Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/ actascianimsci.v39i4.36013

Performance of Holstein-Gyr crossbred heifers on pasture of *Brachiaria decumbens* supplemented with multiple supplement or proteined salt

Ronald Matos dos Santos[1], Rogério de Paula Lana[2*] and César Roberto Viana Teixeira[2]

*[1]Departamento de Zootecnia, Universidade Federal dos Vales do Jequitinhonha e Mucuri, Diamantina, Minas Gerais, Brazil. [2]Departamento de Zootecnia, Universidade Federal de Viçosa, Av. Peter Henry Rolfs, s/n, 36570-900, Viçosa, Minas Gerais, Brazil. *Author for correspondence. E-mail: rlana@ufv.br*

ABSTRACT. This study aimed to evaluate the performance, efficiency and economic viability of different supplements for dairy heifers on *Brachiaria decumbens* pasture. Twelve heifers with 186 ± 30.5 kg average weight were divided in three groups of four animals. The treatments were mineral salt *ad libitum*; 0.4 kg animal^{-1} day^{-1} proteined salt and 1.0 kg animal^{-1} day^{-1} multiple supplement. The experimental design was randomized blocks, with the contrasts considered significant at 5% probability. There was greater ($p < 0.05$) body weight and higher daily weight gain in animals supplemented with proteined salt or multiple supplement, compared to supplemented with mineral salt. There was no difference ($p > 0.05$) in any of the performance parameters between proteined salt and multiple supplement. The use efficiency was 1.31 and 0.61 for proteined salt and multiple supplement, respectively. The cost per kg weight gain in treatments with mineral salt, proteined salt and multiple supplement was R$ 0.67, R$ 0.68 and R$ 1.25, respectively. The use of proteined salt or multiple supplement provides superior performance than mineral salt in crossbred heifers. However, the proteined salt has higher utilization efficiency and economic advantage.

Keywords: agrosilvipastoral system, crossbred cows, protein supplementation.

Desempenho de novilhas Girolandas em pasto de *Brachiaria decumbens* suplementadas com mistura múltipla ou sal proteinado

RESUMO. O objetivo deste trabalho foi avaliar o desempenho, a eficiência e a viabilidade econômica de diferentes suplementos para novilhas, em pasto de *Brachiaria decumbens*. Foram utilizadas 12 novilhas, divididas em três grupos de quatro animais, com peso médio de 186 ± 30,5 kg. Os tratamentos foram: sal mineral *ad libitum;* 0,4 kg animal^{-1} dia^{-1} de sal proteinado e 1,0 kg animal^{-1} dia^{-1} de mistura múltipla. O delineamento experimental utilizado foi o de blocos casualizados, sendo os contrastes considerados significativos a 5% de probabilidade. Houve maior ($p < 0,05$) peso corporal e maior ganho de peso diário dos animais suplementados com sal proteinado ou mistura múltipla, em comparação aos suplementados com sal mineral. Não houve diferença ($p > 0,05$) entre sal proteinado e mistura múltipla em nenhum dos parâmetros de desempenho. A eficiência de uso foi de 1,31 e 0,61 para sal proteinado e mistura múltipla, respectivamente. O custo por kg de peso ganho nos tratamentos sal mineral, sal proteinado e mistura múltipla foi R$ 0,67, R$ 0,78 e R$ 1,25, respectivamente. A utilização de sal proteinado ou mistura múltipla proporciona desempenho superior ao sal mineral na alimentação de novilhas girolandas. Porém, a utilização de sal proteinado apresenta maior eficiência e vantagem econômica.

Palavras-chave: sistema agrossilvipastoril, vaca mestiça, suplementação proteica.

Introduction

Brazil has the third largest herd of milking cows, with 21.75 million animals, and the sixth largest milk production in the world, producing 35 billion liters per year (Instituto Brasileiro de Geografia e Estatística [IBGE], 2015), with most of the milk produced in extensive pasture systems (Costa, Meirelles, Silva, & Factori, 2008). The Brazilian pasture is mainly composed of grasses of the *Brachiaria* genus, and supplementation with concentrate is generally used in the winter, with the main objective of mitigating the low production and quality of forage in this period (Silva et al., 2009).

In these production systems, rearing heifers plays an important role in the replacement of animals in the dairy herd and in the marketing of surplus animals, which represents a significant

fraction of the dairy income. However, heifer rearing has often been neglected by producers, and food with low nutritional quality has been supplied, which negatively affects the growth and subsequent productive lives of animals (Signoretti et al., 2012). According to Mendonça et al. (2010), in dairy heifer rearing, a diet based on only pasture and mineral mix provided an average daily gain of 0.071 kg, which is lower than that required for productive optimization, mainly due to the insufficient supply of crude protein.

Protein supplementation associated with highly nutritional forage improves nutrient utilization efficiency in the ruminal environment by synchronizing the availability of energy and protein for use by microorganisms (Figueiredo et al., 2008). Thus, the use of supplements such as proteined salt and multiple mixture in the rainy period may be an option for the supply of limiting nutrients, contributing to increase pasture utilization efficiency (Porto et al., 2009) and result in higher animal performance (Barbosa, Graça, Maffeil, Silva, & Souza, 2007; Villela, Paulino, Valadares, Leão, & Figueiredo, 2008).

Therefore, the objective of this study was to evaluate the performance, utilization efficiency and economic viability of different supplements (mineral salt, proteined salt and multiple mixture) in dairy heifer feeding, reared on pasture in the rainy period.

Material and methods

The experiment was carried out at the Experimental Farm of Moura (FEM), belonging to the Federal University of the Jequitinhonha and Mucuri Valleys (UFVJM), in the municipality of Curvelo, State of Minas Gerais, from January to March 2013. It was approved by the Ethics Committee on the Use of Production Animals - CEUAP/UFV, process number 02/2013.

An area of 3.0 ha was used in an agrosilvopastoral system with one year of implantation. The pasture was predominantly formed of *Brachiaria decumbens* between eucalyptus trees with 12 m-spacing between rows and 2 m between plants. Pasture fertilization was done in a single dose in the system implantation and the area was divided into three paddocks of 1.0 ha each, with troughs and drinking fountains.

Twelve heifers with *Holstein* blood varying from 62.5 to 75%, average weight of 186 ± 30.5 kg and average age of 13 months, were assigned to three treatments (mineral salt, proteined salt and multiple mixture), in which each group received the same treatment from the beginning to the end of the experiment. The heifers were divided into four blocks of three animals each according to the weight and *Holstein* blood percentage. Each of the three heifers of each block randomly assigned to a treatment. The composition of treatments is shown in Table 1.

Table 1. Percentage composition of treatments and percentage of crude protein (CP) and total digestible nutrients (TDN) on a dry matter basis.

Ingredients	Treatments		
	Mineral salt	Proteined salt	Multiple mixture
Mineral mixture (%)	100	11	5.5
Urea (%)	-	13	-
Ammonium sulfate (%)	-	1.3	-
Common salt (%)	-	1.7	-
Ground corn grain (%)	-	57	44.5
Soybean meal (%)	-	16	50
CP, %DM	-	54.8	27.9
TDN, %DM	-	56.4	75.5

Proteined salt and multiple mixture were offered twice a day at 7:00 a.m. and at 4:00 p.m., in the total amount of 0.4 kg^{-1} $animal^{-1}$ day^{-1} and 1 kg^{-1} $animal^{-1}$ day^{-1}, respectively. The mineral salt was supplied without restriction.

The experiment consisted of three periods, and each period consisted of 21 days, totaling 63 experimental days plus seven days for adaptation at the beginning of the experiment to preventy, therefore, possible intoxication with urea and the better effectiveness of microorganisms in the use of ammonia. All animals were weighed and subjected to the control of endo- and ectoparasites, using 1% abamectin.

On the first day of each experimental period, the forage mass available in each paddock was quantified by performing the cut close to the ground of five areas delimited by a square frame of 0.5 x 0.5 m dimensions selected at random in each paddock. The forage collected was weighed and sampled for the calculation of dry matter (DM), quantification of forage availability for the animals and analysis of chemical composition. Also, the manual grazing simulation was carried out, making it possible to estimate the quality of the forage selected by the animals (Lista et al., 2007). Pasture sampling was performed at the beginning of the experiment and at the end of each experimental period (days 0, 21, 42 and 63). On the same days, heifers were weighed to evaluate their development.

Chemical evaluations of the forage consisted of the following analyses: content of DM, crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF), according to Detmann et al. (2012). The nitrogen content (N) was determined by the Kjeldahl analytical method,

obtaining the CP content by multiplying the N content by 6.25.

The estimate of the potentially digestible dry matter of the pasture was performed as described by Porto et al. (2009):

$$MSpd = 0.98 (100 - NDF) + (NDF - NDFi)$$

The economic analysis was performed using average values practiced in the local market, in the first two months of 2017.

Data of animal performance data were analyzed in a completely randomized design, with three treatments and four replicates. In the analysis of variance, the treatments were broken down in the following complete orthogonal contrasts: Supplements (proteined salt and multiple mixture) versus mineral salt; and proteined salt versus multiple mixture. The contrasts were considered significant at 5% probability. The software Statistical and Genetic Analysis System (SAEG, 2000), developed at the Federal University of Viçosa (UFV), was used, adopting the following statistical model:

$$Yijk = \mu + ti + bj + eijk$$

where: Yijk = experimental response on treatment i, in repetition k of block j; μ = overall constant or overall mean; ti = effect relative to treatment i; bj = effect relative to block j (% of *Holstein* blood and weight); eijk = random error, associated to each observation, NID assumption (0; σ^2).

Results and discussion

In the first period, the amount of total dry matter available was higher when compared to the other periods, with a mean availability of 6.16 tons per hectare, but with a lower quality than the other periods, with a mean MSpd of 55% at the beginning of the experiment and 66% at the end of the third period (Figure 1).

This was probably because the pasture at the beginning of the experiment had an average height of 50 centimeters, which favored lower leaf stem^{-1} ratio and high senescent material content. Despite this, the mean availability of MSpd at the beginning of each experimental period was, on average, 3.40; 1.86; 2.37 tons ha^{-1}, respectively, for the periods 1, 2 and 3, which were higher than the recommended values of 4 to 5% body weight of the animals in MSpd, per day (Porto et al., 2009) with suitable quantity and quality of forage in all experimental periods.

The mean content of DM, NDF and ADF contents during the experiment were reduced, from 30.3; 71.0 and 34.23% to 24.1; 67.3 and 29.3%, and the percentage of crude protein increased from 8.8% to 12.3%, respectively (Table 2), from the beginning to the end of the experiment, evidencing an improvement in available forage quality. Thus, in all experimental periods, the forage contained a percentage of CP in the dry matter above the minimum, so that the ruminal microorganisms presented full degradation capacity of fiber substrates of the basal forage (7%) (Lazzarini et al., 2009; Sampaio et al., 2009).

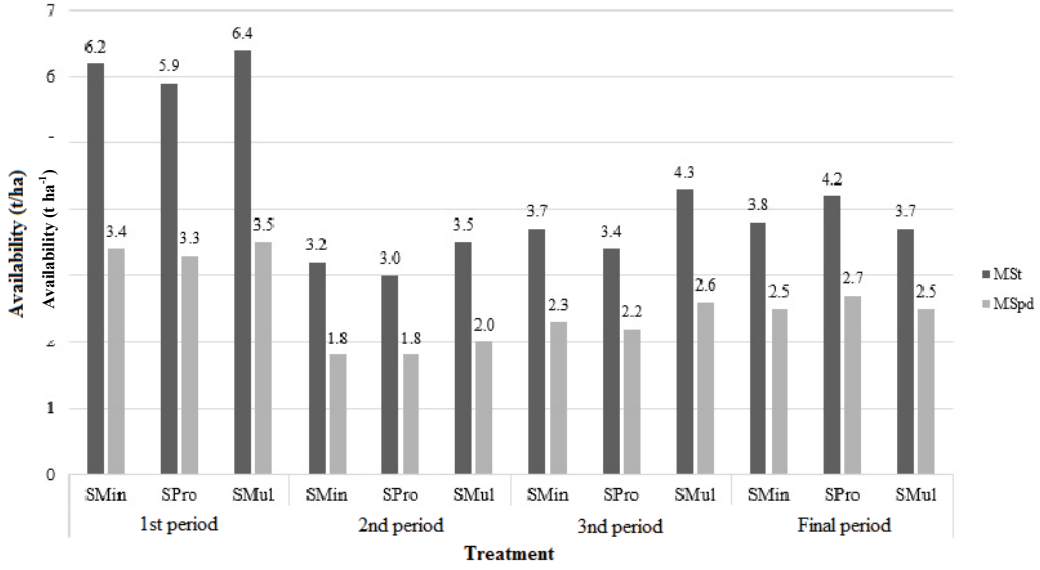

Figure 1. Availability of total dry matter (MSt) and potentially digestible dry matter (MSpd), per period, in each treatment. Where: SMin - mineral salt; SPro - proteined salt and SMul - multiple mixture ➔ horizontal title = Treatments.

Table 2. Content of dry matter (DM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) of *Brachiaria decumbens* in the three periods and at the end of the third period.

	Manual grazing simulation				
Item	P1	P2	P3	Final	Média
Paddock 1					
DM	30.3	28.0	27.3	23.5	27.3
NDF	72.8	71.4	70.2	67.2	70.4
ADF	35.0	34.6	33.1	28.4	32.8
CP	8.9	10.5	12.0	12.9	11.1
Paddock 2					
DM	29.3	31.0	25.2	24.2	27.4
NDF	70.1	69.4	68.1	67.7	68.8
ADF	34.6	35.0	31.2	30.0	32.7
CP	9.0	13.0	10.5	12.1	11.2
Paddock 3					
DM	31.3	29.5	26.8	24.7	28.1
NDF	70.1	68.3	67.1	67.0	68.1
ADF	33.1	32.8	29.9	29.5	31.3
CP	8.5	11.4	11.5	11.9	10.8

DM is expressed in % natural matter, the other items are expressed in % DM; P1, P2 and P3: periods 1,2 and 3, end of the experiment and mean in the total experimental period.

Supplements (proteined salt and multiple mixture), when compared to mineral salt, caused an increase in body weight ($p < 0.05$) at the end of the experiment (Table 3). According to Zorzi, Detmann, Queiroz, Mantovani and Bayão (2009), nitrogen supplementation for cattle reared on pasture during the rainy period increases the efficiency of pasture use by maximizing microbial activity and, consequently, fiber degradation.

Table 3. Performance of Gyr heifers reared on pasture in the rainy period according to treatments.

	Treatments				P-value	
Item	Mineral salt	Proteined salt[1]	Multiple mixture[2]	SEM[3]	SMin*Supl[4]	SPro*Smul
	Body weight (kg)					
1st day	171	194	196	15.6	0.247	0.938
21st day	176	211	221	17.1	0.086	0.668
42rd day	177	220	233	18.0	0.053	0.615
63rd day	181	233	242	16.8	0.024	0.711
	Weight gain (kg day^{-1})					
0-21	0.20	0.79	1.21	0.16	0.002	0.086
0-42	0.14	0.61	0.88	0.10	0.002	0.076
0-63	0.16	0.62	0.73	0.06	0.001	0.217
Efficiency[5]	-	1.31	0.61	-	-	-

[1] Protein salt (57% corn meal, 16% soybean meal, 13% urea, 1.3% ammonium sulfate, 1.7% common salt and 11% mineral salt); [2] multiple mixture (44.5% corn meal, 50% soybean meal and 5.5% mineral salt); [3] standard error of the mean; [4] SMin = mineral salt, Supl = supplement, SPro = proteined salt; Smul = multiple mixture); [5] increase in weight gain increase^{-1} of supplement intake in relation to SMin treatment.

Thus, the animal has the capacity to increase the intake of the basal diet, known as associative effect (Silveira, Patiño, Medeiros, Langwinski, & Mallmann, 2008; Perez de la Ossa, Lana, Gutierrez, Balbino, & Peixoto, 2013; Teixeira et al., 2015), since fiber is the major responsible for the effect of physical filling of the rumen, which is the main limitation to the consumption in pasture systems (Lazzarini et al., 2009; Sampaio et al., 2009). In a study conducted by Villela, Paulino, Valadares, Leão, and Figueiredo (2008), the supply of 0.5 kg^{-1} animal^{-1} day^{-1} of concentrate supplement did not affect the pasture dry matter intake. Thus, it allowed higher intake of total DM and protein, with increase in the ammonia content, allowing greater efficiency of ruminal microorganisms.

There were no differences ($p > 0.05$) between the proteined salt and the multiple mixture on body weight (Table 3), indicating that both treatments provided nitrogen and nutrients required by the animal and its microbiota in a similar way, even receiving a smaller amount of proteined salt than the multiple mixture.

Similar to body weight, supplements (protein salt and multiple mixture), when compared to the control treatment (mineral salt), provided greater weight gain ($p < 0.05$) in all experimental periods (0-21, 0-42 and 0-63 days) and there was no significant difference ($p > 0.05$) in weight gain between the animals fed proteined salt and multiple mixture (Table 3). These results are consistent with research in which supplementation including mostly urea as the main nitrogen compound improves animal performance during the rainy period (Figueiredo et al., 2008; Porto et al., 2009).

In research on increasing supply of concentrate supplement with 24% crude protein to growing cattle grazing of *Brachiaria* grass, Goes et al. (2005) reported a weight gain of 0.26; 0.51; 0.58; and 0.68 kg animal^{-1} day^{-1} with mineral salt supply; 0.4; 0.8; and 1.6 kg of concentrate animal^{-1} day^{-1}, respectively. In the present experiment, the average gain during the 63 days was lower in the control treatment (0.15 versus 0.26 kg animal^{-1} day^{-1}) and higher with the use of multiple mixture (0.73 versus 0.58 and 0.68 kg animal^{-1} day^{-1}).

The efficiencies in the use of concentrate were 1.31 and 0.61 kg increase in weight gain per kg of supplement in relation to the mineral salt treatment (Table 3), for proteined salt and multiple mixture, respectively. These values are higher than those obtained by Goes et al. (2005): 0.7; 0.4; and 0.25 kg increase in weight gain per kg of concentrate for 0.4; 0.8; and 1.6 kg concentrate animal^{-1} day^{-1} relative to the mineral salt treatment.

Table 4 lists the economic data represented by the supplements used in the experiment and the cost in Reals per kg body weight. The animals treated with mineral salt were those that presented better economics, however resulted in a lower average daily gain (GMD), and a deeper analysis of their viability should be made, since the animal remains in this category for a long time, reducing the economic return.

Table 4. Analysis of the cost, per weight gain, between treatments.

	Treatments		
	Mineral salt	Proteined salt	Multiple mixture
Cost (R$ kg^{-1})*	1.92	1.21	0.91
Consumption (kg animal^{-1} day^{-1})	0.055	0.40	1.00
R$ animal^{-1} day^{-1}	0.11	0.48	0.91
R$ animal^{-1} experiment^{-1}	6.69	30.49	57.33
Cost kg^{-1} WG	0.67	0.78	1.25

*Mean values practiced in Curvelo, State of Minas Gerais, the first two months of 2017; GMD: average daily gain; WG: weight gain during the total experimental period (Table 3).

The weight gain of heifers receiving the protein salt and multiple mixture was not significantly different ($p > 0.05$, Table 3), but the cost of each kg body weight gain when using the multiple mixture was higher than when used the proteined salt as supplement (R$ 1.25 and R$ 0.78, respectively).

Conclusion

The use of proteined salt provides performance similar to the multiple mixture and superior to mineral salt in feeding dairy heifers on *Brachiaria decumbens* pasture in the rainy period. However, the proteined salt exhibits greater efficiency and economic advantage over the multiple mixture.

Acknowledgements

To the Federal University of the Jequitinhonha and Mucuri Valleys for the availability of animals and facilities for conducting the research.

References

Barbosa, F. A., Graça, D. S., Maffeil, W. E., Silva, F. V., Júnior, & Souza, G. M. (2007). Desempenho e consumo de matéria seca de bovinos sob suplementação protéicoenergética, durante a época de transição água-seca. *Arquivo Brasileiro de Medicina veterinária e Zootecnia, 59*(1), 160-167.

Costa, C., Meirelles, P. R. L., Silva, J. J., & Factori, M. A. (2008). Evolução das pastagens cultivadas e do efetivo bovino no Brasil. *Veterinária e Zootecnia, 15*(1), 8-17.

Detmann, E., Souza, M. A., Valadares, S. C., Filho, Queiroz, A. C., Berchielli, T. T., Saliba, E. O. S., & Azevedo, J. A. G. (2012). *Métodos para análise de alimentos*. Visconde do Rio Branco, MG: Suprema.

Figueiredo, D. M., Paulino, M. F., Detmann, E., Moraes, E. H. B. K., Valadares, S. C., Filho, & Souza, M. G. (2008). Fontes de proteína em suplementos múltiplos para bovinos em pastejo no período das águas. *Revista Brasileira de Zootecnia, 37*(12), 2222-2232.

Goes, R. H. T. B., Mancio, A. B., Lana, R. P., Leão, M. I., Alves, D. D., & Silva, A. T. S. (2005). Recria de novilhos mestiços em pastos de *Brachiaria brizantha*, com diferentes níveis de suplementação, na região amazônica. *Revista Brasileira de Zootecnia, 34*(5), 1740-1750.

Instituto Brasileiro de Geografia e Estatística [IBGE]. (2015). *Produção da pecuária municipal* (43). Rio de Janeiro, RJ: IBGE.

Lazzarini, I., Detmann, E., Sampaio, C. B., Paulino, M. F., Valadares, S. C., Filho, Souza, M. A., & Oliveira, F. A. (2009). Dinâmica de trânsito e degradação da fibra em detergente neutro em bovinos alimentados com forragem tropical de baixa qualidade e compostos nitrogenados. *Arquivo Brasileiro de Medicina veterinária e Zootecnia, 61*(3), 635-647.

Lista, F. N., Silva, J. F. C., Vásquez, H. M., Detmann, E., Domingues, F. N., & Ferolla, F. S. (2007). Avaliação de métodos de amostragem qualitativa em pastagens tropicais manejadas em sistema rotacionado. *Revista Brasileira de Zootecnia, 36*(5), 1413-1418.

Mendonça, B. P. C., Lana, R. P., Mancio, A. B., Detmann, E., Barbosa, A. M., & Guimarães, G. (2010). Levels of mineral mixture and urea in supplementation of crossbred heifers, with Gyr predominance, reared at pasture during the dry season. *Revista Brasileira de Zootecnia, 39*(10), 2273-2280.

Perez de la Ossa, J. E., Lana, R. P., Gutierrez, G. S., Balbino, M. E., & Peixoto, J. C. (2013). Formas de utilização de cana-de-açúcar e níveis de suplementação concentrada para vacas mestiças leiteiras de baixa produção. *Revista Brasileira de Agropecuária Sustentável, 3*(1), 138-150.

Porto, M. O., Paulino, M. F., Valadares Filho, S. C., Sales, M. F. L., Leão, M. I., & Couto, V. R. M. (2009). Fontes suplementares de proteína para novilhos mestiços em recria em pastagens de capim-braquiária no período das águas: desempenho produtivo e econômico. *Revista Brasileira de Zootecnia, 38*(8), 1553-1560.

Sistema de Análises Estatísticas e Genéticas [SAEG]. (2000). *Versão 8*. Viçosa, MG: Fundação Arthur Bernardes – UFV.

Sampaio, C. B., Detmann, E., Lazzarini, I., Souza, M. A., Paulino, M. F., & Valadares, S. C., Filho (2009). Rumen dynamics of neutral detergent fiber in cattle fed low-quality tropical forage and supplemented with nitrogenous compounds. *Revista Brasileira de Zootecnia, 38*(3), 560-569.

Signoretti, R. D., Queiroz, M. F. S., Berchielli, T. T., Schmidek, A., Oliveira, E. M., & Dib, V. (2012). Crescimento, comportamento ingestivo e desempenho reprodutivo de novilhas mestiças Holandês x Zebu, em pastejo, submetidas à suplementação proteica durante a época das águas. *Ciência Animal Brasileira, 13*(3), 298-305.

Silva, F. F., Sá, J. F., Schio, A. R., Ítavo, L. C. V., Silva, R. R., & Mateus, R. G. (2009). Suplementação a pasto: disponibilidade e qualidade x níveis de suplementação x desempenho. *Revista Brasileira de Zootecnia, 38*(spe), 371-389.

Silveira, A. L. F., Patiño, H. O., Medeiros, F. S., Langwinski, D., & Mallmann, G. M. (2008). Efeitos associativos da suplementação com energia e proteína degradável no rúmen. *Archivos de Zootecnia, 57*(218), 179-186.

Teixeira, C. R. V., Lana, R. P., Rennó, L. N., Veloso, C. M., Carvalho, J. C., & Menezes, A. A. (2015). Urea and salt as supplementary diet for crossbreed milk cows. *Acta Scientiarum. Animal Sciences, 37*(3), 281-287.

Villela, S. D. J., Paulino, M. F., Valadares Filho, S. C., Leão, M. I., Figueiredo, D. M. (2008). Fontes de proteína em suplementos para abate de bovinos em pastejo: período de transição águas-secas. *Revista Ciência Agronômica*, 39(2), 317-326.

Zorzi, K., Detmann, E., Queiroz, A. C., Mantovani, H. C., & Bayão, G. F. (2009). In vitro degradation of neutral detergent fiber of high-quality tropical forage according to supplementation with different nitrogenous compounds. *Revista Brasileira de Zootecnia, 38*(5), 964-971.

Received on March 14, 2014.
Accepted on April 24, 2017.