and final), mean daily gain (MDG), weight increase (WI) and yield per hectare, were determined. To the samples taken from the loin, cut between the tenth and the twelfth rib, the beef color was measured at 24 h with the aid of a colorimeter (CROMA-MATER® model). The water holding capacity and acidity were determined in the laboratory of ruminants of the ICA. The concentration of long-chain fatty acids was also analyzed through analytical techniques in the laboratories of the National Center of Scientific Research of Cuba (CNIC). In addition, the conversion efficiency of supplement intake (sugarcane and corn meal) was calculated through offer-refuse and the conversion efficiency of total intake was estimated, according to the tables proposed by Martín and Palma (2017).

Mathematical analysis. A mixed linear model was applied and the macro *GLIMMIX* was used through the software SAS®, version 9.3 (2013). In the established model, the treatment was considered as fixed effect. The system, nested animals within the system and residual error were considered random effects. The model equation is shown below:

$$Yijkn = \mu + T_i + \beta_j + \alpha(\beta)kj + e_{ijkn}$$

Where:

Yijkn = (μ) value of the indicators

μ = general mean or intercept

T_i = fixed effect of the i-eth treatment (i=1 y 2)

β_j = random effect of the j-eth system (j =1, 2)

$\alpha(S)_{kj}$ = random effect of the k-eth animal (n=1, 2,. . ., 15), in the j-eth system (1,2)

e_{ijkn} = random error associated to the observations

Variance analysis was carried out for the productive and carcass indicators. For the effects that were significant in the model ($p < 0,05$), multiple comparison test for the arithmetic means was performed, according to Duncan's test. The percentage value of the concentration of long-chain fatty acids in the loin samples was determined. The information was processed with the aid of the software SAS® (2013).

Results and Discussion

The evaluated indicators in the productive performance per treatment are shown in table 1. For the initial live weight (LW) no differences were found, but there were differences for the live weight at slaughter at 24 months, in favor of the *Zebu* group. Differences were also found ($p < 0,001$) for the MDG, WI and yield per hectare between treatments. With regards to these last indicators, all the values were higher in the treatment with *Zebu* (24, 18 and 12,4 %, respectively).

Zebu showed higher conversion efficiency for the complementation and estimated ration. The yield values per hectare did not exceed 750 kg LW. Similar results were reported by Iraola *et al.* (2017) with similar stocking rate (1,5 heads/ha) and MDG close to 0,900 kg, which could have been determined because the stocking rate limits the yield per hectare. However, studies of mathematical modeling conducted by Stuart *et al.* (2019) from research results under grazing conditions, focused on the stocking rate and production per hectare, corroborate that if these systems a stocking rate higher than the one in this study is used, the pastureland sustainability can be affected and, thus, the MDG in the animals is reduced.

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Table 1. Productive indicators of bulls under silvopastoral system conditions with *L. leucocephala*, supplemented with *Z. mays* meal and fresh *S. officinarum* in the dry season.

Indicator	Treatment		SE ±
	Siboney de Cuba	*Zebu*	
Initial weight, kg	275,0	283,0	0,710
Final weight, kg	422,1	464,1	0,670***
Weight increase, kg	147,1	181,1	0,380***
Cumulative gain, kg	0,750	0,930	0,010***
Yield, kg/ha	633,5	712,3	0,010***
Supplement conversion, kg DM/kg LW	5,1	4,3	-
Ration conversion, kg DM/kg LW	9,9	8,1	-

*** $p < 0,001$

Regarding the beef coloring in the loin samples, no differences were found in luminosity, red and yellow pigmentation of the beef and there were no differences in acidity either (pH). The values of these indicators were in the expected range for finishing cattle under grazing conditions, according to the report by Legako *et al*. (2018) and Peregrino-Peña *et al*. (2018); although difference was found ($p < 0,01$) for higher water holding capacity in the *Zebu* genotype. This superiority of *Zebu* (*Bos indicus*) could have been associated with its breed effect (Torres and Aranguren, 2014).

The percentage concentration of long-chain fatty acids (table 2) is in correspondence with the values of *Zebu* cattle and their crossings, fattened with bulky feedstuffs (Grompone, 2015; Torres and Afanador, 2018). Differences were found ($p < 0,001$) in the concentration of the acids C18:0 and C18:1, with the highest values in the *Zebu* genotype. Significant differences were also found ($p < 0,001$) in the concentration of myristic and palmitic acid (C14:0 and C16:0, respectively). Nevertheless, the highest quantity was obtained in *Siboney de Cuba*. Yet, the percentage relation of saturated and unsaturated fatty acids was similar between genotypes (table 3).

With regards to the omega 6:3 ratio, the *Zebu* genotype, under similar feeding conditions, was higher in 0,57 %. This value of omega 6:3 is in agreement with the findings by Torres and Afanador (2018) for grazing animals in Colombia, when evaluating crossbred genotypes and *Bos taurus*. The above-explained facts support the idea that with these genotypes and fibrous diets production of beef with adequate 6:3 ratio can be obtained in

Table 2. Percentage concentration of total fatty acids in the muscle *Longissimus dorsis* (mg/100 g of sample).

Classification	Name	Treatment		SE ±
		Siboney de Cuba	*Zebu*	
C14:0	Myristic	3,84	2,63	0,0008***
C15:0	Myristoleic	1,18	1,12	0,2629
C16:0	Palmitic	26,49	24,68	0,0075***
C16:1	Palmitoleic	3,98	3,79	0,1974
C17:0	Heptadecanoic	1,62	1,63	0,8985
C17:1	Cis-10-Heptadecanoic	0,77	0,74	0,2852
C18:0	Stearic	19,22	22,48	0,0003***
C18:1	Oleic	38,00	38,27	0,0001***
C18:2	Linoleic	2,27	2,89	0,2465
C18:3	Alpha-linolenic	0,97	0,99	0,9040
C20:0	Arachidic	0,78	0,78	0,3133

*** $p < 0,001$

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Table 3. Percentage relation of fatty acids in the beef.

Fatty acids	Treatment	
	Siboney de Cuba	*Zebu*
Saturated acids	53,13	53,32
Unsaturated fatty acids	43,53	42,80
Poly-unsaturated acids	3,24	3,88
Omega 6:3 ratio	2,34	2,91

Cuba. Its consumption could reduce the risk of cardiovascular diseases.

Conclusions

The *Zebu* group, under the conditions of this research, showed better productive performance, although between both groups there were instrumental values of beef quality which were close; nevertheless, in both genotypes, the percentage values of saturated, unsaturated and polyunsaturated fatty acids were similar.

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Authors' contribution

- Jorge Iraola-Jérez. Contribution to the conception and design, to the data acquisition, analysis and interpretation, wrote and revised the paper.
- Yenny García-Orta. Contribution to the conception and design, to the data analysis and interpretation, wrote and revised the paper.
- Luis Mateo Fraga-Benítez. Contribution to the conception and design, to the data analysis and interpretation.
- Fidel Monteagudo-Díaz. Contributed to the data acquisition, analysis and interpretation.
- Dainel Albelo-Chaves. Contributed to the data acquisition, analysis and interpretation.
- Jorge Luis Hernández-Báez. Contributed to the data acquisition, analysis and interpretation.
- Osvaldo Tuero-Tuero. Contributed to the data acquisition, analysis and interpretation.

Conflicts of interests

The authors declare that there are no conflicts of interests.

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