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REGULAR ARTICLES

Intake and ingestive behavior of lambs fed diets containing ammoniated buffel grass hay

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Abstract This study aimed to evaluate the effect of diets with ammoniated buffel grass hay on the ingestive behavior of feedlot lambs. Thirty-two sheep of no defined breed with an average body weight of 17.7 ± 1.8 kg were used. A completely randomized design with four treatments (0, 18, 36, and 54 g/kg dry matter (DM) basis) and eight repetitions was used. Ingestive behavior, rumination, and idle time were similar ($P > 0.05$) among the diets containing ammoniated buffel grass hay, with mean values of 294.5, 554.44, and 594.25 min per day, respectively. Regarding the chews, all of the variables resulted in similar behavior ($P > 0.05$). The quadratic effect ($P < 0.05$) observed for daily intake can be explained based on the amount of DM and neutral detergent fiber (NDF) per meal per rumination. There was no effect of urea levels from the ammoniation ($P > 0.05$) on the efficiency of DM and NDF consumption. However, the rumination efficiency of DM and NDF showed a quadratic effect ($P < 0.05$). Thus, the use of ammoniated buffel grass hay with urea in lamb diet affects the ingestive behavior by increasing the rumination efficiency, increased intake, and feed utilization.

Keywords Efficiency · Feeding activities · Idle · Rumination

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Introduction

Ruminants are able to express their ingestive behavior through metabolic alterations caused by certain amounts nutrient intake (Silva et al. 2015a). These animals adapt to different feeding conditions, management, and environment and modify the parameters of ingestive behavior to achieve and maintain a certain level of intake consistent with their nutritional requirements (Hodgson 1990).

The quality of the diet can be increased with the ammonization of the forage, which has been shown to improve the nutritional value of tropical hay that originates from plants harvested at an advanced stage of development (Fernandes et al. 2002). The changes in the composition of the fiber result in increased digestibility and dry matter intake of the animals (Berger et al. 1994).

The study of the feeding behavior (Cirne et al. 2014; Facuri et al. 2014; Silva et al 2015a; Silva et al. 2015b; Silva et al. 2016; Souza et al. 2013; Costa et al. 2014; Correia et al. 2015; Nicory et al. 2015) is a tool of great importance for the understanding of food intake, which is essential when aiming to improve and define management practices in animal production. According to Silva et al. (2014) and Eustáquio Filho et al. (2014), the ingestive behavior that the animal expresses is determined by the metabolic changes that are promoted by greater or lower intake of a certain nutrient.

According to Carvalho and Pires (2008) and Mendes et al. (2015), variations in fiber content in experimental diets can promote changes in time spent in feeding activity and rumination. Van Soest (1994) reported that the time spent in rumination is influenced by the nature of the diet, and probably, it is proportional to the cell wall content of forages, so that the higher is the fiber content of the diet, the more time is spent on rumination.

Thus, this study aimed to evaluate the ingestive behavior of feedlot lambs fed diets with buffel grass hay ammoniated with urea.

Material and methods

The experiment was conducted at Estação Experimental Pendência, da Empresa de Pesquisa Agropecuária da Paraíba S.A. (EMEPA), located at mesoregion of Paraibano Agreste, microregion of West Curimataú, city of Soledade-PB (7° 8′ 18″ S and 36° 27′ 2″ W), with an altitude of 534 m. The experimental period was between September and November 2012.

Animals and experimental diets

During the pre-experimental period, the animals were weighed, dewormed, and quarantined for 15 days to confinement and experimental diets. The haying process was carried out in August 2012 using the traditional method with buffel grass harvested at the beginning of the dry season in a pasture not grazed during the rainy season.

The ammonization process was conducted initially by weighing the hay bales then adding urea concentrations at the following proportions: 0, 18, 36, and 54 g/kg dry matter (DM). Urea was diluted with water and applied uniformly to moisten all of the material wrapped in plastic canvas. After 30 days, the hay was opened and given to the animals after 24 h of outdoor exposure.

Thirty-two lambs with no defined breed with an initial average weight of 17.7 ± 1.8 kg were used. The animals were distributed in a completely randomized design, and treatments consisted of four diets of buffel grass hay ammoniated with different concentrations of urea. The diets were isonitrogenous and calculated to meet the nutritional requirements of an average daily gain of 0.2 kg for sheep according to the NRC (2007) (Tables 1 and 2).

The diets were fed twice daily to the lambs at 9:00 and 16:00 h, ad libitum, to allow for 10 to 20% leftovers. The offered food samples and remains were collected weekly, and thereafter, the samples were partially pre-dried in a drying oven at 60 °C for 72 h and ground in a mill with a sieve equipped with 1-mm sieves, placed in plastic pots with covers, and stored for further analysis.

Laboratory analysis

The ingredients, diets, and leftovers were analyzed for levels of dry matter (DM; method 967.03), ash (method 942.05), crude protein (CP; method 981.10), and ether extract (EE; method 920.29) contents according to the AOAC (1990), whereas the neutral detergent fiber (NDF) and acid detergent fiber (ADF) levels were determined by adopting the methodology of Mertens (2002). Lignin was obtained by adopting the methodology of Silva and Queiroz (2002), with the residue from the ADF treated with 72% sulfuric acid.

Table 1 Chemical composition of the ingredients in the experimental diets

Item (g/kg DM)[1]	Ammoniated buffel grass hay				Soybean meal	Corn meal
	Urea level (g/kg)					
	0	18	36	54		
DM	850.7	841.6	830.5	831.0	913.2	901.1
OM	892.0	870.3	910.6	890.5	934.5	984.5
CP	23.0	46.4	63.3	78.2	453.9	99.2
EE	7.9	11.6	9.9	12.4	24.9	45.6
NFC	94.3	64.5	69.6	64.8	317.1	721.3
NDF	747.2	740.9	751.7	735.1	138.6	118.4
NDIP	25.4	33.0	32.2	31.0	422.5	87.3
TC	841.5	805.4	821.3	799.9	45.7	839.7
ADF	530.1	514.5	536.4	514.9	98.6	40.8
Hemicellulose	217.1	226.4	215.3	220.2	40.0	77.6
Cellulose	477.2	463.2	482.9	463.6	85.3	29.2
Lignin	52.9	51.3	53.5	51.3	13.3	11.6
Ash	108.0	129.6	89.3	109.4	60.2	15.5

DM dry matter, *OM* organic matter, *CP* crude protein, *EE* ether extract, *NFC* non-fibrous carbohydrates, *NDF* neutral detergent fiber, *NDIP* neutral detergent-insoluble protein, *TC* total carbohydrates, *ADF* acid detergent fiber

[1] Regression equation of the respective variable that had an effect

Table 2 Proportion of the ingredients and composition of the experimental diets

Ingredients (g/kg DM)	Ammoniated buffel grass hay			
	Urea level (g/kg MS)			
	0	18	36	54
Buffel grass hay	485	511	523	536
Corn meal	382	365	358	350
Soybean meal	95	90	89	87
Calcareous	5	4	4	4
Mineral supplement	17	16	16	15
Urea	8	5	2	0
Ammonium chloride	8	8	8	8
Bromatological composition (g/kg DM)				
Dry matter (g/kg fresh matter)	881.5	874.1	868.2	867.2
Organic matter	897.4	888.1	911.8	903.1
Crude protein	127.4	127.9	127.7	129.2
Ether extract	23.6	24.8	23.7	24.7
Neutral detergent fiber	420.7	434.2	447.8	447.5
Acid detergent fiber	282.0	286.6	303.9	298.8
Non-fibrous carbohydrate	351.3	324.7	322.8	314.7
Total carbohydrate	772.1	759.0	770.7	762.2
Ash	102.6	111.9	88.2	96.9
NDIP[2]	85.8	86.8	85.7	84.0
Cellulose	250.7	256.0	270.9	266.1
Hemicellulose	138.7	147.6	143.9	148.7
Lignin	31.3	31.6	33.3	32.7
iNDF[3]	257.4	245.8	241.9	251.3

Assurance levels (per kg active element): calcium, 120.00 g; phosphorus, 87.00 g; sodium, 147.00 g; sulfur, 18.00 g; copper, 590.00 mg; cobalt, 40.00 mg; chromium, 20.00 mg; iron, 1800.00 mg; iodine, 80.00 mg; manganese, 1300.00 mg; selenium, 15.00 mg; zinc, 3800.00 mg; molybdenum, 300.00 mg; maximum fluorine, 870.00 mg; soluble phosphorus (P) in 2% citric acid, 95%; neutral detergent-insoluble protein, 2%; and indigestible NDF, 3%

Superscript numbers refer to the regression equation of the respective variable that had an effect

Using the methodology of Mertens (1997), the concentration of non-fibrous carbohydrates (NFC) of the feeds was quantified, while the NDF was corrected for residual ash and protein. The neutral detergent-insoluble protein (NDIP) was obtained according to the methodology of Licitra et al. (1996).

The percentage of total carbohydrates (TC) was calculated according to the method by Sniffen et al. (1992), and non-fiber carbohydrate (NFC) was obtained by the difference between TC and NDF.

$$TC = 100 - (\%CP + \%EE + \%ash)$$
$$NFC = TC - NDF$$

Ingestive behavior evaluation

For the evaluation of ingestive behavior, the animals were subjected to visual observation for a period of 24 h while on the 14th day of the experimental period, observations were made for 5 min to evaluate the feeding, rumination, and idling times. During the night, the environmental observations were carried out under artificial lighting. Also, observations of each animal were divided into three periods: morning, afternoon, and evening. During these periods, the number of chews per ruminal bolus and the time spent ruminating each bolus were recorded. The data were collected by trained observers with the aid of digital timers.

In order to calculate behavior variables, feeding, and rumination in minutes per kilograms of DM and NDF, feeding efficiency (g DM and NDF/h), rumination efficiency (in g DM and NDF/cuds and g DM and NDF/h), and mean intake of DM and NDF per feeding period, we considered the voluntary intake of DM and NDF on the 14th day of each period and computed the leftovers on the 15th day of each period. The data on behavioral variables were obtained according to the methodology described by Burger et al (2000).

The number of daily ruminated cuds was calculated by dividing the total rumination time (min) by the average time spent on the rumination of a cud. For the concentration of DM and NDF in each ruminated cud (g), the quantity of DM and NDF consumed (g) in 24 h was divided by the number of ruminated cuds per day.

The feed and rumination efficiencies were obtained as follows:

$$DMFE = DMI/FEED$$
$$NDFFE = NDFI/FEED$$

where DMFE is the feed efficiency in gram DM consumed/hour, NDFFE is the feed efficiency in gram NDF consumed/hour, DMI and NDFI are the daily intakes of dry matter and NDF, respectively, and FEED is the time spent feeding per day.

$$DMRE = DMI/RUM$$
$$NDFRE = NDFI/RUM$$

where DMRE is rumination efficiency in gram DM rumination/hour, NDFRE is the rumination efficiency in gram NDF ruminated/hour, DMI and NDFI are the daily intakes of dry matter and NDF, respectively, and RUM is the time spent ruminating per day.

$$\mathrm{TCT} = FEED + RUM$$

where TCT is the total chewing time, in minute/day.

The numbers of feeding, rumination, and idle periods were counted by observing the sequential number of activities on the data spreadsheet. The mean daily time spent on these periods was calculated by dividing the total duration in each activity (feeding, rumination, and idle) by its respective number of periods.

Statistical analysis

The experimental design was completely randomized, with four treatments and eight repetitions. The data were interpreted statistically using the parametric technique of analysis of variance (ANOVA) and regression at 5% probability, using the System for Statistical Analyses and Genetics (SAEG) program SAEG 9.1 (SAEG 2007).

Results and discussion

The activities of feeding, rumination, and idleness were similar ($P > 0.05$) between treatments with buffel grass hay ammoniated at different levels of urea, with averages of 294.5, 554.44, and 594.25 min per day, respectively (Table 3).

According to Carvalho et al. (2008), changes in time spent in feeding behavior and rumination have frequently been observed in studies in which the experimental diets showed variations in fiber content. Van Soest (1994) also reported that the time spent ruminating is influenced by the nature of the diet and is probably proportional to the cell wall content; thus, the higher the fiber content of the diet, the greater the time spent in rumination. In the present study, we observed the absence of an ammoniation effect in decreasing the fiber in the buffel grass hay diet (Table 1), explaining the similar behavior in the time spent on feeding and ruminating.

Another explanation for the lack of an observed effect on feeding behavior and rumination may also be related to the similarity of food particles sizes because the processing was the same for all of the experimental diets. The particle size can be an important factor influencing the nutritional value of the food because it affects both the dry matter intake as rumen retention (Van Soest 1994) and the activities of rumination and chewing (Saenz 2005).

According to Van Soest (1994), confined animals spend up to 6 h consuming foods with low energy and high fiber. In this study, the average figure for feeding time was 4.89 h/day, which is equivalent to 38.42% of the daily activities. Silva et al. (2016) evaluated the feeding behavior of lambs fed diets containing cottonseed cake replacing soybean meal and found mean values of 4.77 h/day. The values are similar to the present study because the diets showed similar NDF.

Welch (1982) stated that rumination activity is within the range of 8–9 h per day. In this study, the average time spent in rumination was 9.22 h/day. Lower values were reported by Alves et al. (2010). They reported that sheep fed diets containing mesquite meal with various levels of urea spent 7.81 h/day in rumination, and in the study by Mendes et al. (2010), the mean value was 4.91 h/day in lambs fed diets of sugarcane bagasse.

Table 4 presents data on the ruminating chews, the number of cud per day, the number of chews per rumination, the average time of chewing per swallowed cake, and the number of chews per minute, which were similar ($P > 0.05$) between the experimental diets, respectively averaging 581 cuds/day, 73.69 chews/cud, 58.10 chews/cuds in seconds, 72.56 chews/min, and 104,496.3 chews/day.

It should be therefore noted that feeding conditions and feed characteristics can change the ingestive behavior parameters because the interactions between dietary components can increase the microbial efficiency and improve digestibility, thereby shortening the retention time in the rumen (Bastos

Table 3 Time spent eating, ruminating, and idling; number of cud per day; chewing number per rumination; average time of chewing per swallowed cud; chews number per minute; and total chewing per day in lambs fed hay ammoniated with urea

Item	Ammoniated buffel grass hay				*P* value		SEM
	Levels of urea (g/kg DM)						
	0	18	36	54	L	Q	
Feed							
Min/day	275.4	311.4	303.6	285.4	0.807	0.189	10.029
Rumination							
Min/day	557.1	553.9	555.0	547.5	0.782	0.925	11.145
Idle							
Min/day	607.5	574.7	581.4	607.1	0.975	0.348	15.208
Chew							
Cuds/day	632	551	586	555	0.201	0.464	15.208
Num/cud	67.41	81.42	73.24	72.70	0.676	0.085	2.025
Seconds/cud	53.43	61.66	57.52	59.81	0.623	0.586	1.417
Num/minutes	60.24	85.16	71.38	73.49	0.425	0.124	3.581
Total	86745	122629	102782	105829	0,425	0.124	5157

SEM standard error of the mean, *L* linear effect, *Q* quadratic effect

Table 4 Dry matter and insoluble neutral detergent fiber intakes and dry matter and neutral detergent fiber by cud ruminated in lambs fed diets containing hay ammoniated with urea

Item	Ammoniated buffel grass hay				*P* value		SEM
	Levels of urea (g/kg DM)						
	0	18	36	54	L	Q	
Intake (g/day)							
DM[1]	1058.0	1245.9	1229.6	1112.5	0.629	0.032	33.591
NDF[2]	426.12	530.07	552.12	486.03	0.137	0.008	14.683
Intake (min/kg)							
DM	263.32	255.35	255.56	257.35	0.866	0.836	11.590
NDF	658.48	597.56	566.18	590.08	0.333	0.436	26.772
Intake (g/feed period)							
DM	96.14	107.44	104.60	116.61	0.416	0.950	7.905
NDF	38.64	45.68	47.12	51.09	0.222	0.827	3.464
Mass to ruminated cud (g/cud)							
DM[3]	1.70	2.30	2.18	2.06	0.168	0.025	0.075
NDF[4]	0.69	0.97	0.96	0.89	0.045	0.009	0.032
Regression equations							R^2
1. $\hat{Y} = 1063.2 + 13.526x - 0.2353x^2$							0.978
2. $\hat{Y} = 425.81 + 8.206x - 0.1312x^2$							0.999
3. $\hat{Y} = 1.736 + 0.0353x - 0.0006x^2$							0.868
4. $\hat{Y} = 0.7015 + 0.0179x - 0.0003x^2$							0.698

Superscript numbers refer to the regression equation of the respective variable that had an effect

SEM standard error of the mean, *L* linear effect, *Q* quadratic effect

et al. 2014). The number of ruminal cuds depends on the rumination time and the time spent ruminating each cud, and the absence of variation in these times indicates similar levels of digestibility among the treatments.

Pereira et al. (2007) reported 524.98 and 636.39 cuds per day for diets containing 30 and 60% NDF, respectively. These values are compatible with the average obtained in this study which was 581 cuds per day at 43.75% NDF. According to Mendes et al. (2008), time spent chewing increases with the level of NDF in the fiber supply. This is due to the increase in time spent chewing and the reduction in dry matter intake.

Chewing activities are important mechanisms in the process of reducing the particle size of the food, accounting for over 80% of the total breakdown of particles (McLeod and Minson 1988). For bulky diets, chewing increases the amount of rumination by increasing the fractions of dry matter and potentially digestible fiber, and it reduces latency to fiber degradation (Burger et al 2000). Further, according to Carvalho and Pires (2008), the process of chewing is very important not only for reducing particle size but also for producing cracks into which the rumen microorganisms can enter.

The diets containing different amounts of urea for the ammoniation of buffel grass hay showed levels of DM and NDF intake with a quadratic positive effect ($P < 0.05$), with diets with intermediate urea levels of 18 and 36 g/kg DM, obtaining higher consumption values of DM and NDF (Table 4). The incorporation of increasing doses of urea in the diet increased the intake of nutrients, but up to a point. This demonstrates the stimulus provided by degradable protein supplementation; however, there is a certain limit (Mathis et al. 2000) that was observed with the diet containing higher level of urea (54 g/kg DM) where there was a decrease in the intake of DM and NDF.

According to Berchielli et al. (2011), DM intake is positively correlated to the digestibility of NDF. The NDF is responsible for regulating the consumption of nutrients due to the physical effect of filling the rumen. Thus, with more efficient fiber rumination, digestion occurs more quickly, leading to emptying of the rumen and increasing the possibility of new consumption. Non-protein nitrogen is very important in the digestion of fiber diets (Kozloski 2011) because it stimulates the growth of fermenting bacteria. Importantly, large amounts of fibrous carbohydrates are present in buffel grass hay, whether ammoniated or untreated. The decline in feed consumption is probably due to metabolic factors and/or the poor palatability of urea, which has a bitter taste (Melo et al. 2003).

There were no significant differences ($P > 0.05$) between treatments for DM and NDF per period. This likely led to the absence of differences in time spent feeding per feeding period and in the number of feeding periods, as reported in the following (Table 3). The mean values per feeding period for DM and NDF were 106.19 and 45.63, respectively.

The ammoniation with urea produced no significant effects ($P > 0.05$) on the DM and NDF consumption, with mean values of 257.89 and 603.07 min/kg, respectively. The mass per brooded cake can be an important indicator of the effectiveness of rumination; thus, according to Burger et al. (2000), the animal chews a larger amount of food per bolus over the same period of time, therefore obtaining a higher consumption rate and a better feed. Thus, the quadratic behavior observed for daily consumption can be explained by the quadratic relationship ($P < 0.05$).

The inclusion of dietary urea by ammoniation and concentrate offers a greater amount of nitrogen to the rumen microorganisms, enhancing microbial efficiency. This can improve the digestibility of DM and NDF, thus potentially increasing the average daily consumption and mass quantity by rumination, which in this case showed a difference between the urea levels used in the ammoniation. The quadratic effect is probably due to the greater effectiveness of this fiber diet due to the incorporation of the urea. By the regression equation (Table 4), it was observed that the maximum amount of mass of ruminated DM per cud (of 2.31 g/cud) was found in the diet containing 31.77 g of urea per kilogram of DM. The ammonia toxicity produced by increasing the amount of urea via hay ammoniation should therefore directly affect feed consumption.

However, there was no effect of urea levels from the ammoniation ($P > 0.05$) on the efficiency of DM and NDF consumption, with averages of 244.25 and 105.25 g/h, respectively (Table 5). The lack of an observed effect on supply activities may also be related to the consistent chemical composition among the diets, due to the lack of the expected effects of ammoniation on the bulky fiber, in addition to the same variation between the consumption values and feeding time. According to Macedo Junior et al. (2007), the intake of long particles during feeding stimulates ruminating activity via the promotion of physical motor activity of the gastrointestinal tract.

The rumination efficiency of DM and NDF showed a quadratic effect ($P < 0.05$). Rumination efficiency is an important mechanism for controlling the use of poorly digestible food. Generally, these variables are influenced by the consumption of DM and NDF, and Carvalho et al. (2004) observed higher rumination efficiency when animals consumed larger amounts of these nutrients, similar to the behavior observed in this study.

The use of non-protein nitrogen sources in the diet, through hay ammoniation through the use of urea (Table 2), increased rumination efficiency by improving the cellulolytic activity of rumen microorganisms, thereby providing greater nutrient uptake.

Table 5 Feed and rumination efficiency; number of periods in feeding, rumination, and idleness; and time spent per period in feeding, rumination, and idleness in lambs fed with hay buffel grass ammoniated with urea

Item	Ammoniated buffel grass hay				*P* value		SEM
	Levels of urea (g/kg DM)						
	0	18	36	54	L	Q	
Feed efficiency (g/h)							
DM	241.46	252.61	247.05	237.03	0.834	0.599	9.928
NDF	97.58	106.97	111.04	103.54	0.561	0.320	4.159
Rumination efficiency (g/h)							
DM[1]	114.84	134.49	137.86	124.45	0.428	0.077	4.465
NDF[2]	46.32	57.16	61.90	54.37	0.116	0.029	1.983
Periods (num/day)							
Feed	12.00	12.29	12.64	11.64	0.914	0.668	0.598
Rumination	27.14	25.50	25.64	24.79	0.207	0.745	0.739
Idle	35.00	31.86	33.36	32.71	0.458	0.439	0.794
Min/period							
Feed	25.21	26.77	25.77	29.45	0.420	0.743	1.598
Rumination	20.96	21.86	22.70	22.88	0.318	0.805	0.721
Idle	17.60	18.17	17.70	19.22	0.426	0.698	0.605
Regression equations							R^2
1. $\hat{Y} = 114.82 + 1.5564x - 0.0255x^2$							1.0
2. $\hat{Y} = 46.012 + 0.9259x - 0.0142x^2$							0.985

Superscript numbers refer to the regression equation of the respective variable that had an effect

SEM standard error of the mean, *L* linear effect, *Q* quadratic effect

There were no differences between treatments ($P > 0.05$) for the observations of the number of periods per day for variables: feeding, rumination, and idleness (Table 5). The average values were 12.14, 25.57, and 33.03 periods per day, for feed, rumination, and idle, respectively. Dado and Allen (1995) found that the number of rumination periods increases with dietary fiber, due to increased need of processing the ruminal digest to improve the digestive efficiency.

There was no significant difference between the treatments ($P > 0.05$) in the observations of time spent in minutes by feeding period, ruminating, and idle, expressed in minutes per period. This result is due to the lack of effect in feeding times, ruminating, and idle (min/day) and the number of periods of each daily activity, indicating that the supply of ammoniated hay in the diet does not affect activities in times spent of the ingestive behavior in sheep under the conditions of supply of this experiment.

In a study using Santa Inês sheep fed diets containing the substitution of soybean meal for castor seed meal, Nicory et al. (2015) found that the average times spent per period for feeding, rumination, and idleness were 18.4, 18.8, and 18.2 min, respectively. However, Carvalho et al. (2008) in a study involving Santa Inês lambs fed diets containing cocoa meal observed 22.5, 23.4, and 24.5, respectively, and these values were different from those found in this work: 26.27, 22.28, and 17.935 min, respectively. This can be explained by the presence of greater rumination efficiency given that the diet used in this experiment, even with low-quality roughage, resulted in lower time spent per period in rumination and idleness, providing a longer time to feed. Dias et al. (2014) evaluated the ingestive behavior on the productive performance of crossbred steers post-weaned on pasture during the rainy period. They concluded that rumination efficiency improved when the animals were fed protein supplementation, which led to better utilization of the ingested feed. Perazzo et al. (2016) in a study of the correlation of ingestive behavior identified a positive connection between the efficiency of rumination with intake and weight gain, which provided a favorable effect on the productive performance of sheep in confinement.

Rumination is considered a physiological action triggered at varying frequencies, depending on the quality of the forage, to improve the utilization food. Thus, the quadratic increase in the daily consumption observed for the dietary urea levels after hay ammoniation (Table 3) was influenced by the increase in the amount of dry matter per ruminated cud (Table 4). The similarity observed for the time spent in rumination between diets (Table 3) associated with the quadratic increase in the mass of DM and NDF per ruminated cud and the quadratic effect of dietary intake of DM and NDF explains the quadratic increase in rumination efficiency.

Conclusion

The use of ammoniated buffel grass hay with urea in lamb diet affects the ingestive behavior by increasing the rumination efficiency, increased intake, and feed utilization.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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