

Scientific Paper

Productive performance and behavior of grazing river buffaloes and Zebu bulls in a silvopastoral system

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Abstract

The objective of this work was to characterize the productive and ethological daily performance of cattle and buffaloes, raised together in the fattening stage, in a silvopastoral system which included *Megathyrus maximus* (Jacqs.) B.K. Simon & S.W.L. Jacobs cv. Likoni as basis pasture (85 % of the floristic composition of the pastureland) and the woody plant *Leucaena leucocephala* (Lam) de Wit cvs. Cunningham, Peru and CNIA-250, with a density of 555 trees/ha. The area was divided into eight paddocks, with initial and final stocking rate of 1,24 and 1,78 LAU/ha, respectively. The pasture yield was 4 325,0 kg DM/ha/rotation. Twelve buffaloes and 12 bullocks of 280,5 and 291,0 kg of live weight, respectively. At the beginning of the trial, they were monthly weighed and the mean daily gains and weight increase were estimated. For the ethological behavior, the considered variables were: time and percentage in pasture ingestion, rumination, water intake, among other activities. The buffaloes surpassed cattle in 0,714 kg in the live weight gain. Similar performance was found in the final weight, which was higher ($p \leq 0,05$) in the buffaloes, which finished with 425,2 kg, more than 30 kg over the bullocks. Statistically significant differences were found in the ethological behavior between species, where the buffaloes made a higher utilization of the established conditions in the system with trees, ruminated more and dedicated less time to grazing. It is concluded that both species dedicated more than 83 % of the day time to pasture consumption and rumination, with preponderance for the ingestion activity, for which the silvopastoral system can contribute to a good performance of both species.

Keywords: Bovinae, fattening, ethology

Introduction

Animal husbandry in Cuba has been characterized, in recent years, by the extensive and semi-extensive character of production. The expanse of marginal lands of the Cuban countryside allows the buffalo livestock to occupy floodable, coastal and other zones which are undesirable for cattle (CENCOP, 2014), where this animal provides throughout its life important primary products, such as meat and milk.

However, it is known that buffaloes can also be raised in zones where other species are grown, as long as baths and mudholes to control the body temperature (Caraballoso, 2017), but they can also thermoregulate under shade, particularly the one naturally supplied by trees and shrubs in the paddocks (Simón and Galloso, 2008), with the characteristic that, even under conditions of natural pastures, they are not as selectively as cattle and makes a better utilization of feedstuffs.

In this sense, the sowing of protein trees and shrubs in buffalo production plans or the incorporation of buffaloes to the areas with these woody plants constitute interesting options (Simón and Galloso, 2011), because these plants, besides providing shade and browsing feed of high nutritional value for the animals, could also control erosion, decrease environment pollution and be sources of energy, seed and timber (Toral *et al.*, 2015).

According to Marai and Haebe (2010), some differences have been observed between buffaloes and cattle regarding the anatomy and physiology of the digestive system, such as: length and capacity of the gastrointestinal tract, chewing type and quantity, rumination, rumen contractions, rumen ecosystem and fermentation (population of microorganisms, synthesis of microbial protein, pH, nitrogen recycling), as well as in nutrient digestibility and degradation.

On the other hand, Paul and Lal (2010) state that grazing buffaloes have the possibility of consum-

ing daily the same proportion of their live weight in organic matter as cattle, but they convert feed into meat more efficiently.

There is relatively little information about the performance of these animals under silvopastoral system conditions (Lourenço Junior *et al.*, 2010; Garcia *et al.*, 2011) and, although recent studies have advanced the knowledge about heat and shade tolerance (Sabia *et al.*, 2018; Wang *et al.*, 2018; Pezzopane *et al.*, 2019), so far cattle and buffaloes have not been evaluated together in a same tenancy system without immersion water or mudhole and there is no information about the behavior of these animals together under tree system conditions. For such reason, the objective of this work was to characterize the productive and ethological daily performance of cattle and buffaloes, raised together in the fattening stage, in a silvopastoral system

Materials and Methods

Geographic location of the experimental area. The study was conducted at the Pastures and Forages Research Station Indio Hatuey (EEPFIH), Matanzas province, Cuba. The geographic coordinates of the site are 22° 48' 7" North latitude and 81° 2' West longitude, at a height of 19,01 m.a.s.l.

Soil. The experimental area was located on a soil classified as lixiviated Ferralitic Red (Hernández-Jiménez *et al.*, 2015).

Climate. Some of the most important indicators of the climate conditions that prevailed in the study area are shown in table 1. The data were taken from the monthly records of the meteorological station located at the EEPFIH and are in correspondence with the report by INSMET (2016) for this region of the country.

Experimental procedure. Twenty four animals of 20 ± 2 months of age were selected, 12 buffaloes of

280,5 kg and 12 bullocks of 291,0 kg of live weight, according to complete randomized design, to evaluate the productive performance and behavior under grazing conditions in the daily hours during the rainy season.

The animals grazed together in an 11-ha silvopastoral system, composed by *Megathyrus maximus* (Jacqs.) B.K. Simon & S.W.L. Jacobs cv. Likoni (Guinea grass) as basis pasture (85 % of the floristic composition of the pastureland) and *Leucaena leucocephala* (Lam) de Wit (leucaena) cvs. Cunningham, Peru and CNIA-250, with a density of 555 trees/ha. The area was divided into eight paddocks, which allowed 4,5 rotations, with resting times of 40 days for each paddock. The stocking rate in the system at the beginning was 1,24 LAU/ha; while at the end of the study (180 days) it was 1,78 LAU. The average pasture yield was 4 325,0 kg DM/ha/rotation, with a CP content in the edible biomass of 11,5 %. In the case of leucaena the yield was not estimated, because the trees were more than 2,5 m high (they were not pruned) and the animals could not utilize their foliage through browsing. All the animals grazed from 6:00 a.m. to 8:00 p.m. and were confined in a pen during the night, for their protection. During the day the pen remained opened and had four circular drinking troughs, deliberately exposed to sunlight to reduce the permanence of the animals around them and prevent competition for water between the two species. In addition, they had two salt deposits with mineral salts *ad libitum*. The herd had access exclusively to shade; there were no mudhole zones for any of the species.

The buffaloes and bullocks were monthly weighed, in the morning, before entering the corresponding paddock for grazing. From this weighing the average daily gain was calculated.

Table 1. Performance of the climate variables during the experimental period.

Month	Rainfall, mm	Minimum temperature, °C	Mean temperature, °C	Maximum temperature, °C	Relative humidity, %
May	329,8	20,4	25,4	31,8	76,0
June	185,2	21,9	26,0	32,6	80,0
July	199,4	22,2	27,5	34,4	74,0
August	151,1	22,4	27,5	34,1	79,0
September	267,2	22,1	26,7	33,0	81,0
October	167,3	20,6	25,3	31,6	81,0
Average or total	1 300,0	21,6	26,4	32,9	78,5

In July, when the mean and maximum temperatures reached values of 27,5 and 34,4 °C and rainfall was around 200 mm (stressing factors in the behavior of grazing animals), the behavior measurements of the animals were made, for five consecutive days, every 20 minutes and during 14 hours. The number of animals dedicated to pasture ingestion, to water intake, to rumination, as well as to other activities, was estimated.

The times were represented as result of applying the equation proposed by Dumont and Petit (1995), which expresses the time used in each activity:

$\text{Time used in each activity} = \text{sum} (a_i \times n) / A$; where:

a_i : is the number of animals that perform the activity
 n : time between two successive observations and,
 A : total number of animals

The results related to animal production and behavior were analyzed through variance analysis, after adjusting the initial live weight. The compiled information was processed by the statistical package SPSS® 10.0.5. The difference among means was evaluated through Duncan's test (1955) for $p < 0,05$.

Results and Discussion

Table 2 shows the live weight gain of the two groups of animals, the buffaloes surpassed cattle in 0,174 kg. This caused the final weight to be higher too ($p \leq 0,05$) in the buffaloes, which finished with more than 30 kg over the bullocks.

Table 2. Productive indicators of buffaloes and Zebu bullocks under silvopastoral system conditions (kg).

Indicator	Buffaloes	Cattle	SE ±
Initial live weight ¥	280,5	291,0	2,18*
Final live weight	425,3	394,0	6,50**
Mean daily gain	0,775	0,601	22,32**

¥ Adjusted by covariance analysis to initial live weight of 285,6 kg

* $p < 0,05$; ** $p < 0,01$

Similar results regarding the differences between buffaloes and cattle were obtained in Cuba by Fundora *et al.* (2003); although the animals of this study grazed in a system based only on pastures, without supplementation, for which the gains were not high (0,567 and 0,352 kg/animal/day for the buffaloes and bullocks, respectively), and were lower than that of this research.

Joel *et al.* (2013) also reported for the Brazilian Amazonia higher production per hectare and better

carcass composition in the buffaloes with regards to cattle.

The gain (0,6 kg) of cattle in this trial is in correspondence with the one reported in the studies conducted in recent years by diverse institutions of the country with silvopastoral systems (Sánchez *et al.*, 2016; López *et al.*, 2017); while that of buffaloes is considered within the range of this species (0,7 kg) in different feeding systems with concentrate feeds (Fundora, 2015), because there are no evidences about their productive performance when trees are used.

Significant contribution to these results was propitiated by Guinea grass, which is a shade-tolerant species, which allowed it to maintain its floristic composition within the system in more than 80 %, with acceptable dry matter availability for the animals and crude protein values higher than 11 %.

Regarding behavior the buffaloes were observed to dedicate most of the day time to pasture ingestion and rumination; while they used the remaining time, mainly, to rest and other activities, such as transfer and water consumption (table 3).

Table 3. Time dedicated to the different activities under silvopastoral system conditions (%).

Activity	Species		SE ±
	Buffaloes	Cattle	
Ingestion	53,42	59,6	0,75*
Rumination	29,64	24,75	1,08*
Rest and others	13,78	14,28	0,68
Water intake	3,14	1,37	0,07*

* $p < 0,05$

The Zebu bullocks had a similar behavior; although they dedicated more time to the activity of pasture ingestion and less to rumination, which suggests that the latter activity was displaced to the night hours, when they were in the pen enabled for their safekeeping, as a mechanism of adjustment to the restricted grazing conditions of the research (Galloso *et al.*, 2008). Similar results were reported by Fundora *et al.* (2007), when evaluating river buffaloes and Siboney de Cuba cattle in the fattening stage.

In general, more than 85,0 % of the day time, the two species were dedicated to the most important activities for their physiology and metabolism: feed ingestion, rumination and water intake. These results

coincide with the ones reported by Fundora *et al.* (2007) in a research under confinement conditions, but with the particularity that these authors found higher rumination time in the buffaloes. This is in contradiction with the previous studies conducted under grazing conditions (Caraballosa *et al.*, 2011), where the feed ingestion activity in this species occupied more than 43,0 % of the time.

As it is observed, the buffaloes dedicated less time to pasture ingestion than cattle ($p < 0,05$), which coincides with the results reported by Fundora (2015) and could be related to the anatomical and physiological characteristics of these animals, which allow them to consume a higher quantity of feedstuff per time unit compared with cattle (Simón and Galloso, 2011). However, the time aimed at rumination was higher in the buffaloes; although, supposedly, they consumed lower pasture quantity. This result could be ascribed to the fact that the buffalo retains the consumed material in the reticulum-rumen for more time than cattle (Jorge and Francisco, 2011).

Another no less important aspect, which could have influenced this result, was the homeostatic balance of the animals, because it is known that shade in silvopastoral systems protects them from direct solar radiation and facilitates the heat loss mechanisms for the environment (Pezzopane *et al.*, 2019), mainly in buffaloes; thus, the latter can dedicate more time to rumination under the tree canopy, where the air temperature can be from 2 to 3 °C lower than under full sunlight, due to the positive interference of foliage on the passage of solar radiation (Moraes Júnior *et al.*, 2010).

Habitually, buffaloes are submerged in water at the hottest moments of the day, which is when the comfort status of this species is lower (Barros *et al.*, 2016). Nevertheless, in this research there were no mudholes and the circular drinking troughs located in the pen were deliberately exposed to sunlight,

for which the buffaloes approached them instinctively, submerged the head for a while and returned to grazing. This attitude influenced the observation taking, so there were differences in the indicator water intake in favor of buffaloes (3,14 vs. 1,37 %).

The behavior of partial (“artificial”) immersion of the head in the water of the drinking troughs, supports the value of this region of the body as priority zone of heat dissipation in the buffaloes, which should be evaluated in future studies about thermographic determinations. In this sense, Galloso *et al.* (2019) found that, independently from having water and shade, the buffaloes maintained the dorsal regions covered under shade; although they were wallowing in the water. This could suggest that the combination of both refreshment methods is preferred by the animals instead of either of them individually. For such reason, silvopastoral systems constitute one of the main recommendations to be implemented in the animal husbandry systems, in dairy as well as meat herds, because the use of other systems, where artificial thermoregulating are included, such as nebulization, cold water consumption or artificial shade (Yadav *et al.*, 2016; Barros *et al.*, 2016; Sevegnani *et al.*, 2016) can cause reductions in animal body temperature, but at a cost that could not be accessible for farmers.

In addition to the above-explained facts, it should be emphasized that trees, besides improving the environment and comfort, also contribute nutrients and can increase the nutritional value of the diet (Wanapat *et al.*, 2016), favor hydrothermal stability (Gu *et al.*, 2016), as well as feeding stability (Simón and Galloso, 2011) and the balance of the soil-plant-animal-fauna system components.

Table 4 shows the ethological activity with regards to the hours dedicated to each one of them.

Highly significant differences were observed for the different activities performed by the

Table 4. Activities performed by the two species with regards to the hours dedicated to each one of them.

Species	Ethological activity (No. of hours/activity)				SE ±	Significance
	Ingestion	Rumination	Rest and others	Water consumption		
Buffaloes	7,5 ^a (53,4)	4,1 ^b (29,6)	1,9 ^c (13,8)	0,4 ^d (3,1)	0,105	***
Bullocks	8,3 ^a (59,6)	3,5 ^b (24,8)	2,0 ^c (14,3)	0,2 ^d (1,4)	0,109	***

Means in the same row with different letters indicate significant differences

() Values between parentheses mean percentages of the total time dedicated to each activity.

*** $p < 0,001$

animals, with similar pattern in the two species, which dedicated more than seven hours to feed ingestion when grazing. These values are even higher than the ones found by Fundora *et al.* (2001), who reported five hours of ingestion in day time grazing, which indicated the possibility that, at this time, the buffaloes as well as the cattle satisfy most of their intake needs.

Carballoso *et al.* (2011) reported grazing activity between 5,7 and 7,7 hours in buffaloes raised under swamp conditions in the Ciego de Ávila province, although these authors reported lower values than the ones in this research in the rumination activity. This could have been related to the edaphoclimatic conditions of the site, where the animals needed more time for the displacement and collection, due to the low pasture availability and quality, with the subsequent increase of refreshment actions in the mudholes in the hottest hours of day.

With regards to cattle, the behavior pattern was similar to that of the report by Iraola *et al.* (2013), which corroborates that the feeding behavior patterns can be affected when the system used is that of grazing restricted only to daytime hours, when the animals attempt to supply their nutrient demand, dedicating more time to the pasture ingestion activity (Castellanos, 2010).

In general, the highest values of rumination for both species were shown between 11:00 a.m. and 3:00 p.m., coinciding with the noon hours, in which the solar radiation is more intense; while the grazing activity was higher in the three first morning hours and after 3:00 p.m., before being confined in the pen. These results coincide with the report by Galloso *et al.* (2009, 2019), which ratifies that the ingestion activity and rumination were influenced by the prevailing climate conditions in the grazing area and the management system with grazing restriction.

Conclusions

Silvopastoral systems can contribute to a good performance by both species, because the weight gain of cattle exceeded 0,600 kg per day; while that of the buffaloes (0,775 kg) was similar to the gain of feeding systems with supplementation. Both species dedicated more than 83 % of the daytime to pasture consumption and rumination, with preponderance for the ingestion activity. Nevertheless, the animal behavior was not evaluated during the night and early morning, for which the study of this aspect in future studies is suggested,

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