Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/ actascianimsci.v39i4.35176

Cuts of dairy-origin cattle fed mesquite pod meal in replacement of corn

Marina de Paula Almeida[1], Evaristo Jorge Oliveira de Souza[2*], Antonia Sherlânea Chaves Véras[1], Ítalo Marcos de Vasconcelos Morais[2], Danilo Ribeiro Vítor[2] and José Ricardo Coelho da Silva[3]

*[1]Departamento de Ciência Animal, Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil. [2]Unidade Acadêmica de Serra Talhada, Universidade Federal Rural de Pernambuco, Avenida Gregório Ferraz Nogueira, s/n, 56909-535, Serra talhada, Pernambuco, Brazil. [3]Unidade Acadêmica de Garanhuns, Universidade Federal Rural de Pernambuco, Garanhuns, Pernambuco, Brazil. *Author for correspondence. E-mail: evaristojorge@gmail.com*

ABSTRACT. This study was carried out in order to assess commercial front and rear cuts of dairy-origin cattle fed mesquite pod meal. Twenty-five non-castrated male bovines (Holstein-Zebu), distributed according to a completely randomized design, with five animals per treatment, were used. The feed contained about 121.2 and 544.98 g kg^{-1} of crude protein and total digestible nutrients, respectively, and was composed of tifton grass hay, cornmeal, soybean meal, mesquite pod meal and mineral salt. The right half carcass of each animal was separated between the 5th and 6th ribs, in front and rear quarters, from which commercial cuts were obtained. There was no effect ($p > 0.05$) as to the replacement of corn for mesquite pod meal on the weights and yields of front cuts (shoulder, brisket, chuck, hump and flanks) and rear cuts (tenderloin, shank, knuckle, thin flank, flat, eye round, rump tail, top side, cap of rump, rump, cut of rump, striploin, cap of cube roll). Mesquite pod meal can substitute cornmeal in 100% in the concentrate without changes in weight and yield of the commercial front and rear cuts of male bovines of dairy origin.

Keywords: amino acids, feedlot, muscle, weight, yield.

Cortes de bovinos de origem leiteira alimentados com farelo da vagem de algaroba em substituição ao milho

RESUMO. Este trabalho foi realizado para avaliar os cortes comerciais do dianteiro e traseiro de bovinos de origem leiteira alimentados com farelo da vagem de algaroba. Utilizou-se 25 bovinos machos, não castrados (Holandês-Zebu), distribuídos no delineamento inteiramente casualizado, com cinco animais por tratamento. A ração teve aproximadamente 121,2 e 544,98 g kg^{-1} de proteína bruta e nutrientes digestíveis totais, respectivamente, e foi composta por feno de capim tifton, farelo de milho, farelo de soja, farelo da vagem de algaroba e sal mineral. A meia carcaça direita de cada animal foi separada entre a 5ª e a 6ª costelas em quarto dianteiro e traseiro, dos quais se obteve os cortes comerciais. Não houve efeito ($p > 0,05$) da substituição do milho pelo farelo da vagem de algaroba sobre os pesos e rendimentos dos cortes do dianteiro (paleta, peito, acém, cupim e costelas) e traseiro (filé mignon, músculos, patinho, fraldão, chã de fora, lagarto, maminha, chã de dentro, picanha, alcatra, aranha, contra filé, capa do contra filé). O farelo da vagem de algaroba pode substituir o farelo de milho em 100% no concentrado sem que haja alteração nos pesos e rendimentos dos cortes comerciais do dianteiro e traseiro de bovinos de origem leiteira.

Palavras-chave: aminoácidos, confinamento, músculo, peso, rendimentos.

Introduction

Food is one of the most important components of the production system, because consumption of it by animals will determine breeding viability to a greater or lesser degree, considering that its nutritional value is closely related to variations observed in animal products such as meat.

Contemporarily, corn is largely present in cuisines worldwide; it is however used also as commodities and raw material for biofuels, raising its prices to consumers. With this in mind, researching alternative foods that can substitute it in ruminants' diet could reduce costs with animal feeding, the main input of production (Guerrero et al., 2016), besides contributing to increasing the availability of corn for human consumption and corroborating to attest another food alternative available for ruminants.

Mesquite pod meal can be one of these alternatives, since it presents adequate chemical composition, with 86.9 to 87.6% of dry matter;

8.5 to 12.9% of crude protein; 25.6 to 33.0% of neutral detergent fiber; 71.6 to 74.3% of in vitro dry matter digestibility and 14 to 20% of organic acids, pectins and other substances (Braga, Ezequiel, Braga, & Mendonça, 2009; Oliveira, Barreto, Lima Júnior, Aguiar, & Silva, 2010), with a high amount of soluble carbohydrates and good palatability. Thus, it can be consumed by bovines and small ruminants (Silva, Melo, Pires, & Stamford, 2007; Alves et al., 2010), attesting its nutritional value. For these reasons, mesquite pod meal (MPM) can become an alternative food for ruminants such as cattle farmed in the northeastern semi-arid region of Brazil.

It is more interesting to use mesquite fruits in the form of meal because the use of MPM favors the control of possible thermo labile factors, in addition to eliminating intestinal perforation risks in bovines, for instance.

In the case of cattle, it is prudent to use dairy-origin bovines for meat production as an alternative to be explored, since in the semi-arid region of Brazil dairy-origin animals are considered one of the main economic alternatives (Silva et al., 2015), in addition to contributing to the growth of domestic beef production, increasing the national supply and, consequently, making meat cuts available for export, without losses to supply in the national market.

This does not mean, however, a decrease in the quality of the meat offered internally, because the meat of these animals has quality attributes, such as color and tenderness, similar to those of beef cattle (Dannenberger, Nuernberg, Nuernberg, & Ender, 2006). In addition, bovines from dairy herds have a potential for weight gain due to their precocity and feed efficiency, with high yielding and carcass quality (Jorge et al., 2009).

Not only the slaughtering of young animals improves the carcass quality of dairy-origin calves (Prado et al., 2015), but meat juiciness and an adequate protein level of the diet seem to improve the amount of intramuscular lipids of the meat (Prado et al., 2014) and, consequently, its taste.

This study was carried out in order to assess commercial front and rear cuts of dairy-origin cattle fed with mesquite pod meal in replacement of corn.

Material and methods

All international, national and/or institutional guidelines applicable to the care and use of animals were complied with (Federal Rural University of Pernambuco (Universidade Federal Rural de Pernambuco), license: 041/2013).

The experiment was carried out in the bovine sector of Serra Talhada Academic Unit [Unidade Acadêmica de Serra Talhada]- UFRPE, located in the city of Serra Talhada, Pernambuco State, Semi-arid region of Northeast Brazil. It lasted 109 days, 15 days being for adaptation of the animals to the experimental conditions, 84 days (three periods of 28 days each) for data collection and samples, and 10 days for slaughter, as five animals were slaughtered per day, on five alternate days, with each slaughter containing one representative animal of each treatment. Twenty-five male, non-castrated bovines (Dutch-Zebu) were used, which came from Pernambuco's backcountry, with 18 months of age and 219 kg of initial live weight. The animals were kept in feedlots, with the use of individual stalls equipped with feeder and drinking fountain.

After the adaptation period, the animals were weighed and randomly distributed into the facilities and treatments, which consisted of levels of substitution of cornmeal for mesquite pod meal in proportions of 0; 25; 50; 75 and 100% on the dry matter basis.

The experimental feeds were composed of Tifton grass hay (filler), cornmeal, mesquite pod meal, soybean meal and mineral mixture, whose bromatological composition is shown in Table 1. The proportions of the ingredients and the bromatological composition of the experimental feeds are displayed in Table 2.

At the end of the experiment, the animals were slaughtered, after a 16-hour fast approximately, in the municipal slaughterhouse of Serra Talhada, Pernambuco State. Bleeding, flaying, removal of the head, legs, tail, organs, genitals, viscera and internal fat were performed, being weighed separately.

Next, the carcasses of each animal were tagged and sectioned longitudinally with the aid of an electric saw; afterwards, they were weighed as left and right half carcasses to obtain hot carcass weight and their yield in relation to body weight (BW).

The right half carcass of each animal was separated between the 5th and 6th ribs, in front and rear quarters. The front quarter comprised the shoulder and front cuts without shoulder (chuck, brisket, flanks and hump); all were weighed. The rear quarter was represented by tenderloin, shank, knuckle, thin flank, flat, eye round, rump tail, top side, cap of rump, rump, cut of rump, striploin, cap of cube roll, which were weighed as well, including patella and hind bones. The yield of the commercial cuts was assessed in absolute form (kg) and relative form (as a function of half carcass weight).

Table 1. Bromatological composition of the main ingredients of the experimental feeds.

Nutrients	Foods			
	Tifton grass hay	Soybean meal	Corn meal	Mesquite pod meal
Dry matter (g kg^{-1} of NM[1])	956.20	905.14	902.24	943.51
Organic matter (g kg^{-1} of DM[2])	913.40	933.99	983.74	962.55
Crude protein (g kg^{-1} of DM[2])	87.78	510.80	81.20	94.26
Total carbohydrates (g kg^{-1} of DM[2])	814.10	405.90	839.30	851.30
Neutral detergent fiber (g kg^{-1} of DM[2])	755.10	120.51	146.92	245.70
Non-fibrous carbohydrates (g kg^{-1} of DM[2])	589.00	285.40	692.30	605.60

[1]Natural matter; [2]dry matter.

Table 2. Proportion of ingredients and bromatological composition of the experimental feeds.

Ingredients	Replacement levels (% in the Dry Matter – DM)				
	0	25	50	75	100
Tifton grass hay	73.5	73.5	73.5	73.5	73.5
Soybean meal	8.0	8.0	8.0	8.0	8.0
Cornmeal	18.0	13.5	9.0	4.5	0.0
Mesquite pod meal	0.0	4.5	9.0	13.5	18.0
Mineral salt[1]	0.5	0.5	0.5	0.5	0.5
Nutrients	Nutritional Composition				
Dry matter (g kg^{-1} of NM[2])	942.0	943.9	945.9	952.3	949.8
Organic matter (g kg^{-1} of DM)	931.6	930.8	929.9	929.0	928.2
Crude protein (g kg^{-1} of DM)	120.0	120.6	121.2	121.8	122.4
Total carbohydrates (g kg^{-1} of DM)	781.9	782.4	783.0	783.5	784.0
Neutral detergent fiber (g kg^{-1} of DM)	591.1	595.6	600.0	604.5	608.9
Non-fibrous carbohydrates (g kg^{-1} of DM)	190.8	186.8	182.9	179.0	175.1
Total digestible nutrients (g kg^{-1} of DM)	549.9	547.6	537.3	542.1	548.0

[1]Mineral salt composition (nutrients kg^{-1} of the product): 140 g kg^{-1}; P - 70 g kg^{-1}; Mg - 1.320 mg kg^{-1}; Fe - 2.200 mg kg^{-1}; Co - 140 mg kg^{-1}; Mn - 3.690 mg kg^{-1}; Zn - 4.700 mg kg^{-1}; I - 61 mg kg^{-1}; Se - 45 mg kg^{-1}; S - 12 g kg^{-1}; Na - 148 g kg^{-1}; F - 700 mg kg^{-1}. [2]MN = Natural matter.

The experimental design was the completely randomized one (CRD), with five treatments and five replications. Data were assessed by means of the Statistical Analysis Systems program (SAS, version 9.1), through analysis of variance and regression. For all statistical procedures, a 5% probability level was adopted. The statistical model adopted was $y_{ij} = \mu + t_i + e_{ij}$, where y_{ij} is the response of the variable, μ is the overall mean, t_i is the treatment effect and e_{ij} is the random error.

Results and discussion

Corn and mesquite meal are foods with very similar bromatological composition, presenting equivalence mainly in dry matter (DM), crude protein (CP), non-fibrous carbohydrates (NFC) and neutral detergent fiber (NDF) contents (Table 1). This fact led to significant similarity ($p > 0.05$) in performance responses (Table 3) due to a similarity in the amount of nutrients in the experimental diets (Table 2), indicating an equivalent nutrient input for the animals, with a reflection on analogous responses of dry matter intake, final live weight and average daily gain.

There was no significant effect ($p > 0.05$) as to the substitution of cornmeal for mesquite pod meal on the weight and yield of the front cuts. This result is a positive aspect, as the mesquite pod meal, compared to cornmeal, was able to provide similar cut weights. Good yield of cuts obtained from concentrated foods, such as corn, can be considered normal, bearing in mind the high nutritional value of this food, with 9.11% and 87.24% of CP and total digestible nutrients (TDN), respectively (Valadares, Paulino, & Magalhães, 2006). The maintenance of this yield achieved with the substitution of corn by mesquite pod meal shows that this alternative food is of good quality and can be used to feed ruminants. One reason may be related to the premise of an important parameter for ruminants, according to Jorge et al. (2008), which is the nutritional value of mesquite pod meal, that is, good bromatological composition, with a CP content of 9.4% and TDN higher than 70%, in addition to high DM digestibility. Suryawan et al. (2008) reported that mesquite pod meal has a higher proportion of leucine when compared to corn, an essential amino that is at the heart of muscle protein synthesis. Moraes et al. (2016) argued that the digestibility of nutrients was not affected by the replacement of corn for mesquite pod meal.

The means obtained with the use of mesquite pod meal to feed dairy-origin cattle were compatible and, in some cases, as the shoulder and chuck weights, higher than those described by Bonilha et al. (2007), who worked with Nelore animals, which reinforces the value and importance of exploring this group. Shoulder yield in the present study (15.61%) was close to that described by Melo et al. (2007), who also worded

Table 3. Front carcass performance, cuts and yields in mixed dairy-origin cattle fed with mesquite pod meal in substitution of cornmeal.

Variables	Replacement levels					Ŷ	P value	CV[5] (%)
	0%	25%	50%	75%	100%			
Performance								
Initial LW[1], kg	218.6	219.4	219.0	219.0	221.5	219.4	0.9999	14.25
Final LW, kg	321.8	318.4	327.8	324.0	326.0	323.5	0.9944	10.96
ADG[2], kg day^{-1}	1.040	0.922	1.096	1.062	1.066	1.04	0.1619	9.75
DMI[3], kg day^{-1}	6.95	6.78	7.05	7.06	7.16	6.99	0.8102	12.27
Front cuts and their yields								
Shoulder								
kg	13.05	13.01	13.85	13.08	12.89	13.17	0.8834	12.18
% ½CCW[4]	15.64	15.59	15.83	15.65	15.37	15.61	0.8691	4.32
Brisket								
kg	7.06	6.920	6.996	6.686	6.358	6.80	0.8723	17.13
% ½CCW	8.30	8.32	8.03	7.98	7.55	6.80	0.5004	17.13
Chuck								
kg	14.12	13.47	14.92	13.70	14.16	14.07	0.8603	15.56
% ½CCW	16.92	16.01	17.10	16.43	16.90	16.67	0.8550	10.44
Hump								
kg	1.20	1.33	1.20	1.22	1.56	1.30	0.8924	50.33
% ½CCW	1.37	1.54	1.34	1.46	1.83	1.50	0.7345	41.61
Flanks								
kg	5.70	5.71	6.25	5.51	6.17	5.86	0.7995	19.26
% ½CCW	6.71	6.56	7.17	6.56	7.34	6.93	0.7133	14.26

[1]live weight; [2]average daily gain; [3]dry matter intake; [4]cold half carcass weight; [5]coefficient of variation.

with mixed dairy-origin cattle, whose value found was 17.20%. Silva et al. (2015) conducted a research with crossbred dairy-origin calves (Holstein-Zebu) and described hot and cold carcass yields of 54 and 52%, respectively, for the treatment that received lower concentrate level (17%).

These carcass yield values are compatible with those described by Dian et al. (2006), who worked with ½ Nelore x ½ Angus calves in feedlots, and Freitas et al. (2008), who used super early and early animals, receiving 40% of concentrate.

These findings can be explained initially by the body composition of these animals, which, despite their dairy origin, have in their genome a good zebuine genetic participation. This assertion can be corroborated with results found by Neves et al. (2016), who reported similarity in the nutritional requirements of dairy-origin male bovines when compared to Nelore and its crossbreeds. This means that dairy-origin bovines (Holstein-Zebu) present organs + viscera weight, carcass characteristics and cut weights similar to those of Nelore and its crossbreeds, which directly reflects on the parity of nutritional requirements. Thus, it can be considered that dairy-origin male bovines, when properly fed, can present satisfactory performance compared to Nelore and its crossbreeds.

It is believed that the fact that internal organs and viscera are more developed in dairy animals is important for obtaining food, that is, a greater ruminal volume is desirable, as well as a larger size of organs and viscera, such as intestines and liver, as it increases the capacity of absorption and processing of nutrients.

The results described in Table 4 show the potential not only of mesquite pod meal but also of dairy-origin cattle for commercial cut yields, since they showed yields of noble cuts such as eye round, similar or, in other cases, superior, such as rump tail, compared to those obtained by Vaz et al. (2013), who worked with Nelore animals.

During animal growth process, some body regions develop earlier than others, such as head and leg. Thus, in the context in which this study was conducted, that is, crossbred young animals with low concentrate level, the occurrence of treatment effects in carcass regions with early formation, such as the muscles that compose the leg cuts, or even in the cuts that are formed by muscles of late growth, was unlikely, since body growth is a reflection of intake and gain, which, in their turn, did not show any variation between treatments (Table 3). Moreover, the animals at the time of slaughter showed no significant differences ($p > 0.05$) as to live weight, and such characteristic is closely related to the cuts.

The equivalence between total carbohydrates (TCHE) and NFC of the foods assessed (Table 1) favored the use of nutrients by ruminal microorganisms, which contributed significantly ($p > 0.05$) to the mesquite pod meal providing cut weight and yields equivalent to those of cornmeal (Tables 3 and 4). Although mesquite pod meal has a lower proportional amount of NFC (60.5%) compared to corn (69.2%), the pulp, which accounts for 56% of the mesquite pod meal weight, contains in its chemical composition a concentration of 46.3% of sucrose (Figueiredo et al., 2007). Rincón, Muñoz, Ramírez, Galán, and Alfaro (2014) reported that mesquite pod meal NFCs have a high amount of mannose and galactose.

Table 4. Rear cuts and their yields in mixed dairy-origin cattle fed with mesquite pod meal in replacement of cornmeal.

Variables	Replacement levels					Ŷ	P Value	CV[2] (%)
	0%	25%	50%	75%	100%			
Tenderloin								
kg	2.120	2.062	2.296	2.076	1,888	2.08	0.3557	14.46
% ½CCW[1]	2.56	2.47	2.62	2.48	2,25	2.47	0.3042	11.04
Shank								
kg	2.764	2.818	2.834	2.864	2.764	2.80	0.9577	8.87
% ½'CCW	3.33	3.40	3.25	3.412	3.30	3.34	0.7636	6.72
Knuckle								
kg	3.488	3.600	3.396	3.336	3.520	3.46	0.7933	10.34
% ½CCW	4.18	4.33	3.93	3.99	4.21	4.12	0.4497	9.06
Thin flank								
kg	2.378	2.586	2.856	2.496	2.752	2.61	0.4929	17.53
% ½CCW	2.88	3.13	3.24	3.01	3.27	3.10	0.6880	15.61
Flat								
kg	3.412	3.642	3.742	3.440	3.370	3.52	0.5431	11.53
% ½CCW	4.09	4.38	4.27	4.10	4.04	4.17	0.2866	6,66
Eye round								
kg	1.714	1.680	1.864	1.676	1.750	1.73	0.6750	12.94
% ½CCW	2.05	2.02	2.13	1.99	2.09	2.05	0.6881	8.09
Rum tail								
kg	1.092	0.966	0.994	0.976	1.018	1.00	0.8348	18.61
% ½CCW	1.29	1.15	1.13	1.16	1.22	1.19	0.4376	12.53
Top side								
kg	6.234	6.052	6.506	5.956	5.968	6.14	0.6560	10.72
% ½CCW	7.44	7.31	7.47	7.11	7.13	7.29	0.5776	5.99
Cap of rump								
kg	1.086	0.950	1.096	1.082	1.188	1.08	0.6048	21.10
% ½CCW	1.30	1.13	1.25	1.29	1.41	1.27	0.2447	14.54
Rump								
kg	2.460	2.610	2.578	2.688	2.608	2.58	0.9038	14.17
% ½CCW	2.94	3.13	2.95	3.22	3.12	3.07	0.5991	10.61
Cut of rump								
kg	0.198	0.162	0.210	0.202	0.214	0.19	0.3752	22.15
% ½CCW	0.24	0.19	0.24	0.23	0.25	0.23	0.2887	20.22
Stripion								
kg	4.630	4.634	4.588	4.556	4.462	4.57	0.9971	17.72
% ½CCW	5.47	5.56	5.26	5.43	5.30	5.40	0.9225	10.63
Cap of cube roll								
kg	0.940	0.782	0.716	0.878	0.96	0.85	0.5433	30.72
% ½CCW	1.11	0.95	0.83	1.03	1.13	1.00	0.3598	25.41

[1]half cold carcass weight; [2]coefficient of variation.

NFCs, because of their rapid ruminal degradation, favor the growth of bacteria that produce propionate, one of the main short-chain fatty acids and the main gluconeogenic substrate in ruminants, which in the hepatocytes and in the kidneys is converted into glucose, which will be available for energy supply to protein synthesis in the host, since in diets with adequate energy supply the oxidation of amino acids to obtain energy is virtually non-existent.

Additionally, secondary compounds present in the mesquite pod have a selective action on gram-negative bacteria, which are more efficient in the use of food nutrients, such as the propionic ones, resulting in improved nutrient digestibility and performance (Silva et al., 2017). Rogero and Tirapegui (2008) reported that adequate supply of glucose and branched-chain amino acids, mainly leucine, after a meal, is able to increase protein synthesis in skeletal muscle as efficiently as the set of all amino acids.

In this sense, it is worth highlighting the role of branched-chain amino acids (leucine, isoleucine and valine), with leucine being one of the main stimulators of protein synthesis in skeletal muscles (Suryawan et al., 2008), whose concentration in the mesquite pod accounts for 4.59% of all present amino acids (Zavala & González, 1997), concentration higher than that found in corn, of approximately 1.05%, based on dry matter (Agustini et al., 2015), as it is able to stimulate protein synthesis (Suryawan et al., 2008) and, when combined, boosts the increase in muscle growth through this amino acid (Wu, 2009).

Conclusion

Mesquite pod meal can replace cornmeal in 100% in the concentrate without changes in the weight and yield of commercial front and rear cuts of dairy-origin male bovines.

Acknowledgements

We thank the National Council for Scientific and Technological Development (Conselho Nacional de

Desenvolvimento Científico e Tecnológico) for funding the project.

References

Agustini, M. A. B., Nunes, R. V., Silva, Y. L., Vieites, F. M., Eyng, C., Calderano, A. A., & Gomes, C. C. (2015). Coeficiente de digestibilidade e valores de aminoácido digestivos verdadeiros de diferentes cultivares de milho para aves. *Semina: Ciências Agrárias, 36*(2), 1091-1098.

Alves, E. M., Pedreira, M. S., Oliveira, C. A. S., Aguiar, L. V., Pereira, M. L. A., & Almeida, P. J. P. (2010). Comportamento ingestivo de ovinos alimentados com farelo da vagem de algaroba associado a níveis de ureia. *Acta Scientiarum. Animal Sciences, 32*(4), 439-445.

Bonilha, S. F. M., Packer, I. U., Figueiredo, L. A., Alleoni, G. F., Resende, F. D., & Razook, A. G. (2007). Efeitos da seleção para peso pós-desmame sobre características de carcaça e rendimento de cortes cárneos comerciais de bovinos. *Revista Brasileira de Zootecnia, 36*(5), 1275-1281.

Braga, A. P., Ezequiel, J. M. B., Braga, Z. C. A. C., & Mendonça Júnior, A. F. (2009). Composição química e digestibilidade da vagem de algarobeira (*prosopis juliflora*, (sw) dc) submetida a diferentes tratamentos térmicos. *Revista Caatinga, 22*(1), 256-262.

Dannenberger, D., Nuernberg, K., Nuernberg, G., & Ender, K. (2006). Carcass and meat quality of pasture versus concentrate fed erman simmental and german holstein bulls. *Archiv Tierzucht Dummerstorf, 49*(4), 315-328.

Dian, P. H. M., Prado, I. N., Fugita, C. A., Prado, R. M., Valero, M. V., & Bertipaglia, L. M. A. (2006). Substituição do milho pelo resíduo de fecularia de mandioca sobre o desempenho, digestibilidade e características de carcaça de novilhos confinados. *Acta Scientiarum. Animal Sciences, 31*(4), 381-387.

Figueiredo, M. P., Cruz, P. G., Costa, S. S., Rodrigues, C. S., Pereira, L. G. R., Ferreira, J. Q., ... Irmão, J. N. (2007). Fracionamento dos carboidratos e componentes nitrogenados do farelo e diferentes partes integrantes da vagem de algaroba (*Prosopis juliflora (Swartz)*. *Revista Brasileira de Saúde e Produção Animal, 8*(1), 24-31.

Freitas, A. K., Restle, J., Pacheco, P. S., Padua, J. T., Lage, M. E., Miyagi, E. S., & Silva, G. F. R. (2008). Características de carcaças de bovinos Nelore inteiros vs castrados em duas idades, terminados em confinamento. *Revista Brasileira de Zootecnia, 37*(6), 1055-1062.

Guerrero, A., Muela, E., Valero, M. V., Prado, I. N., Campo, M. M., Olleta, J. L., ... Sañudo, C. (2016). Effect of the type of dietary fat when added as an energy source on animal performance, carcass characteristics and meat quality of intensively reared Friesian steers. *Animal Production Science, 56*(7), 1144-1151.

Jorge, J. R. V., Zeoula, L. M., Prado, I. N. Silva, R. R., Andrade, R. V., Macedo, L. M. A., ... Marques, J. A. (2009). Gordura protegida sobre o desempenho, carcaça e composição química da carne de novilhos holandês. *Archivos de Zootecnia, 58*(223), 371-382.

Jorge, J. R. V., Zeoula, L. M., Prado, I. N., Silva, R. R., Andrade, R. V., Prado, J. M., & Bublitz, E. E. (2008). Lipídios em dietas para novilhos holandeses: digestibilidade aparente. *Revista Brasileira de Saúde e Produção Animal, 9*(4), 743-753.

Melo, W. S., Véras, A S. C., Ferreira, M. A., Dutra Júnior, W. M., Andrade, D. K. B., & Santos, G. R. A. (2007). Cortes nobres, componentes do peso vivo e órgãos viscerais de bovinos mestiços de origem leiteira em condições de pastejo restrito ou *ad libitum*. *Revista Brasileira de Ciências Agrárias, 2*(1), 90-97.

Moraes, G. S. O., Souza, E. J. O., Véras, A. S. C., Almeida, M. P., Cunha, M. V., Torres, T. R., ... Pereira, G. F. P. (2016). Total replacement of corn by mesquite pod meal considering nutritional value, performance, feeding behavior, nitrogen balance, and microbial protein synthesis of Holstein-Zebu crossbred dairy steers. *Tropical Animal Health and Production, 48*(7), 1415-1420.

Neves, L. M. W., Véras, A. S. C., Souza, E. J. O., Ferreira, M. A., Valadares Filho, S. C., Silva, G. S., ... Barreto, L. M. G. (2016). Energy and protein requirements of crossbred cattle in feedlot. *Semina: Ciências Agrárias, 37*(2), 1029-104.

Oliveira, J. P. F., Barreto, L. M. J., Lima, D. M., Júnior, Aguiar, E. M., & Silva, T. O. (2010). Algarobeira (*Prosopis juliflora*): Uma alternativa para alimentação de ovinos no Nordeste brasileiro. *Revista Verde de Agroecologia e Desenvolvimento Sustentável, 5*(2), 1-4.

Prado, I. N., Campo, M. M., Muela, E., Valero, M. V., Catalan, O., Olleta, J. L., & Sañudo, C. (2014). Effect of castration age, protein level and lysine/methionine ratio in the feed on animal performance, carcass and meat quality of Friesian steers intensively reared. *Animal, 8*(10), 1-8.

Prado, I. N., Campo, M. M., Muela, E., Valero, M. V., Catalan, O., Olleta, J. L., & Sañudo, C. (2015). Effects of castration age, protein level and lysine/methionine ratio in the diet on colour, lipid oxidation and meat acceptability of intensively reared Friesian steers. *Animal, 9*(8), 1423-1430.

Rincón, F., Muñoz, J., Ramírez, P., Galán, H., & Alfaro, C. (2014). Physicochemical and rheological characterization of *Prosopis juliflora* seed gum aqueous dispersions. *Food Hydrocolloids, 35*(6), 348-357.

Rogero, M. M., & Tirapegui, J. (2008). Aspectos atuais sobre aminoácidos de cadeia ramificada e exercício físico. *Revista Brasileira de Ciências Farmacêuticas, 44*(4), 563-575.

Silva, C. G. M., Melo Filho, A. B., Pires, E. F., & Stamford, T. L. M. (2007). Caracterização físico-química e microbiológica da farinha de algaroba (*Prosopis juliflora* (Sw.) DC). *Ciência e Tecnologia de Alimentos*, *27*(4), 733-736.

Silva, C. S., Souza, E. J. O., Pereira, G. F., Cavalcante, E. O., Lima, E. I. M., Torres, T. R., ... Silva, D. C.

(2017). Plant extract as phytogenic additives considering intake, digestibility, and behavior of sheep. *Tropical Animal Health and Production, 49*(2), 353-359.

Silva, G. S., Véras, A. S. C., Ferreira, M. A., Dutra Júnior, W. M., Neves, M. L. M. W., Souza, E. J. O., ... Lima Júnior, D. M. (2015). Performance and carcass yield of crossbred dairy steers fed diets with different levels of concentrate. *Tropical Animal Health and Production, 47*(5), 1307-1312.

Suryawan, A., Jeyapalan, A. S., Orelhana, R. A., Wilson, F. A., Nguyen, H. V., & Davis, T. A. (2008). Leucine stimulates protein synthesis in skeletal muscle of neonatal pigs by enhancing mTORC1 activation. *American Journal of Physiology Endocrinology and Metabolism, 295*(4), 868-875.

Valadares Filho, S. C., Paulino, P. V. R., & Magalhães, K. A. (2006). *Exigências nutricionais de zebuínos e tabelas de composição de alimentos BR-corte* (1st. ed.). Viçosa, MG: Universidade Federal de Viçosa.

Vaz, F. N., Restle, J., Pádua, J. T., Pacheco, P. S., Fonseca, C. A., & Ávilla, M. M. (2013). Receita dos cortes secundários da carcaça de machos nelore não castrados abatidos com diferentes pesos e dentições. *Ciências Animal Brasileira, 14*(2), 172-184.

Wu, G. (2009). Amino acids: metabolism, functions, and nutrition. *Amino Acids, 37*(1), 1-17.

Zavala, D. E. E., & González, N. (1997). Utilización del fruto del cují (*Prosopis juliflora*) em la elaboración de medios del cultivos bacterianos. *Revista científica,* 7(1), 57-64.

Received on February 2, 2017.
Accepted on April 4, 2017.