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Feeding behavior of Nellore heifers grazing during the dry season of the year supplemented with mineral salt and urea types

Comportamento ingestivo de novilhas Nelore em pastejo no período seco suplementadas com sal mineral e tipos de ureia

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Resumo

Avaliou-se o comportamento ingestivo de novilhas Nelore, na fase de recria em pastejo de *Brachiaria brizantha* durante o período seco do ano, recebendo suplementos contendo sal mineral, ureia convencional e ureia de liberação lenta. Foram utilizadas 56 novilhas com aproximadamente 284,72 ± 27,48 kg de peso corporal médio, distribuídas em delineamento inteiramente casualisado sob quatro tratamentos, sendo: Sal mineral; Ureia – suplementação com 8,18% ureia convencional; Ureia mista - suplementação com 4,09% ureia convencional e 4,39% ureia de liberação lenta e Ureia lenta – suplementação com 8,78% ureia de liberação lenta. Animais suplementados com sal mineral apresentaram maior tempo de pastejo comparado aos que receberam suplemento ureia mista, ureia lenta e ureia. O consumo de matéria seca, fibra em detergente neutro e nutrientes digestíveis totais apresentou efeito similar, com maiores valores para as novilhas consumindo suplemento contendo ureia e ureia lenta comparado à ureia mista. Entretanto, quando se avalia a eficiência de consumo por hora, os animais que receberam suplemento ureia foram mais eficientes em relação aos demais tratamentos. O número de períodos em pastejo para as novilhas que receberam suplemento ureia lenta foi maior comparado com novilhas que receberam suplemento sal e ureia mista. O tempo de duração do período de pastejo e ruminação foram maiores para as novilhas que receberam suplemento sal e ureia mista do que àquelas que receberam ureia e ureia lenta. Recomenda-se utilizar suplementos no nível de 0,3% do peso corporal para novilhas de corte contendo ureia convencional.

Palavras-chave: Consumo. Diferimento. Nitrogênio não proteico. Ruminante

Abstract

In this study, the feeding behavior of Nellore heifers receiving supplements containing mineral salt, conventional urea and slow release urea during the grazing stage at *Brachiaria brizantha*-based pastures during the dry period of the year was evaluated. Fifty-six heifers with approximately 284.72 ± 27.48 kg of body weight were used, distributed in a completely randomized design with four different treatment

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types: mineral salt; Urea - supplementation with 8.18% conventional urea; Mixed urea - supplementation with 4.09% conventional urea and 4.39% slow release urea and slow urea - supplementation with 8.78% slow release urea. Animals supplemented with mineral salt had longer grazing times compared to those supplemented with mixed urea, slow urea and regular urea. The dry matter intake, neutral detergent fiber and total digestible nutrients presented a similar effect, with higher values for heifers consuming supplements containing regular urea and slow urea compared to those of mixed urea. However, when the efficiency of hourly intake was evaluated, the animals that received urea supplement were more efficient in relation to the other treatments. The number of grazing periods for heifers receiving slow urea supplementation was higher compared to heifers receiving salt and mixed urea. The duration of grazing and rumination periods was longer for heifers receiving salt supplementation and mixed urea than those receiving regular urea and slow urea. It is recommended to use supplements at the level of 0.3% of body weight for heifers receiving conventional urea.
Key words: Intake. Deferral. Non-protein nitrogen. Ruminant.

Introduction

In Brazil, the use of tropical pastures, along with the supplementation of cattle, especially in the dry season, has been explored as a means to enable the production of beef cattle at lower costs (SILVA et al., 2009).

According to Berchielli et al. (2006), the forage intake of grazing animals is influenced by three groups of factors: those that affect the digestion process, those that affect the intake process, and those that affect nutritional requirements and the demand for nutrients.

These factors involve the entire breeding system and are defined directly by the pasture structure, characterized by height, leaf/stem ratio, forage availability and leaf blade mass, as well as chemical characteristics and digestibility of pasture (SCHIO et al., 2011). However, other factors that are not inherent to the plant are also related to the feeding behavior, such as the use of supplementation (SOUZA et al., 2011).

The use of non-protein nitrogen that is released gradually in the rumen, known as slow release urea, may be a strategy to decrease the use of true protein sources and conventional urea in bovine supplements (ALVAREZ ALMORA et al., 2012). The advantages include the reduction of urea intoxication risks, substitution of sources of true protein of high cost and / or limited availability, as well as improvement of nutrient synchronism in the rumen (SOUZA et al., 2010), thus affecting, among other things, the feeding behavior of the animals.

The feeding behavior of cattle in pastures is characterized by long periods of feeding, from 4 to 12h00 per day, for low energy diets (BÜRGER et al., 2000). The time spent in grazing and rumination is influenced by the pasture type and use of supplements, besides presenting differences in the duration of ingestion, rumination and of idle (MARTINS et al., 2012).

Thus, the objective of this study was thus to evaluate the feeding behavior of Nellore heifers under grazing conditions during the dry period of the year, receiving supplements containing mineral salt, conventional urea and slow release urea.

Materials and Methods

The field experiment was conducted at Fazenda Boa Vista, located in the municipality of Macarani - BA, between August and October 2009, which corresponds to the dry period in the region, lasting 84 days and divided into three periods of 28 days each. The tests were carried out at the Laboratory of Forage and Pasture and the Laboratory of Anatomy and Animal Physiology - LAFA, State University of Southwest of Bahia, Campus of Itapetinga, BA.

Nellore heifers with a mean age of 22 ± 4 months and 284.72 ± 27.48 kg of initial body weight were used for the experiment. The animals were confined

to an experimental area consisting of four pickets, two of them with an area of approximately 7.31 hectares and another two of approximately 6.12 hectares, formed by Brachiaria brizantha cv. Marandu grass deferred for 90 days, equipped with drinking fountains and double access, non-covered collective troughs of 4 meters each. The animals were rotated every seven days, in order to minimize the inherent effects of the pickets.

The experimental design was completely randomized, with four treatments and 14 replicates, with four supplements evaluated (Table 1), those being: a supplement with 8.18% of conventional urea; a supplement with 4.09% conventional urea plus 4.39% slow release urea and a supplement containing 8.78% slow release urea, plus a control group, in which the animals only received mineral supplementation at will.

Table 1. Availability of dry matter (ADM), forage allowances and Leaf: stem ratio of experimental pickets.

Variables*	**P1**	**P2**	**P3**	**P4**
ADM (kg ha^{-1})[1]	7248	5635	8869	8263
AGDM (kg ha^{-1})[2]	3445	2810	5340	4282
FS (Kg/100 $kgPC^{-1}$)[3]	14,85	11.47	21.58	20.27
Leaf: stem ratio	0.84	0.84	0.80	0.87

P: pickets; [1]ADM: Pasture dry matter availability; [2]AGDM: availability of green dry matter; [3]FA: forage supply.

Multiple supplements with different types of urea were balanced in advance in order to achieve daily mean gains of 0.300 g / day. It was supplied daily at 10 a.m. in the amount of 0.3% of body weight based on dry matter, with an individual trough length of approximately 30 cm per heifer located 15 meters from the water source. Following the recommendations of Santos et al. (2011), there was a period of adaptation that lasted for seven days prior to the beginning of the experimental period. During the adaptation stage, the heifers received supplements containing 0.5% of the urea mixture, in order to adapt to this ingredient, thus preventing intoxication. All animals had free access to shade, water and multiple supplementation.

The chemical-bromatological composition of the picket fodder was evaluated at the beginning and at intervals during each experimental period, when 12 samples were collected, cut at 5 cm from the soil. Sampling for the qualitative evaluation of the forage consumed by the animals was performed through simulated grazing, observing grazing of the heifers and then collecting the pasture from areas where grazing happened, thus simulating the material ingested by the animal. From these samples, individual dry weight and data on the percentage of each sample were obtained.

The residual biomass of dry matter (RBD) was estimated in two occupied pickets using double sampling method (WILM et al., 1994).

The estimation of daily DM accumulation rate (DAR) was performed using the equation proposed by Campbell (1966):

$$DARj = (Gi - Fi - 1)/n$$

Where: DARj = accumulation rate of daily dry matter during the j period, expressed in kg MS $ha\ day^{-1}$; Gi = the initial average dry matter of the four empty pickets at the moment i, expressed in kg MS ha^{-1}; Fi – 1 = the average final dry matter present in the empty pickets at the moment i – 1, expressed in kg MS ha^{-1}; n = number of days in the j period.

The forage supply (FS) was calculated according to the formula proposed by Prohmann (2004):

$$FS = \{(RBD + DAR)/LWtotal\}*100$$

Where: FS = forage supply, expressed in kg MS/100 kg PC day^{-1}; BRD = total residual biomass, expressed ind kg de MS ha day^{-1}; DAR = daily accumulation rate, expressed in kg MS ha day^{-1}; LW = animal live weight, expressed in kg ha^{-1}.

Table 2 shows the availability of dry matter, forage supply and leaf / stem ratio of the experimental pickets.

The forage samples and supplements were identified, weighed and dried in a forced air ventilation oven at 55 ºC for 72h00, then milled in a Willey type mill using a 1 mm mesh sieve, then packed in previously marked plastic containers and stored for further analysis. The dry matter (DM), crude protein (CP), ethereal extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF), hemicellulose (HEM), cellulose (CEL), lignin (LIG) and mineral matter (MM), were then determined in the samples according to procedures described by Detmann et al. (2012), while neutral ash and protein-free detergent fiber (NapDF) was determined according to Mertens (2002).

Table 2. Proportions of ingredients, based on natural matter.

Foods (%)	Tratamentos			
	Salt	Urea	Mixed urea	Slow Urea
Ground corn	-	68.58	68.28	67.98
Soybean meal	-	17.41	17.41	17.41
Slow Urea + AS[1]	-	-	4.39	8.78
Conventional urea + AS[1]	-	8.18	4.09	-
Mineral salt [2]	100	5.83	5.83	5.83

[1]Mix composed of nine parts of urea and one part of ammonium sulphate (AS). [2]Mineral salt containing 233 g de Ca/kg, 80 g de P/kg, 5 g de Mg/kg, 48 g de Na/kg, 25 mg de Co/kg, 380 mg de Cu/kg, 25 mg de I/kg, 1080 mg de Mn/kg, 3,75 mg de Se/kg, 1722 mg de Zn/kg.

The non-fibrous carbohydrates (NFC) of samples that did not contain urea were calculated using the equation proposed by Detmann and Valadares the Son (2010):

NFC = 100 – (%CP + %EE + %Cinzas + %NapDF)

At the same time, the NFCs of the samples containing urea were calculated using the equation proposed by Hall (2000):

NFC = 100 - (%CP - %CPU + %U) + %MM + %EE + %NapDF)

Where %CPU = crude protein content derived from urea and %U = urea content.

The contents of food components and supplements present in pastures are shown in Table 3.

Table 3. Chemical composition of *Brachiaria brizantha* grass and supplements.

Components	*Brachiaria brizantha*[1]	Suplements		
		Urea	Mixed urea	Slow urea
Dry matter (%)	43.70	86.34	86.31	86.32
Neutral detergent fiber corrected (% DM)	68.88	2.90	3.35	5.01
Acid detergent fiber (% DM)	38.50	1.83	1.85	2.15
Non-fibrous carbohydrates (% DM)	13.27	38.27	37.02	36.82

[1]Simulated grazing.

For the evaluation of the animal behavior, 14 heifers from each treatment were used, numerically identified in a visible way on their carcasses. The variables were evaluated visually by 16 trained observers distributed by treatment and working in alternate shifts every 03h00. The studied behavioral data included grazing periods, rumination, idle and trough. Behavioral activities were considered mutually exclusive, as defined by Pardo et al. (2003).

To record the time spent on each activity: feeding, rumination, idle and trough, the animals were visually observed every 5 minutes for 24h00 using a digital timer and lanterns during night time to facilitate the visualization of the animals and the making of necessary notes. This procedure was performed on the 23rd day of each experimental period (MEZZALIRA et al., 2011).

The mean number of mericics chewing per ruminal cuds (MRC), time spent for rumination of each cuds (TRC) and number of ruminated cuds (NRC) in the period was obtained according to the methodology described by Burger et al. (2000). The total chewing time (TCT) was determined by the sum of the grazing time and rumination time.

The discretization of the time series was performed directly on data collection worksheets, with the counting of the discrete periods of grazing, rumination, idle and trough, as described by Silva et al. (2009). The mean duration of each of the discrete periods was obtained by dividing the daily times of each activity by the number of discrete periods. In all behavioral variables, one animal represented an experimental unit. Feed efficiency was calculated according to methodology described by Bürger et al. (2000).

The results were interpreted statistically by means of variance analysis and the significance observed between treatments using the F test and the mean values compared using the Tukey test. All statistical procedures adopted the $\alpha = 0.05$ formula, using the SAEG program, version 9.1 (SAEG, 2007).

Results and Discussion

The studied pickets did not disfavor pasture intake. According to Paulino et al. (2008) and Silva et al. (2009) values for tropical pastures of dry matter availability and green forage dry matter of 4,000 and 2,500 kg / ha, respectively, can be considered as ideal for providing maximum forage intake rate by cattle.

The time spent on grazing, rumination, idle and trough are shown in table 4. Heifers receiving supplementation with mineral salt had a longer grazing time compared to those receiving supplementation with mixed urea (6.45%), slow urea (13.64%) and regular urea (22.54%). What probably could have happened was the substitution effect of the supplements containing urea, leading to the reduction of grazing time, as opposed to mineral supplementation. Therefore, heifers that received supplements containing urea spent less time on grazing, a fact explained by the higher bulk energy and protein intake provided by the higher intake and synthesis of nutrients from the supplement. In contrast, heifers who received only the mineral supplement (salt) had to resort to just pasture to meet their protein and energy requirements, resulting in longer grazing time. The same behavior was observed in studies carried out by Benatti et al. (2012).

The animals consuming supplement with mixed urea showed a longer grazing time (600.00 min day^{-1}) compared to those supplemented with slow urea (553.93 min day^{-1}), which, in turn, presented higher values than those supplemented with regular urea (496.79 min day^{-1}). This effect can be explained by the low synergism of the nutrients in the rumen, that is, inadequate nitrogen availability and ruminal pH for maximum performance of the microorganisms, provided by the supplementation containing mixed urea, compared to the slow urea and urea supplements (RIBEIRO et al., 2011), which led them to try and satisfy their demands through the pasture, resulting in longer grazing time.

Table 4. Grazing times, rumination, idleness and trough time in minutes of heifers fed diets containing mineral salt, conventional urea and slow release urea.

Activity (min.)	Suplements				CV (%)[1]	P[2]
	Salt	Urea	Mixed urea	Slow urea		
Grazing	641.43a	496.79d	600.00b	553.93c	6.40	0.001
Rumination	490.93b	476.79b	535.71a	543.21a	8.06	0.001
Idle	303.64b	454.64a	293.57b	317.50b	14.46	0.001
Trough	4.00c	11.78b	10.72b	25.36a	35.70	0.001

Means followed by different letters on the same line differ at the 0.05 level of significance.
[1]Coefficient of variation in percentage. [2]Probability of error.

According to Hodgson (1990), when animals receive supplementation, new factors interfere with nutrient intake and are associated with forage substitution ratios of the supplement and / or total dry matter intake gain, which change according to the characteristics of the forage base and of the supplement itself.

Heifers consuming supplementation composed of mixed urea and slow urea were found to chew more than those supplemented with mineral salt and urea (535.71 and 543.21 x 490.93 and 476.79 min day^{-1}, respectively). The supplementation by mixed urea could have resulted in failures of the synchrony between the degradation of the fibrous carbohydrates and the sources of non-protein nitrogen contained in the supplement (ÍTAVO et al., 2016). This may be justified by the increased rumination time of the animals, even when they presented lower intake of dry matter in relation to the other diets. On the other hand, supplementation containing slow urea resulted in higher fiber intake and, consequently, heifers spent more time ruminating (SILVA et al., 2010). Van Soeste (1994) states that the composition of the diet interferes with the time spent for rumination, which is probably proportional to the cell wall content of the roughage, so that the more fibrous the diet, the more time the animal spends on rumination.

Heifers that consumed regular urea supplements ruminated less time, probably because this type of supplement allows for maximum microbial growth and greater efficiency of fiber degradation, favoring lesser rumination periods. Although they also had a longer grazing time, heifers who received mineral salt supplements ruminated during smaller periods as well. This behavior may have occurred because the animals performed more efficient selection of the roughage, which favored the intake of a diet with more nutritional quality, thus favoring rumination (BARBOSA et al., 2013).

The heifers supplemented with common urea remained longer in idle compared to those supplemented with salt, mixed urea and slow urea (454.64 x 303.64, 293.57 and 317.50 min day^{-1}, respectively), probably due to them spending less time on grazing and ruminating, a fact also observed by Souza et al. (2011).

The supplements containing urea, mixed urea and slow urea contributed to the animals remaining longer in the trough compared to those supplemented with mineral salt (16.43, 15.36 and 30.36 x 5.00 min day^{-1}, respectively). This effect was expected, since the animals with longer time spent in the trough received a higher amount of supplementation (0.3%PC). However, animals consuming slow urea supplement remained longer in the trough compared to those supplemented with urea and mixed urea (30.36 x 16.43 and 15.36 min day^{-1}, respectively). According to Alvarez Almora et al. (2012), this effect can be explained by the lower acceptability of the urea-containing supplement with slow release compared to conventional urea, allowing its intake by the animals in a gradual manner.

The intake of DM and NDF from pasture and diet NDT had a similar effect, with higher values for heifers that received urea and slow urea supplements compared to those of mixed urea (Table 5). Heifers supplemented with salt showed similar NDF and NDT intake when compared to mixed urea. These results show that supplements containing urea and slow urea improved the ruminal environment, favoring the intake of nutrients, probably by maximizing microbial activity and, consequently, fiber degradation.

Table 5. Nutrient intake and rumination of heifers eceiving supplement containing mineral salt, conventional urea and slow release urea.

Activity	Suplements				CV (%)[1]	P[2]
	Salt	Urea	Mixed urea	Slow urea		
Intake DM/h pasture (g)	409.71c	670.30a	409.00c	562.16b	15.89	0.001
Intake NDF/h pasture (g)	282.49c	461.36a	282.00c	387.77b	15.89	0.001
Intake TDN/h diet (g)	192.13c	330.85a	204.76c	268.02b	16.07	0.001
Rumination DM/h pasture (g)	532.06bc	698.42a	458.08c	573.26b	15.85	0.001
Rumination NDF/h pasture (g)	366.85bc	480.71a	315.84c	395.43b	15.85	0.001

Means followed by different letters on the same line differ at the 0.05 level of significance.
[1]Coefficient of variation in percentage. [2]Probability of error.

Total chewing time (Table 6) was higher for heifers receiving salt, mixed urea and slow urea supplements, compared to those supplemented with regular urea (1140.36, 1151.07 and 1127.50 x 990.00 min^{-1}) (RIBEIRO et al., 2011), since they were able to satisfy their nutritional requirements more quickly.

Table 6. Total chewing time, number of cuds per day, time spent by cud, number of chews per cud of heifers fed diets containing mineral salt, conventional urea and slow release urea.

Activity	Suplements				CV (%)[1]	P[2]
	Salt	Urea	Mixed urea	Slow urea		
Total chewing time	1140.36a	990.00b	1151.07a	1127.50a	4.48	0.001
Number of cuds per day	577.36	547.40	638.38	639.32	22.45	0.231
Time/cuds (seconds)	51.33	52.26	50.35	50.98	15.60	0.676
chews/cuds	53.89b	53.58b	53.55b	58.58a	16.02	0.013

Means followed by different letters on the same line differ at the 0.05 level of significance.
[1]Coefficient of variation in percentage. [2]Probability of error.

The results regarding total chewing time found in the present study are in disagreement with the theory of Dulphy et al. (1980), which says that with the increase of the levels of concentrate in the total diet and consequent increase of the starch content, there would be a decrease in the total chewing time. However, the supplementation level of 0.3% seems to be too low to detect this effect in treatments with slow urea and mixed urea.

The number of cuds per day and the time spent per ruminated cuds did not present a difference between the supplements, with a mean value of 600.61 cuds/24h00 and 51.23 seconds/cuds, respectively. The number of chews per ruminated

cuds differed in that heifers supplemented with slow urea presented more chews compared to those supplemented with salt, urea and mixed urea (58.58 x 53.89, 53.58 and 53.55 chews / cuds). The possible explanation for the greater chew per cuds ratio of heifers supplemented with slow urea is that the urea capsule coating may become a physical barrier to the access of the microorganisms, thus causing the degradation process to be reduced to the point where both solubility and the availability of nitrogen by ruminal microorganisms decrease (ÍTAVO et al., 2016).

The number of grazing periods (Table 7) for heifers receiving slow urea supplements was higher than those supplemented with salt and mixed urea (14.57 x 11.93 and 11.57, respectively), while common urea presented a grazing period comparable to other supplements. It is possible that this result was due to the time spent consuming the supplement with slow urea, which is a supplement based on self-control of ingestion, with intake divided into separate installments throughout the day.

Table 7. Number of periods and duration of behavioral activities of heifers fed diets containing mineral salt, conventional urea and slow release urea.

Atividades	Suplements				CV (%)[1]	P[2]
	Salt	Urea	Mixed urea	Slow urea		
NFP[3]	11.93b	13.14ab	11.57b	14.57a	14.83	0.001
NRP[4]	12.57b	19.07a	12.64b	20.21a	13.32	0.001
NIP[5]	17.64c	27.86a	12.71d	24.00b	13.89	0.001
PNET[6]	1.00c	2.93b	1.00c	4.71a	38.06	0.001
FT (min)[7]	55.20a	38.17b	52.51a	39.24b	16.67	0.001
TRP (min)[8]	39.95a	25.30b	42.78a	27.40b	15.07	0.001
TIP (min)[9]	17.46b	16.48b	23.35a	13.31c	16.48	0.001
TPT (min)[10]	5.00b	5.76b	15.36a	6.48b	21.95	0.001

Means followed by different letters on the same line differ at the 0.05 level of significance.
[1]Coefficient of variation in percentage. [2]Probability of error. [3]NFP - number of food periods; [4]NRP - number of rumination periods; [5]NIP: number of idle periods; [6]PNET: period number eating in the trough; [7]FT feeding time; [8]TRP: time per rumination period; [9]TIP – time per idle period; TPT – time per period in the trough.

Heifers receiving urea and slow urea supplements had a higher number of rumination periods compared to heifers receiving salt and mixed urea supplements (19.07 and 20.21 x 12.57 and 12.64, respectively). The number of grazing and rumination periods is directly related to ruminal activity (SILVA et al., 2010), in which heifers that received a supplement containing urea and slow urea probably had higher ruminal degradation rate and as a consequence, smaller time of food being retained in the rumen, leading to a greater number of grazing and ruminating periods (CARVALHO et al., 2007).

The idle period was higher for heifers receiving urea supplements (27.86), followed by heifers supplemented with slow urea (24.00), which was higher than that of heifers supplemented with mineral salt (17,64). Animals consuming mixed urea supplement presented a shorter period of rest (12.71), due to the longer time spent on grazing.

The number of periods in the trough was higher for animals receiving slow urea supplement (4.71), followed by those receiving urea (2.93). The animals consuming mineral salt supplement and mixed urea supplement showed a similar trough

period (1. 00), indicating that they used trough only once a day, which may be an intrinsic characteristic of the animals.

The duration of the grazing period and rumination were higher for heifers receiving salt and mixed urea supplements compared to those receiving urea and slow urea, with grazing values of 55.20 and 52.51 x 38.17 and 39, 27 min day^{-1} / period, respectively, and rumination values of 39.95 and 42.78 x 25.30 and 27.40 min. period^{-1}, respectively. This effect is explained by the lower number of grazing and rumination periods of the mixed urea and salt treatments, resulting in larger durations for each period of these activities. According to a study by Silva et al. (2010), it was observed that animals with greater number of grazing or rumination periods spend less time on these activities within each individual period.

Heifers receiving a mixed urea supplement had a longer duration of rest periods (23.35 min, day^{-1} / period); however, those receiving a slow urea supplement had a shorter duration of rest period (13.31 min. day^{-1} / period). The duration of the trough period was higher for heifers receiving mixed urea supplement, compared to heifers receiving salt, urea and slow urea supplements (15.36 x 5.00, 5.76 and 6.48 min. day-1 / period, respectively). These effects for duration of the idle and trough periods are also a reflection of the number of periods of each activity.

Conclusion

The supplementation does change the feeding behavior of the bovine, depending not only on the amount of ingested supplement, but also on its composition, with conventional urea providing better efficiency of intake and rumination of nutrients.

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