Feeding behavior of male cattle under restricted grazing, supplemented with distiller maize grains during the dry period

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Feeding ability and productive yield was evaluated in male cattle under restricted grazing for 90 days during the dry period. Twenty four animals (commercial Zebu) were used with a mean live weight of 359.24 ± 1.09 kg, grazing in 20 ha with different supplementation levels. A completely randomized design was applied with the following treatments: I) grazing, II) grazing plus 1.5 kg of distiller maize grains (DDGS), III) grazing plus 2.5 kg DDGS. The activities: ingestion, rumination, rest, water intake and inactivity were analyzed. The frequency of the activities between each hour of the day and average daily gain (ADG) were determined. Data were processed with INFOSTAT and through ComparPro version I. In treatment I animals devoted more time ($P < 0.001$) to ingestion and less ($P < 0.001$) to rumination regarding the remaining activities (6.88; 5.73 and 5.09 h and 0.58; 0.99 and 1.28 h) for ingestion and rumination in treatments I, II and III, respectively. The ingestion frequency of pastures showed between 8:00 and 9:00 a.m. higher ($P < 0.001$) amount of animals grazing. Treatment I (71 %) was superior by 9 and 21 % to treatments II and III, respectively. ADG was conditioned by the supplementation level. The use of DDGS decreased the ingestion time, increased rumination and improved ADG in the treatment with the highest supplementation level.

Key words: *beef cattle, feeding ability, distiller maize grains*

Numerous studies conducted in Cuba confirm that when bovines are maintained under grazing 24 h with feed availability, they realized greater pasture consumption during the morning and evening-night hours (Alonso and Senra 1993, Pinheiro 1998, Reyes *et al*. 2005, Quincosa 2006 and Fundora *et al*. 2007). However, in many production systems, restricted grazing for 6 to 8 diurnal hours, approximately (Anon 2004) are established. This system affects the habits of feeding behavior and the productive and economical indicators.

According to Provenza (2003) and Suárez *et al*. (2011) the study of the grazing behavior involves the feeding habits, habitat preferences and nutrient effect. Mejías (2002) argued that the variation in animal consumption under grazing is, undoubtedly, the main factor determining the production efficiency level in a ruminant. However, this variation as well as the feeding behavior is difficult to predict under grazing conditions when this is limited, with or without supplementation. Thus, the knowledge of the behavior can markedly improve the efficiency and profitability, quality of life of producers and their animals and the integrity of the environment.

The objective of this paper was to study the feeding behavior of male cattle under diurnal grazing, supplemented with different levels of distiller grains (DDGS) (Norgold®) during the dry period.

Materials and Methods

The study was developed in experimental areas of the Institute of Animal Science, in a grass system with 70 % star grass (*Cynodon nlemfuensis*) and 30 % natural pastures (*Paspalum notatum*, *Dichantium sp.* and *Sporobolus indicus*). The system was established on a brown carbonated soil (Hernández *et al*. 1999) during the dry period.

Eight animals per treatment (24 non-castrated male cattle) were used of a commercial Zebu genetic group, with an initial live weight of 359.24 ± 1.09 kg. Animals grazed in only one group through rotational grazing in 20 ha. These were divided in 16 paddocks of 1.25 ha, with an occupation time of three days in each paddock. Grazing was diurnal from 8:00 a.m. to 5:00 p.m. Previously they had 21 d for adaptation. Animals per treatment were identified with different ear tags. The supplement per treatment was supplied in the morning before grazing. Fifty grams of mineral salt were offered to all animals.

Experimental procedure. The feeding behavior was determined for three consecutive days, in two occasions, in the analyzed period. Measurements were registered each 15 min. The activities developed by each group were evaluated: ingestion, rumination, rest, water intake, and other activities (play, mating attempt and displacement). For the calculation of the information by activity, the formula of Petitt (1972) was used:

Time devoted to each activity: $= \Sigma (ai \times n)/A$

Where:

ai = number of animals exerting the activity,

n = time between two successive observations,

A = total number of animals

Design and treatments. A completely randomized design was used with the following treatments: I) grazing, II) grazing plus 1.5 kg DDGS and III) grazing plus 2.5 DDGS. For the evaluated activities their frequency between daylight hours, grazing pressure and average daily gain (ADG) were monthly determined. Pasture availability was determined. One hundred observations ha^{-1} were carried out according to the method of Haydock and Shaw (1975) with a monthly frequency in all the

paddocks. The botanical composition was determined according to Mannetje and Haydock (1963). The area was divided in diagonals, a 0.25 m^2 frame, with 80 visual observations per paddock was used. The analysis of the bromatological composition of the feed was established according to AOAC (1995) (table 1). The contingency table was used to test the interaction (treatments vs. activities). Data of the contingency table were processed by the X^2 test. For the analysis of comparison of proportions Duncan's (1955) multiple range test was applied. Data were processed through the statistical packages INFOSTAT (Balzarini *et al*. 2001) and the ComparPro version 1 (Font *et al*. 2007).

this indicated medium grazing pressure between the three treatments (6.64 kg DM 100 kg LW^{-1}), although it was higher than the values reported as critical (5 kg DM 100 kg LW^{-1}) by Senra (2005) and Senra *et al*. (2010) for our conditions. The feeding balance calculations realized (energy-protein) for an estimated gain of 500 g ADG, according to table of requirements described by Martín and Palma (1999) indicated that the contributions did not cover the requirements (table 3). However, the treatment with the highest supplementation level had ($P < 0.05$) higher final LW and ADG than the rest.

For instance, authors such as Minson (1990), Galli

Table 1. Chemical composition of the feeds (DDGS supplements and grasses)

Indicators	Measurements	DDGS	SD	Star grass+ natural pastures	SD
ME	%	89.0	0.50	35.0	1.10
CP	MJ kg DM^{-1}	11.71	0.10	8.1	1.8
PB	g kg DM^{-1}	289.0	1.15	83.0	2.1
NDF	g kg DM^{-1}	230.0	0.7	706.1	0.9
ADF	g kg DM^{-1}	152.0	0.2	422.8	1.1
Ca	g kg DM^{-1}	42.0	0.3	7.3	1.5
P	g kg DM^{-1}	8.0	0.1	3.4	0.89

Results and Discussion

Results evidenced that animals from the control treatment devoted more ($P < 0.001$) time to pasture consumption and less ($P < 0.001$) to rumination in regard to the treatments with different supplementation levels. The treatment with the highest level of supplementation (2.5 kg of DDGS $animal^{-1}d^{-1}$) had the lowest grazing time (table 2).

The fact that the treatment with the highest level of supplementation manifested lower ingestion time regarding the medium level and the control (11.17 and 26.02), could be related to multiple factors having to do with the feeding ability and the supplementation contribution. This does not help to explain completely this behavior, since on relating average pasture availability (30 kg DM $animal^{-1}d^{-1}$) *et al*. (1996) and Rinehart (2008) reported in their results that the range of grazing time recorded in beef cattle with the highest number of observations averaged between 420 and 600 min. daily. However, results found in this study were below the values cited. Those authors indicated that lower times are mainly associated to limited or restricted grazing, between 7 and 10 h daytime, with fatigue effect during feed selection, as a consequence of poor pasture availability or the need of having time for other activities. Although in this study the estimated average dry matter availability guaranteed pasture availability, the daytime grazing evidently affected the ingestion activity.

Animals with different supplementation levels devoted greater time to rumination, which differed ($P < 0.001$) regarding the control treatment (23 and 55 %), respectively. In a general way it was observed

Table 2. Proportion (%) of time devoted to the activities during grazing according to the treatments

Variables	Treatments		
	Grazing	Grazing + 1.5 kg DDGS	Grazing + 2.5 kg DDGS
Grazing	27.12^{a} (413)	22.55^{b} (344)	20.07^{c} (306)
Rumination	2.28^{a} (35)	3.91^{bc} (60)	5.04^{bc} (77)
Water intake	1.18^{a} (18)	2.10^{abc} (32)	2.61^{bc} (40)
Rest	1.17^{a} (18)	2.79^{bc} (43)	3.35^{bc} (51)
Other activities	1.53^{a} (23)	1.92^{abc} (29)	2.25^{bc} (34)
SE ± sign.	0.638 ***		

Different letters indicate significant differences ($P < 0.05$)
( ) incidences (min)

Table 3. Productive indicators of grazing Zebu males and strategic supplementation according to the treatments

Indicators	Treatments			SE(±) Sig.
	I Control	II (1.5 kg DDGS)	III(2.5 kg DDGS)	
Initial LW, kg	358.15	360.15	360.15	1.02
Final LW, kg	387.00[a]	392.00[a]	398.00[b]	2.38*
Accumulated gain, g	320.00[a]	355.00[a]	421.00[c]	0.82*

Different letters indicate significant differences ($P < 0.05$) *$P < 0.05$

that the time devoted to that activity was not much and that ingestion occupied longer time. Nonetheless, hours with more daylight intensity and higher temperatures during the day, concentrated the highest time devoted to this activity. Since in paddocks without trees there is certain degree of stress in the animals that limits the ingestion time. This is precisely the moment when the animals search shelter for shadow in live fences present in the system. This behavior is given by the shadow provided by trees that can modify the microclimate and allow reducing up to 2º C the environmental temperature (Soca 2005, Pérez *et al*. 2008 and Ceballos *et al*. 2011).

According to what was reported by Rotger *et al*. (2006), Zabelli *et al*. (2007), Rodríguez (2009) and Anon (2011), this diurnal grazing procedure can have explanation. These authors indicated that the highest time devoted to rumination is usually identified with the possibility of finding fresh environments such as that offered by trees' shadow or the fresher hours of the day. However, with limited grazing, the high demand for nutrients of fattening animals explained that they devoted longer time to the ingestion, in spite of the strategic supplementation with DDGS. This offered greater possibility of stability to the grasses during the dry period, but did not evidence high animal productivity. The rest of the activities behaved the same as the rumination between treatments and regarding water intake, rest and inactivity. Supplemented animals devoted longer time to these activities regarding the control.

The highest ingestion frequency ($P < 0.001$) was during the first hour of the morning (8:00 to 9:00 a.m.) in the animals of the control treatment with marked differences regarding the rest of the treatments and the medium level. It also differed with respect to the treatment with the highest supplementation level (71.0, 62.0 and 50.0 % of animals ingested pasture) for treatments I, II and III, respectively (figure 1). This evidenced that supplement consumption in the morning and before grazing influenced on the percentage of animals consuming pasture.

According to Kalscheur (2005) and Fischer (2007) the supply of DDGS can affect dry matter consumption in grazing ruminants. However, in the remaining hours of the day, there were no differences between treatments for this activity. The behavior of the frequency of animals consuming pasture, after the first hour, showed during the day and, in a general way, an upward curve in the morning attaining average values of up to 94 % declining rapidly at midday, between 1:00 and 2:00

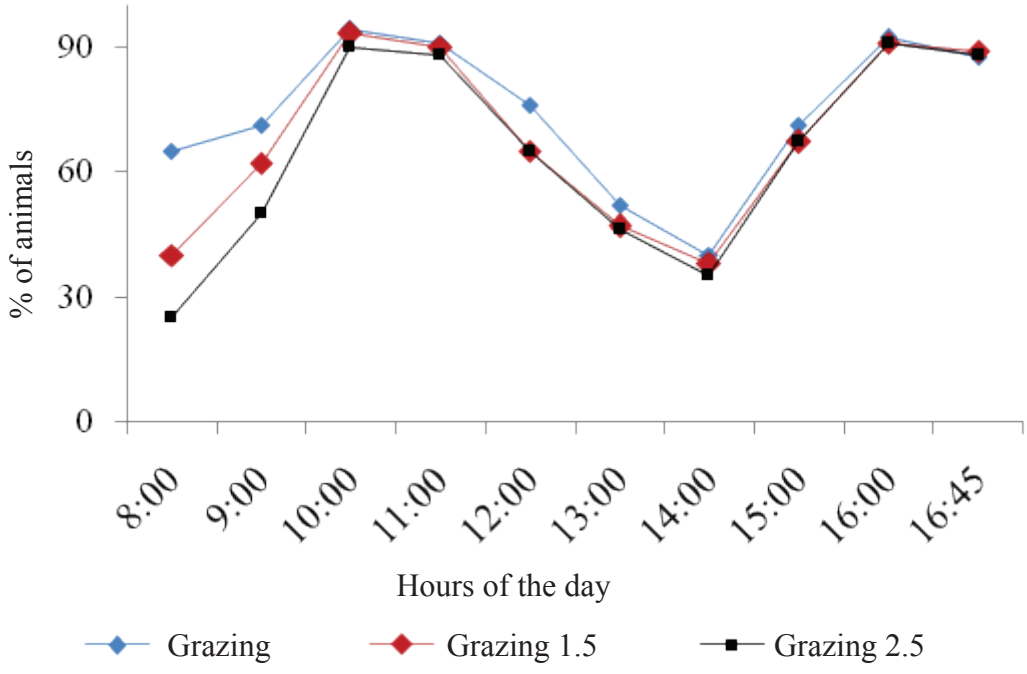

Figure 1. Frequency of animals consuming pasture between the different hours of the day

p.m. with an average frequency of 35 %. In this way, the curve turned to increase during the afternoon hours until 92 % as average.

This pattern of behavior that showed the results are similar to that reported by Anon (2003) and Araujo (2005) for Zebu beef cattle and Zebu crossbreds under grazing in the tropical zone. Corzo *et al*. (2004) found in Cuba that during midday hours, Zebu type animals decrease pasture consumption, even if they have enough availability in the paddock. Regarding this performance, McDowell (1985) indicated that when temperatures increase above a critical level, as at midday, and generally in the tropics, animals tend to stop or decrease the ingestion, as a strategy to reduce the thermal stress for maintaining the body temperature which is inherent to each animal.

Figure 2 represents the rumination activity which in the morning hours manifested its highest percentage. Treatments with supplementation showed differences ($P < 0.001$) regarding the control. In this, supplemented animals had the double of time regarding the unsupplemented treatment (24 % and 12 %, respectively). There were no differences between treatments for the different day hours.

The values of frequency of animals in rumination activity reached as average 5.0, 7.0 and 9.0 % for the control, medium and high supplementation treatments, respectively. There was a curve with medium values for the morning hours of 3 %, which increased until attaining values close to 25 % at midday declining in the afternoon, hours in which no animals in rumination were observed.

According to Ortega *et al*. (2009) and Castellanos (2010), the patterns of feeding behavior can be affected, above all for ingestion and rumination under restricted grazing conditions. These could be pasture selectivity, grazing intensity, physiological stage of the pasture, supplementation, animal genotype, physiological state, body size, reticulum-rumen capacity, water availability, and distances to cover, among others. Consequently, ingestion and rumination, as part of the feeding behavior, vary and are affected by diurnal rhythms and social factors that can be considered stressing for the feeding behavior.

Regarding water intake, only in the hours from 9:00 to 10:00 a.m. the supplemented animals showed longer ($P < 0.001$) times than in the control treatment. For the rest of the day there were no differences (figure 3). This higher water intake for supplemented treatments in the first hour of the morning was associated to Norgold® consumption. Once the supplement is consumed, animals leave for grazing. This behavior did not vary during the period under study. In this sense, McDowell (1985) argued that water consumption is related to that of dry matter (4.5 kg of H_2O/kg DM).

Field observations did not show a consistent pattern for the variables studied, rest and other activities (play, mating attempt and displacement). However, they did not manifest differences for the treatments in the frequency of animals between the different hours of the day. Fraser and Broom (1997) and Ortega and Gomez (2006) indicated that beef cattle modify their habits of feeding behavior when grazing is limited during the day to 8 h, approximately, with or without supplementation. These elements do not allow predicting the behavior, but the adaptation capacity, depending on the animal genotype and the characteristics of the agricultural ecosystems, determines to a great extent, the feeding ability.

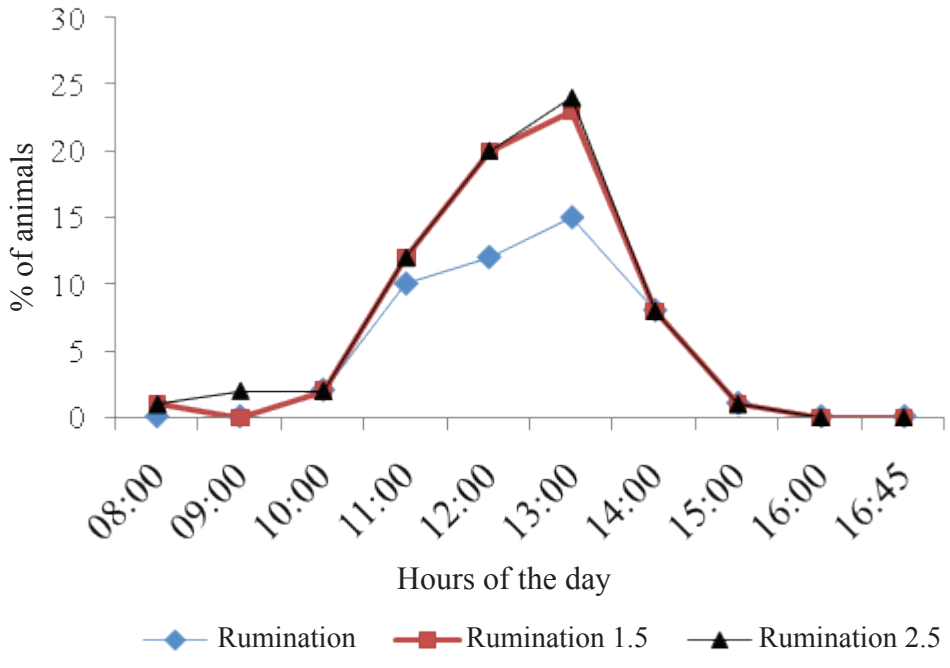

Figure 2. Frequency of animals in the rumination activity between the different hours of the day

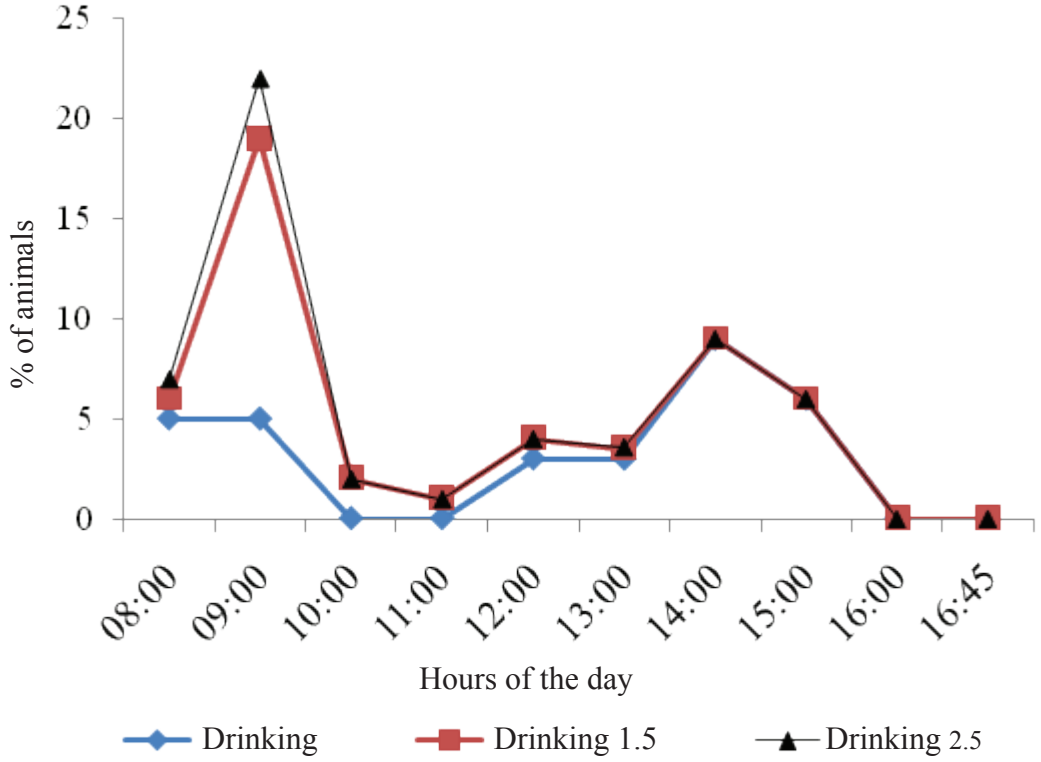

Figure 3. Frequency of animals drinking water between the different hours of the day

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