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Ethological behavior of *Bos taurus*, *Bos indicus,* and Caqueteño Creole cattle in three tree cover systems of *Brachiaria decumbens* paddocks at the Amazon foothills in Colombia

Comportamento etológico do gado Bos taurus, Bos indicus e crioulo Caqueteño em três sistemas de cobertura de árvores de Brachiaria decumbens paddocks no sopé da Amazônia na Colômbia

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ABSTRACT

The study was conducted at the Amazon Research Center CIMAZ - MACAGUAL of the University of Amazonia, Colombia, with a tropical rain forest climate (Af). The behavior of *Bos taurus*, *Bos indicus*, and Caqueteño Creole cattle, the animals were observed in paddocks with three levels of scattered tree cover density. The pasture was composed of *Braquiaria decumbens* with 35 days of regrowth. Direct observations were made from 9:00 a.m. to 5:00 p.m. with 10-minute intervals between the recording of the activities. The activity performed most often during the day by all of the animals was grazing under the sun, and those who pasture the most are the Caqueteño Creole, followed by the *Bos indicus* and, finally, the *Bos taurus*. Ruminating was the second most important activity performed by the cattle, having presented the same tendency. In the paddocks with a low level of tree cover, the animals pasture more in the shade; this trend is more relevant among *B. taurus* cattle. Caqueteño Creole cattle dedicate less time to water consumption and rest, spending more time grazing, in the high and medium cover levels, they interrupt the grazing at noon for a shorter time compared to *B. indicus* and *B. taurus*; after 2 p.m., the creoles vertiginously increase grazing. At the high cover level, the peak of grazing of the Caqueteño Creoles is at 9 a.m. and from 1-1:30 p.m., while at the medium tree cover level, the peak of pasturing was at noon, 1:30 p.m., and 4:30 p.m., at the high tree level of cover, the peak for the three breeds was at 11 a.m. Only at the average tree level of cover did the Caquetaño creoles and *B. indicus* present a similar peak. In 9-9:30 a.m. and 4-5 p.m., the breeds substantially reduce rumination.
KEYWORDS: ethology; cattle; behavior; tree cover.

RESUMO

O estudo foi realizado no Centro de Pesquisa Amazônica CIMAZ - MACAGUAL da Universidade da Amazônia, Colômbia, com um clima de floresta tropical úmida (Af). O comportamento do gado *Bos taurus*, *Bos indicus* e Caqueteño crioulo, os animais foram observados em cercados com três níveis de densidade de cobertura arbórea dispersa. A pastagem era composta de *Braquiaria decumbens* com 35 dias de recrescimento. Observações diretas foram feitas das 9h às 17h com intervalos de 10 minutos entre o registro das atividades. A atividade mais executada durante o dia por todos os animais era o pasto sob o sol, e aqueles que mais pastam são os Caqueteño crioulo, seguido pelo *Bos indicus* e, finalmente, o *Bos taurus*. A ruminação foi a segunda atividade mais importante desempenhada pelo gado, tendo apresentado a mesma tendência. Nos cercados com um baixo nível de cobertura arbórea, os animais pastam mais à sombra; esta tendência é mais relevante entre o gado *B. taurus*. O gado crioulo Caqueteño dedica menos tempo ao consumo de água e descanso, passando mais tempo pastando, nos níveis de cobertura alta e média, interrompem o pastoreio ao meio-dia por um tempo mais curto em comparação com o *B. indicus* e *B. taurus*; depois das 14 horas, os crioulos aumentam vertiginosamente o pastoreio. No nível de cobertura alta, o pico de pastagem dos Caqueteño crioulos é às 9h e das 13h30, enquanto no nível médio de cobertura de árvores, o pico de pastagem era ao meio-dia, 13h30 e 16h30, no nível alto de cobertura de árvores, o pico para as três raças era às 11h. Nas 9-9h30 e 16-17h, as raças reduzem substancialmente a ruminação.

PALAVRAS-CHAVE: etologia; gado; comportamento; cobertura de árvores.

INTRODUCTION

Climate change is alterations on the planet caused by man, including increases in temperature, changes in rainfall patterns, and increases in sea level (HERZOG & TIESSEN 2017). It is estimated that by the year 2100, temperatures will increase between 1.4 and 5.8 °C (FAO 2009), and animal production may decrease (CEPAL et al. 2017).

In the environment, animals need to perceive changes to show their response. Therefore, they consciously control their senses and temperature through specific receptors located in their body (CURTIS 1983). Cattle begin to suffer heat stress when the ambient temperature exceeds 23 °C and the relative humidity exceeds 80% (BARRAGÁN et al. 2015, MOLINA 2017), increases respiratory rate, peripheral blood flow, and perspiration. Consequently, food intake, growth, and milk production are reduced (WEST 2003). The search for forage also decreases because the animals look for places with wind and shade (WEST 2003, GALLARDO et al. 2005).

Livestock systems in tropical conditions use genetically improved animals, resulting from the crossbreeding of European breeds (*Bos taurus*) with zebu breeds (*Bos indicus*). However, cross animals with high percentages of *Bos taurus* present adaptation problems to tropical conditions, manifested in low production. One of them is heat stress, which generates losses in milk and meat production. Therefore, new knowledge about animal responses to the environment seeks to minimize production losses due to climate change (SPROTT et al. 2001, HAHN et al. 2003).

PRAYAGA et al. (2009) indicate that *Bos indicus* cattle can survive, grow and reproduce in the presence of stress factors, such as hot climates (high temperature and humidity) and long periods of low forage nutritional quality. On the other hand, *Bos taurus* breeds are less adapted to stress factors in the tropics.

In Latin America, local genetic resources are called creole breeds, which are adapted to tropical and equatorial lowland areas (SCHOLTZ & THEUNISSEN 2010). Sanga (from Africa) and Pantaneiro cattle are examples of local breeds with these characteristics (SCHOEMAN 1988, McMANUS et al. 2002). One of the mechanisms that cattle have developed to adapt to hostile environments is the improvement of the sweat gland, which varies in volume and density according to the breed type (NAY & HAYMAN 1956, 1963), showing that morphological differences are directly related to functional differences (BERMAN 2011).

The amount of bullfighting compounds in tropical environments are highly likely to increase in the future (BURROW 2006); however, SCHOLTZ & THEUNISSEN (2010) reiterated that creole breeds of livestock must be conserved to guarantee their permanent availability for beef production in the tropics. Furthermore, STRYDOM (2008) indicated little or no difference in meat quality between Sanga cattle and European/British exotic breeds in South Africa, thus the importance of conserving Creole breeds.

The American Creole breeds were formed from animals of the Iberian Peninsula introduced in the continent during colonization, descending from the animals that arrived at La Española island in Columbus's second voyage, in 1493, and in subsequent expeditions (NÚÑEZ et al. 2016).

HERRERA (2010) indicates that in Colombia there are eight breeds of criollo cattle (Romosinuano, Blanco Orejinegro, San Martinero, Casanareño, Costeño con Cuernos, Chino Santandereano, El Hartón del Valle and Caqueteño) and two breeds of synthetic Colombian cattle (Velásquez and Lucerna), which are characterized by their hardiness, tolerance to heat and relative humidity and their capacity to use rough forage of low nutritional value (ANZOLA 2005).

The Caqueteño Creole breed is a local genetic resource adapted to the environment that can be maintained with forage of low nutritional quality, resistant to infectious and reproductive diseases, tolerant of heat and humidity (ANZOLA 2005, MARTÍNEZ et al. 2005, HERNANDEZ 2016).

This study determined the ethological behavior of three racial groups: *Bos taurus*, *Bos indicus* and Caqueteño Creole, raised in dual-purpose production systems in pastures established with *Braquiaria decumbens* with coverage of scattered trees of low, medium, and high density in Amazonian foothills, from Colombia.

MATERIAL AND METHODS

The Amazon Research Center CIMAZ - MACAGUAL Cesar Augusto Estrada of the University of Amazonia is located 20 km from Florencia, in the south of the Department of Caquetá the Colombian Amazon, at 1º37'N and 75º36'W (Figure 1). The region is classified as a rainy tropical forest climate region (Af) (KÖPPEN & GEIGER 1938). This region has an average temperature of 25.5º, 3793 mm of annual rainfall, 1707 hours of solar irradiance per year, relative humidity of 84.27%, and an altitude of 250 meters above sea level (SIAT-AC 2018).

Three breeds of cattle from dual-purpose production systems were studied in the dry season (January – March) to establish a behavioral pattern.

The animals with a higher tendency towards the *Bos indicus* breed are those with more than 50% of genetic ancestry from this breed, particularly Brahman and Gyr. Similarly, the animals that tend towards *Bos taurus* are those with more than 50% of the breed's genetic material. The Caquetaño Creoles are pure breeds. This study used three animals of each breed.

The paddocks were made up of three levels of scattered tree cover-low (less than 20% of coverage), medium (from 20 to 40%), and high density (more than 40%). The paddocks were covered with *Braquiaria decumbens*, a more decumbent pasture, with regrowth of 35 days to guarantee homogeneity. Two paddocks were identified for each cover level (two of low, two of medium, and two of high-density), amounting to six paddocks. Before a period of adaptation of two days, the behavior of the animals of the three racial types was evaluated over three days. In the first low-cover paddock, a resting period of seven days was allowed. Later, applying the same time frames, the animals were moved to a paddock with medium cover and, subsequently, to one with high cover. The same procedure was repeated in each level of cover in the second paddocks, where the animals were always pasturing. The methodology determined to evaluate their behavior was adapted from the proposed method by PÉREZ et al. (2008). The observations were made from portable tents located near the paddocks using binocular equipment. The design was carried out at random and the data was analyzed by means of statistical description. To characterize the behavior of the animals, the time dedicated to the activities of pasture, grazing, ruminating, resting, drinking water, defecating, urinating, and shading was quantified. Observations were made during four days of each month of the dry period for eight consecutive hours, from 9 a.m. to 5 p.m. Activity was recorded every ten minutes (Table 1).

Table 1. Activities recorded every 10 minutes.

ACTIVITY	DENOMINATION	CONSIDERATION
Pasture under the sun	SUNP	Pasturing actions exposed to direct sunlight were considered, whether the animal was still or moving.
Pasture in the shade	SHP	Continuous pasturing under the shade of a tree was considered, whether the animal was still or moving.
Leaf litter consumption	LEAF	Feeding off leaves of trees taken from the ground.
Grazing	GRAZE	Feeding off leaves of trees taken directly from the branches.
Water consumption	WATER	The time used by the animal for water intake.
Rumination (cud chewing) standing under the sun	CCSS	Ruminating while standing, directly exposed to the sun.
Rumination standing in the shade	CCSSH	Ruminating while standing, under the effect of the shadow of a tree.
Rumination lying under the sun	CCSL	Ruminating while directly exposed to the sun.
Rumination lying in the shade	CCSHL	Ruminating lying down under the effect of the shadow of a tree.
Standing rest under the sun	SRS	Standing still under the direct action of the sun, not ruminating or feeding.
Standing rest in the shade	SHRS	Standing still under the shadow of trees, not ruminating or feeding.
Lying rest under the sun	SRL	Lying still under the direct action of the sun, not ruminating or feeding.
Lying shade rest	SHRL	Lying quietly under the shade of trees, not ruminating or feeding.
Excreting	EXC	When the animal excretes solid stools.
Urine excretion	URIN	When the animal urinates.

(Pérez et al. 2008).

The formula by PETIT (1972) and PÉREZ et al. (2008) was used to calculate the total time spent in each action dividing the day, where the product of the time dedicated was related to each activity according to the formula: (ai x n)/A

Where: "ai" is the number of animals performing the activity, "n" is the time between two successive

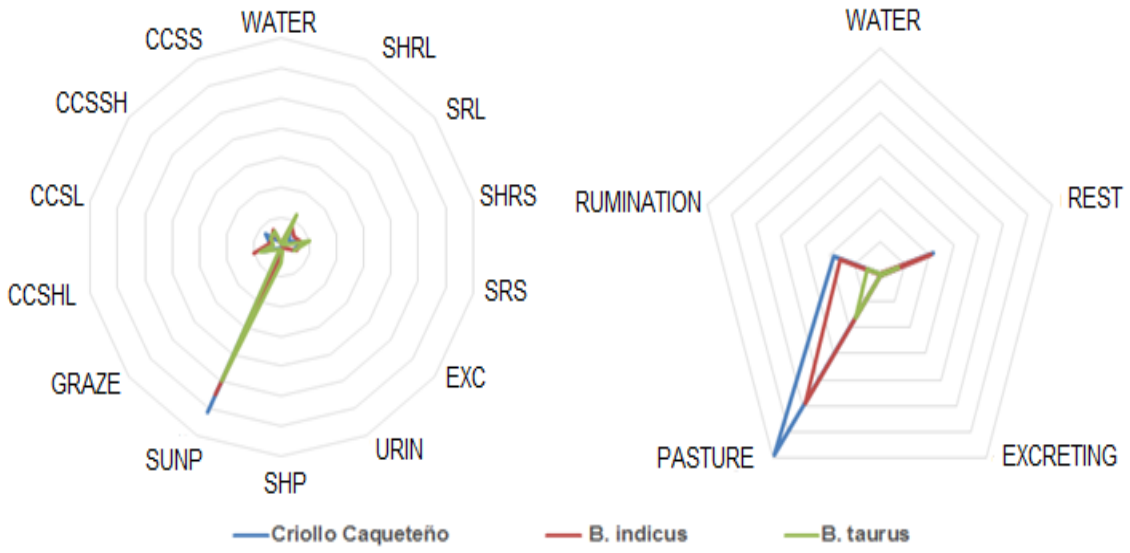
observations, and “A” is the total number of animals.

A descriptive statistics analysis (means and frequencies of the variables) was performed for each one of the ethological variables. In addition, a factorial variance analysis was done, in which the level of tree cover was associated with the breed by the Fisher LSD test ($p<0.05$) using the R package version 3.2.0 (R DEVELOPMENT CORE TEAM 2013) by means of the independent platform for statistical analysis R Commander (FOX 2005) and InfoStat (DI RIENZO et al. 2015).

In the hours between 12:00 a.m. and 2:00 p.m. for each activity and in each hour, a generalized linear model fitted to a Poisson distribution family was applied and a Tukey HSD adjusted multiple comparison of means test (p-value<0.05) was performed to find statistically significant differences between breeds using the R package version 3.2.0 (R DEVELOPMENT CORE TEAM 2013).

RESULTS AND DISCUSSION

Figure 1 shows the behavior of the breeds evaluated. In general, regardless of the breed, the activity performed more often by the animals during the day was pasturing under the sun, and those who perform this activity more often are the Creole Caqueteños, followed by the *Bos indicus* and, finally, the *Bos taurus*. Ruminating is the second most important activity performed by the animals, presenting the same tendency.



SUNP: pasture under the sun; SHP: pasture in the shade; GRAZE: grazing; WATER: water consumption; EXC: excreting; SRS: standing rest under the sun; SHRS: standing shade rest; SRL: lying rest under the sun; SHRL: lying shade rest; URIN: urinating; CCSS: rumination standing under the sun; CCSSH: rumination standing in the shade; CCSL: rumination lying under the sun; CCSHL: rumination lying in the shade.

Figure 1. Ethological behavior of three cattle breeds in the Colombian Amazon foothills.

Table 2 shows how the different activities of the three breeds of cattle evaluated were distributed in time under the three levels of scattered tree cover in the paddocks. It was found that leaf litter consumption, grazing, water consumption, defecating, and urinating are inconsequential. Three large groups of activities are presented: those related to pasturing (SUNP and SHP), to rest (SRS, SHRS, SRL, and SHRL), and to rumination (CCSS, CCSSH, CCSL, and CCSHL), which take up most of the animals’ time. In the paddocks with low tree cover, the cattle pasture more under the shade; this tendency is more relevant in the *B. taurus*.

Table 3 shows the three main activities (grazing, rumination and rest). It is highlighted that the Creole bovine cattle are the ones that consume less water, less rest and more time graze. Thus, it shows that the inclemency of the tropics to which less affected the racial types evaluated is the Creole Caqueteños.

Figure 2, illustrates the grazing behavior of the three selected racial types evaluated in the three levels of coverage of the trees dispersed in the pasture, finding that the creole bovine cattle show a behavior superior to the *B. indicus* and the *B. taurus*. In the midday hours, creoles do not graze less than the other two groups in the high and medium coverage levels. Additionally, when the level of tree cover is low the behavior between the groups of *B. indicus* and Creole Caqueteños is similar, only that after 14:00, the creoles increase dizzyingly grazing.

Table 2. Time distribution (%) of cattle of the racial types *B. indicus*, *B. taurus* and Creole Caqueteño dedicated to different activities at three levels of coverage.

ARBOR COVERAGE	RACIAL TYPE	ACTIVITY *													
		SUNP	SHP	GRAZE	WATER	EXC	URIN	SRS	SHRS	SRL	SHRL	CCSS	CCSSH	CCSL	CCSHL
Low	Indicus	48.1	4.9	0.0	0.0	0.0	1.1	3.2	13.3	8.8	8.4	0.0	6.3	0.0	6.0
	Criollo	45.5	1.9	0.0	0.0	0.0	0.0	1.1	13.3	7.2	10.6	0.3	10.1	0.0	10.1
	Taurus	42.7	9.4	0.0	0.0	0.0	1.0	1.0	19.8	0.0	18.8	0.0	6.3	0.0	1.0
Half	Indicus	56.9	0.0	0.0	1.4	0.3	0.0	12.2	4.5	2.8	0.7	6.6	4.9	4.5	5.2
	Criollo	70.7	0.9	0.0	0.0	0.0	0.9	6.9	3.3	0.9	0.6	4.5	5.7	3.9	1.8
	Taurus	51.5	2.1	1.0	1.0	0.0	1.0	8.2	5.2	1.0	3.1	10.3	5.2	3.1	7.2
High	Indicus	59.2	0.7	0.0	0.0	0.0	0.0	0.3	3.5	0.0	14.3	0.0	2.8	0.0	19.2
	Criollo	68.0	2.1	0.3	0.0	0.0	0.0	0.0	5.2	1.3	8.1	0.0	5.7	0.0	9.4
	Taurus	55.2	4.2	0.0	0.0	0.0	0.0	0.0	5.2	0.0	14.6	1.0	4.2	0.0	15.6

*SUNP: pasture under the sun; SHP: pasture in the shade; GRAZE: grazing; WATER: water consumption; EXC: excreting; URIN: urinating; SRS: standing rest under the sun; SHRS: standing shade rest; SRL: lying rest under the sun; SHRL: lying shade rest; CCSS: rumination standing under the sun; CCSSH: rumination standing in the shade; CCSL: rumination lying under the sun; CCSHL: rumination lying in the shade.

Table 3. Distribution of time (%) of cattle of the racial types *B. indicus*, *B. taurus* and Creole Caqueteño of the main activities.

ARBOR COVERAGE	RACIAL TYPE	ACTIVITY *					TOTAL
		WAI	RST	EXC	PAS	RUM	
Low	Indicus	0.0	2.7	0.1	4.2	1.0	8
	Criollo	0.0	2.6	0.0	3.8	1.6	8
	Taurus	0.0	3.2	0.1	4.2	0.6	8
Half	Indicus	0.1	1.6	0.0	4.6	1.7	8
	Criollo	0.0	0.9	0.1	5.7	1.3	8
	Taurus	0.1	1.4	0.1	4.4	2.1	8
High	Indicus	0.0	1.4	0.0	4.8	1.8	8
	Criollo	0.0	1.2	0.0	5.6	1.2	8
	Taurus	0.0	1.6	0.0	4.8	1.7	8
AVERAGE	Indicus	0.0	1.9	0.0	4.5	1.5	8
	Criollo	0.0	1.6	0.0	5.0	1.4	8
	Taurus	0.0	2.0	0.1	4.4	1.4	8

*water in take (WAI), rest (RST), excreting (EXC), pasture (PAS), rumination (RUM).

In the high coverage level, the grazing peak of the Caqueteños Creoles is at 9 a.m. and between 1 - 1:30 p.m., while in the average tree cover level, it was at 12 p.m., 1:30 p.m. and 4:30 p.m.

The behavior of the rumination is very similar in this activity between the groups of Creole Caqueteños and *B. indicus*, as shown in Figure 3. At the level of high tree cover the peak of the rumination in the three racial types was presented at 11 a.m. In the periods from 9:00 to 9:30 a.m. and from 4:00 p.m. to 5:00 p.m. none of the racial types presented rumination at this level.

At the average coverage level, the Creole cattle and *B. indicus* showed a peak of rumination at 11 a.m.

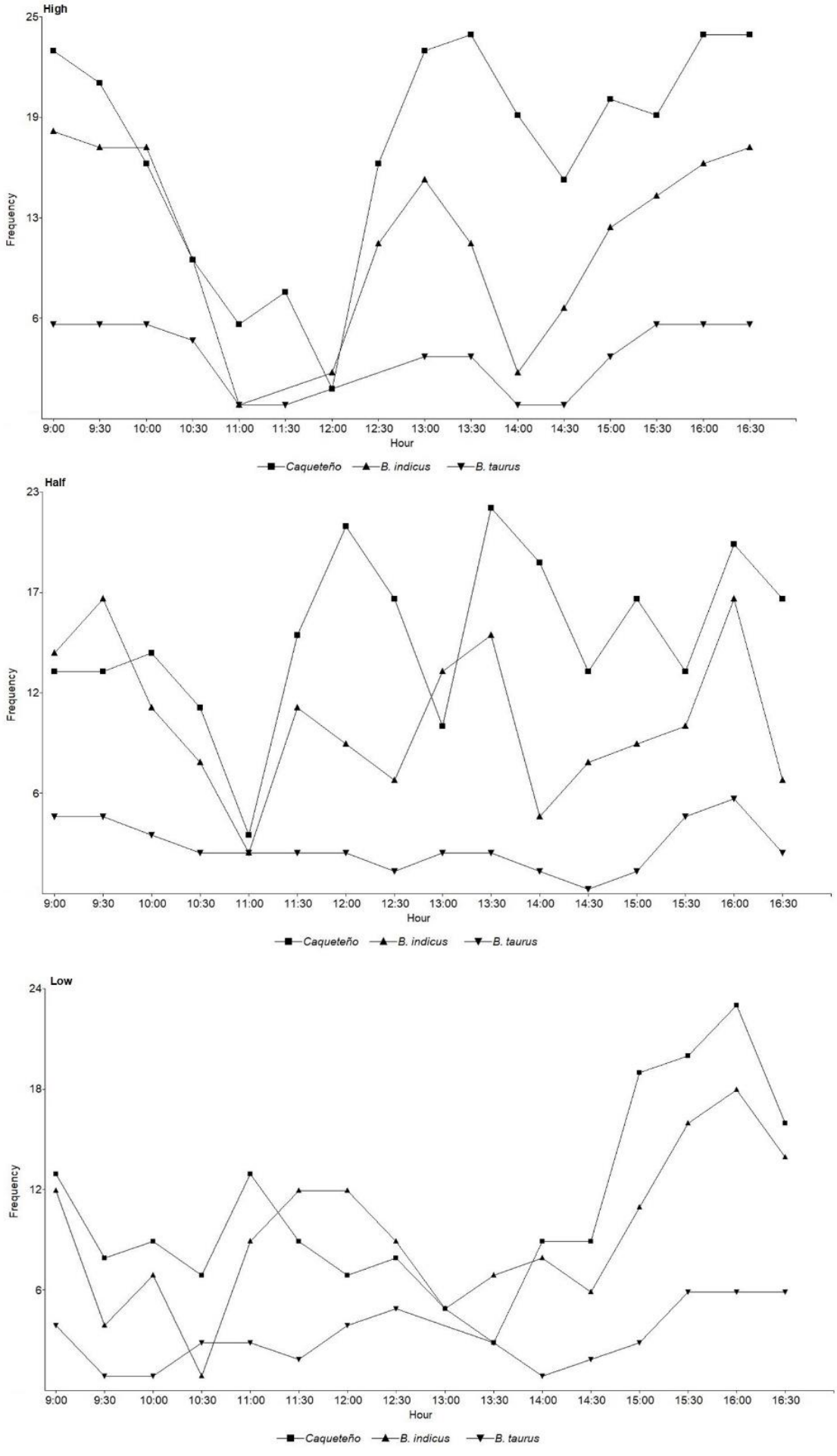


Figure 2. Pasturing of cattle breeds over a day's time in paddocks with different levels of scattered tree cover.

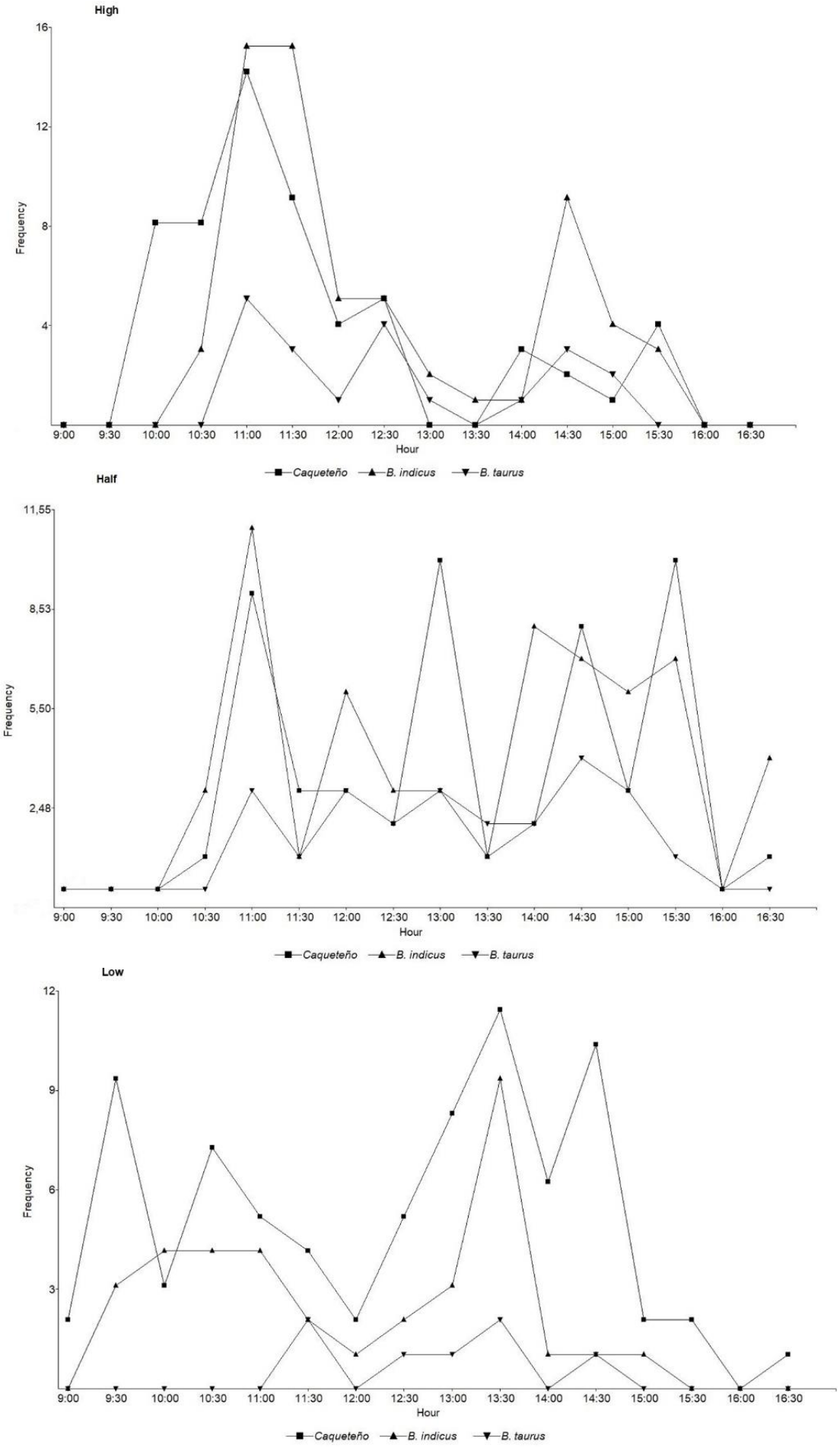
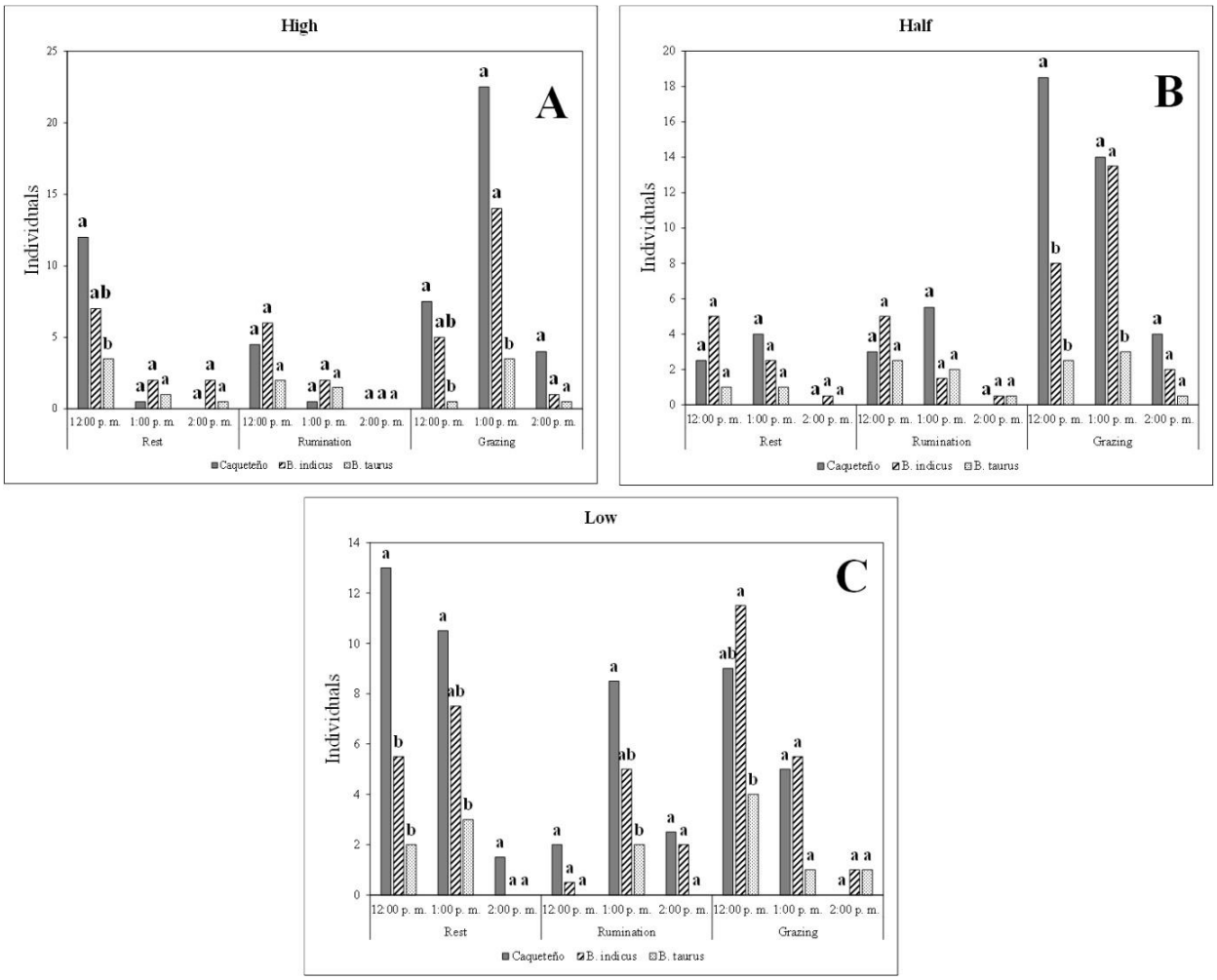


Figure 3. Ruminating of cattle breeds over a day's time in paddocks with different levels of scattered tree cover (high on top, half on the middle and low on the bottom)**.**

Taking into account that the highest temperatures occurred between 12:00 and 2:00 p.m., a greater analysis was carried out to evaluate the effect of the cover and its level of incidence on the three main activities (resting, ruminating and grazing). Graph 4 shows that there were differences in behavior according to Arborea cover. The greatest number of animals resting and ruminating are found in the low tree cover. The highest grazing is found in the high and medium tree cover. The Caqueteño Creoles presented greater grazing in the high and medium cover, always presenting a significant difference ($p<0.05$) with the crosses where *B. taurus* predominated. In the low cover, *B. indicus* grazing was higher, but did not present a significant difference ($p>0.05$) with the Caqueteños.



Letters adjusted to HSD Tukey test (p-value<0.05). *Equal letters indicate no difference between groups.

Figure 4. Bar chart of averages, A: High, B: Half, C: Low.

According to CERQUEIRA et al. (2016), stress is an indicator of adverse environmental conditions for animal welfare. It is difficult to evaluate its magnitude and associated impact on animal production. AGUILAR (2015), suggests that the only way to measure its magnitude is by means of the animals' response, hence the importance of conducting studies of animal behavior under the effects of heat stress generated by the environment.

In the high and medium cover, from 11 a.m. to 1 p.m., the animals reduce pasturing to rest under the canopy of the trees, as this helps them to minimize heat stress caused by the high temperatures. This occurs because, in mammals, the hypothalamic-adrenal-pituitary axis regulates the responses to stress processes SORROZA et al. (2019). According to PHILLIPS (2016), the midday hours mark the peak of environmental heat, and , this generates an physiological disorder. As a result, it increases cortisol levels and raises body temperature, heart rate, and respiratory rate. So, the support of external elements to rebalance physiological functions is needed. According to VEISSIER et al. (2018), the shade of the trees reduces the passage of solar radiation towards the animal's body surface, reducing heat stress.

Considering pasturing on the three selected levels of tree coverage, it was found that at the low level, where few trees are found, the animals of the three breeds pastured more under the shade. According to MAURICIO et al. (2019), the shade generates beneficial effects in animals, such as more pasturing and

grazing, allowing greater consumption and selection of food and decreasing water requirements.

The presence of trees encourages pasturing; in paddocks with medium and high tree cover, the activity's frequency and duration is greater than in the paddocks with low cover, as shown in Figure 2.

In the high cover paddocks, the Caqueteño Creoles presented pasturing peaks from 9-9:30 a.m., 1-1:30 p.m., and 4-5 p.m. The *B. indicus* presented a similar tendency, but with less intensity, and the *B. taurus* presented low pasturing at a constant level from 9 to 10:30 a.m. and from 3 to 5 p.m.

In the average cover, the Caqueteño Creoles presented pasturing peaks at 10:00 a.m., noon, 1:30 p.m., 3 p.m. and 4 p.m. The *B. indicus* also presented peaks, but with less intensity at 9:30 a.m., 11:30 a.m., 1-1:30 p.m., and 4 p.m. The *B. taurus* presented a low trend curve, with higher consumptions from 9-9:30 a.m. and from 3:30-4 p.m.

At the level of low tree cover, the consumption trends were lower than at the other levels. The Caqueteño Creoles presented consumption peaks at 9 a.m. and 11 a.m. and increased their consumption after 2:30 p.m. until 4:30 p.m. The *B. indicus* presented a similar trend, although with less intensity than the Creoles, and the *B. taurus* increased their consumption after 3 p.m.

The difference in behavior associated with the breeds, where *B. taurus* is the least efficient in pasturing, is related to that proposed by VALENTE et al. (2015), that not all bovines have the same comfort temperature range. It is also similar to the trend found by (BRITO et al. 2004), who investigated the effect of stress on *B. indicus* and *B. taurus* breeds and found that the *B. taurus* presented a higher stress index.

The findings on the Caqueteño Creole coincides with GINJA et al. (2019), who states that Latin American Creole cattle adapt to the environment where they evolved, since they can have a unique set of genes for a given environment, which gives them the ability to adapt to the adverse environmental conditions prevailing in the tropical regions and are highly tolerant to high environmental temperatures. Creoles that evolved in warm zones can transfer internal heat to the outside and regulate their body temperature more efficiently than *Bos taurus* breeds (UNCHUPAICO et al. 2020).

The presence of trees in the pastures helped the animals to spend more time pasturing. According to NAVAS (2008), this is due to the fact that trees reduce caloric stress in cattle, they create microclimates, making the pasture more comfortable, partially block solar radiation and decrease the environmental temperature of their area of influence, allowing the animals to approach their zone of thermoneutrality (PÉREZ et al. 2008) and spend their time in feeding activities.

At the level of high tree cover, the Caqueteño Creole cattle presented rumination peaks at 11 a.m. and low activity in the afternoon. However, no rumination was observed from 9 to 9:30 a.m., 1 to 1:30 p.m. and 4 p.m. to 5 p.m. The *B. indicus* also presented a peak at the same time, extending until 11:30 a.m., and another peak at 2:30 p.m. This specific breed did not ruminate from 9 to 10 a.m. In turn, the *B. taurus* presented three peaks with low intensity at 11 a.m., 12:30 a.m., and 2:30 p.m. and did not ruminate from 9:00-10:30 a.m., at 1:30, and from 3:30-5 p.m.

At the level of medium tree cover, the Caqueteño Creole cattle presented four rumination peaks at 11 a.m., 1 a.m., 2:30 p.m., and 3:30 p.m.; the *B. indicus*, at 11 a.m., noon, 2 p.m. and 3:30 p.m.; the *B. taurus* presented very low peaks at 11 a.m., noon, 1 p.m., and 2:30 p.m.

At the level of low tree cover, the Caqueteño Creole cattle presented four peaks at 9:30 a.m., 10:30 a.m., 1:30 p.m., and 2:30 p.m. The *B. indicus* presented a peak from 9:30-11 a.m. and at 1:30 and did not ruminate from 3:30-5 p.m. The *B. taurus* presented little rumination at 11:30 a.m., 12:30-1:30 p.m. and 2:30 p.m. During the remaining eight hours evaluated, they did not ruminate.

In general terms, tree cover was found to affect animal behavior. The least amount of animals graze in the hours of higher temperature where the cover is low. Due to heat stress, animals reduce feed intake, minimizing endogenous heat production (MARTÍNEZ et al. 2005). Medium and high covers decrease the effects of high temperatures, because the leaves and branches of the trees reduce the passage of solar radiation to the body surface of the animal (VEISSIER et al. 2018), reducing heat stress, so there is higher forage consumption than in low covers (UNCHUPAICO et al. 2020).

The greater grazing of Caqueteño and *B. indicus*, presenting significant difference ($p<0.05$) with *B. taurus*, demonstrates the greater adaptation of the first two. These results are similar to those proposed by (NÚÑEZ et al. 2016), genetically *B. indicus* have the adaptive capacity to assimilate extreme environmental conditions, while *B. taurus* do not have the same capacity to withstand high temperatures. However, having evolved in temperate zones, they suffer high levels of heat stress in equatorial or tropical conditions, which modifies their physiology and behavior, decreasing grazing time (LIMA et al. 2020). The adaptation of Creole breeds is due to the fact that these *B. taurus* animals were brought to America more than 500 years ago, achieving acclimatization (GINJA et al. 2019).

CONCLUSION

Medium and high tree cover had a beneficial effect on the animals, decreasing heat stress in the animals allowing them to increase their voluntary intake, while low tree cover drastically decreased the animals' voluntary intake in the hours of 12 to 2 p.m.

The Caqueteño Creole and those crossed with *B. indicus* showed similar behavior, while the *B. taurus* were more affected by the high temperature conditions from 12 to 2 p.m., showing lower feed intake

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