PH and ammoniacal nitrogen from beef cattle fed with diets containing different levels of extruded urea consumption

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ABSTRACT - The objective was to evaluate the best level of extruded urea for bovine consumption, analyzing pH and ammoniacal nitrogen (N-NH3). Four crossbred cannulated steers were used in the rumen, consuming four different diets, containing: 50, 60,70 and 80 g of extruded urea per 100 kg of body weight. Control treatment of 50 g / 100 kg PC was considered, because based on the urea content of the product used, it corresponds to 40 g of urea /100 kg PC, which is the indicated dose for use. There was no significant effect of extruded urea levels on ruminal pH. There was also no significant interaction (P> 0.05) between treatments and time in the same way there was no treatment effect for N-NH3. It is recommended to supply extruded urea in up to 80 g / 100 kg PC for beef cattle receiving balanced diets for 13% CP.

Keywords: amireia, non-protein nitrogen, ruminal parameters

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Introduction

Urea is widely used in ruminants feed. However, there are restrictions due to its palatability that diminishes ingestion by animals besides segregation when mixed with other ingredients and mainly due to its toxicity, worsened by its high solubility in rumen, for it quickly transforms into ammonium (Owens et al., 1980). From ammonium and carbonic skeleton, rumen microorganisms are capable of producing microbial protein, being non protein nitrogen (NNP) one of the ammonium sources. Thus, the replacement of true protein source for NNP is a feasible option to reduce production costs since they are more economic when considering the same nitrogen amount (Miranda et al., 2015). Alternative sources of NNP are formed from the extrusion of starch with urea, presenting low rumen solubility and slow release of ammonium. According to Miranda et al., (2015), the association of food that provide NNP with carbohydrates sources that provide energy with equivalent degradation rate, will result in a better use of ammoniacal nitrogen by rumen microorganisms, maximization of microbial protein synthesis, and consequently, increasing digestion and passage rates, dry matter consumption and animal performance. In this sense, the goal is to determine the best extruded urea level for beef cattle, aiming maximum production potential without causing problem to rumen parameters.

Literature review

Rumen microorganisms exert activities that allow ruminants to use structural carbohydrates as energetic source and non-protein nitrogen as protein source (Zeoula et al., 2002). Protein deriving from diet is hydrolyzed in rumen generating peptides and amino acids, and those may experience deamination, releasing $N\text{-}NH_3$ in rumen, as it happens with urea of endogenous and dietary source (Van Soest, 1994). Therefore, the concentration of ammoniacal nitrogen ($N\text{-}NH_3$) has an important role in the maximization of microbial efficiency. Smith (1979) reports that the changes in ruminal environment or in the microbial population could influence the rate in which the $N\text{-}NH_3$ is absorbed, thus affecting the microbial production in a certain ammonium concentration. Chalupa et al., (1970) affirm that the main ammonium absorption forms by microorganisms are influenced by the nitrogen source and by the ammonium concentrations. Roffer & Satter (1975), assessing the relation between the use of rumen ammonium and the use of non-protein nitrogen for ruminants, have observed that the concentration of 5 mg $N\text{-}NH_3$/100 mL of rumen liquid was enough to obtain a maximum microbial development in vitro. According to NRC (1985), the ammoniacal nitrogen requirements would be related to three main factors, which are the availability of substrates, the fermentation rate and the microbial production. Rumen pH also affects microbial growth, specially of fibrolytic microorganisms. According to Grant & Mertens (1992), when the pH is below 6.2 a significant reduction in fiber digestion happens. Other factors that diminish rumen pH is starch and sugar fermentation, for a bigger production of volatile oily acids (AGV) happens, forming mainly propionate through lactic acid path, that may accumulate in rumen, also reducing the fiber digestion (Van Soest, 1994).

Materials and methods

The paper was performed in the Experimental Farm and in the Lab of Applied Animal Nutrition of UFMS in Campo Grande, Brazil. Four crossbred, castrated and rumen fistulated beef cattle with initial average body weight (PC) of 336.25 ± 47.86 kg were distributed in Latin square framework 4x4 with four treatments and four 14 day-periods, being 10 days for adaptation and 4 days of data collection. The experimental treatments were four diets (Table 1) with voluminous:concentrate ratio of 40:60 for crossbred beef cattle with 350 kg of PC and average weight gain of 1.25 kg/day. Diets had 50, 60, 70 and 80 g of extruded urea for every 100 kg of PC being considered control treatment the one of the 50 g/100kg of PC, because based on the urea content of the used product, it corresponds to 40 g of urea/100kg PC that is the recommended dosage use. The extruded urea used was Amireia-200® (Pajoara Ind. e Comércio Ltda. Campo Grande-MS, Brazil). They were performed in the 13th day of each experimental period. The harvests were performed in seven different times, being before feeding (0) and 2, 4, 6, 8, 10 and 12 hours after diet supply. pH measurements were performed using digital potentiometer with an electrode inserted straight in rumen environment. Aliquots of 50 mL of each rumen liquid samples were collected and acidified with the addition of 1 mL of sulfuric acid 1:1, it was later distilled with 2 mL of sample with addition of 5 mL of KOH 2N in nitrogen distiller. The distilled liquid was received in 10 mL of H3BO3 2% until final volume of 75 mL, followed by titration with HCI 0.005 N, according to the technique described by Fenner (1965) and adapted. The rumen parameter data (pH and $M\text{-}NH_3$) were assessed as subdivided portions (time) and the multiple regression model with treatment effect and time in level of 5% significance.

Results and discussion

There was no effect of treatments over the rumen pH (P 0.05) (Table 2) pointing that the extruded urea levels included in the supplied diets did not influence rumen environment. Data observed for pH have varied from 6.51 before feed up to 5.94 and 12 hours post-prandial. Oliveira Júnior et al., (2004) have supplied amireia-150S for beef cattle and found an average pH of 6.63. Carmo et al. (2005) assessing the use of amireia-150 (3.85% of total MS) in replacement to soy bran meal of dairy cows, it was found an average value of pH 5.81 lower than the pH value observed to the soy bran meal (5.98). It is necessary to highlight that the treatment with 80g/100 kg PV had the participation of 3.12% of total MS of amireia-200, corresponding to 6.24% of protein equivalent. Such results suggest that the increase of NNP in diet would not cause significant changes in rumen pH. There was no significant interaction (P>0.05) between treatments and time and the same way there was no treatment effect (Table 2). A significant difference for collection times was observed, which was already expected, since after time 0 (before feed) animals had free access to diet in all other times (2, 4, 6, 8, 10 and 12 hours post-prandial). According to Hoover (1986) the ideal range of ammoniacal nitrogen concentration is between 3.3 and 21.5 mg/dL and helps the microbial protein synthesis, demonstrating that the ammoniacal nitrogen concentration to maximize the microbial protein synthesis is highly variable, the values found in Table 2 support such study. Oliveira Júnior et al. (2004) evaluating the total replacement of soy bran for urea or amireia, in diets with high content of concentrate over rumen ammonium, the blood parameters and the nitrogen metabolism in beef cattle, it was found an average value of ammoniacal nitrogen of 17.2 mg/dL for the treatment with amireia-150, average value of 14.7 mg/dL for treatment with soy bran and 21.1 for treatment with urea. The averages of ammoniacal nitrogen for the present study according to the treatments are of 20.90, 18.72, 18.22 and 20.76 mg/dL for treatments of 50, 60, 70 and 80 g of extruded urea/100kg PC, and support data observed in literature.

Conclusions

Increasing levels of amireia-200 do not provide negative effects over rumen pH and ammoniacal nitrogen. It is recommended the extruded urea supply in up to 80 g/100 kg PC for beef cattle receiving balanced diets of 13% of PB.

Graphs and Tables

Table 1 – Ingredients and chemical composition of experimental rations.

	Extruded urea (g/100 kg PV)					
	50	60	70	80		
Corn silage (g/kg MS)	400.0	400.0	400.0	400.0		
Maize (g/kg MS)	488.9	503.2	517.5	531.9		
Soy bran (g/kg MS)	73.6	55.4	37.2	19.0		
Amireia-200S (g/kg MS)	19.5	23.4	27.3	31.2		
Mineral Core (g/kg MS)	18.0	18.0	18.0	18.0		
Chemical Composition					EPM[1]	P*
Dry Matter (g/kg of MN)	435.5	438.9	434.7	435.1	16.5	0.9821
Organic Matter (g/kg of MS)	951.1	952.1	953.2	955.8	4.3	0.4778
Raw protein (g/kg of MS)	133.7	138.3	143.1	143.0	9.8	0.3515
Fiber in neutral detergent (g/kg of MS)	380.4	369.7	377.7	374.6	33.3	0.9716
Fiber in acid detergent (g/kg of MS)	170.9	153.7	167.2	154.9	15.37	0.3267

[1]EPM= Average standard error; [2]Assurance levels: Na: 100 g/kg; P: 88 g/kg; Ca: 188 g/kg; S: 22 g/kg; Mg: 8000 mg/kg: Zn: 3000 mg/kg: Cu: 1000 mg/kg: Co: 80 mg/kg: I: 60 mg/kg: Se: 20 mg/kg: F: 880 mg/kg; *Averages followed by lowercase letter distinct, differ between each other by the Tukey test (P<0.05);

(http://cdn5.abz.org.br/wp-content/uploads/2017/04/Tabela-1-20.jpg)

Table 2 - pH and ammoniacal nitrogen ruminant of cutting steers due to experimental treatments and collection times.

ph rumen

Hours post-prandial	Extruded Urea (g/100 kg PC)				EPM[1]	P
	50[2]	60[3]	70[4]	80[5]		
0	6.25	6.70	6.56	6.54	0.189	0.7029
2	6.51	6.28	6.25	6.33	0.120	0.4676
4	6.22	5.83	6.15	6.23	0.135	0.4631
6	5.13	5.92	6.29	6.39	0.113	0.4257
8	5.80	5.82	6.14	6.39	0.115	0.1964
10	5.74	5.74	5.73	6.09	0.113	0.4258
12	5.82	5.90	5.97	6.08	0.156	0.7094
EPM	0.105	0.058	0.101	0.074	-	
P linear	0.0001	0.0001	0.0083	0.0602	-	
P quadratic	0.4525	0.0016	0.7391	0.8089	-	

Ammoniacal nitrogen (mg/dL)

Hours post-prandial	Extruded Urea (g/100 kg PC)				EPM[1]	P linear	P quadratic
	50[6]	60[7]	70[8]	80[9]			
0	12.12	14.84	10.44	10.68	1.095	0.2715	0.6567
2[10]	37.38	35.10	28.15	27.50	1.684	0.0308	0.9841
4	25.55	18.29	25.32	28.18	1.544	0.2626	0.0927
6	22.97	18.46	18.15	19.86	1.676	0.6880	0.6263
8	22.50	19.54	22.95	28.33	0.772	0.1162	0.1488
10	16.54	15.45	21.95	20.27	1.532	0.1949	0.9983
12	9.28	9.39	10.57	10.54	0.985	0.8008	0.9385
EPM	1.030	1.133	1.159	1.092			
P linear	0.0008	0.0009	0.5719	0.2185			
P quadratic	<0.0001	0.0106	0.0005	<0.0001			

[1]EPM=Standard error of average; [2]$Y = 6.54371 - 0.0727902*t$ ($R^2 = 0.89$); [3]$Y = 6.66274 - 0.219286*t + 0.0130655*t^2$ ($R^2 = 0.94$); [4]$Y = 6.45888 - 0.0503795*t$ ($R^2 = 0.69$); [5]$Y = 6.292679$; [6]$Y = 17.6732 + 3.81612.t – 0.38634.t2$ ($R2 = 0.90$); [7]$Y = 20.0552 + 1.41254.t – 0.192898.t2$ ($R2 = 0.90$); [8]$Y = 13.9670 + 3.80234.t – 0.333892.t2$ ($R2 = 0.60$); [9]$Y = 20.0552 + 1.41254.t – 0.192898.t2$ ($R2 = 0,90$); [10]$Y = 51.6981 – 0.301846.n$ ($R2 = 0,90$)

(http://cdn5.abz.org.br/wp-content/uploads/2017/04/Tabela-2-9.jpg)

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