NUTRIENT CONSUMPTION AND DIGESTIBILITY OF SUGAR CANE DIETS SUPPLEMENTED WITH SOYBEAN MEAL OR UREA

[CONSUMO DE NUTRIENTES Y LA DIGESTIBILIDAD DE DIETAS DE CAÑA DE AZÚCAR COMPLEMENTADOS CON HARINA DE SOJA O UREA]

A. H. N. Rangel[1], J. M. S. Campos[2], S. C. Valadares Filho[3], G. S. Difante[1], D. M. Lima Júnior[4], L. P. Novaes[1], M. G. Costa[1]

[1]Unidade Acadêmica Especializada em Ciências Agrárias, Universidade Federal do Rio Grande do Norte – UFRN, 59000-000, Macaíba, RN, Brazil. Corresponding autor: Adriano Henrique do Nascimento Rangel. Tel: +55 84 9915-0062; e-mail:adrianohrangel@yahoo.com.br .

[2] Unidade Acadêmica de Garanhuns, Universidade Federal Rural de Pernambuco – UFRPE, Garanhuns, PE, Brazil.

[3] Universidade Federal de Viçosa - UFV, Viçosa, MG, Brazil.

[4] Campus Arapiraca, Universidade Federal de Alagoas - UFAL, Arapiraca, AL, Brazil

**Corresponding author*

SUMMARY

The present work was developed aiming to verify the effect on intake and digestibility of diets based on sugar cane, whose CP levels were supplemented with concentrate based on soybean meal or different levels of urea, fed to dairy cows. Twelve Holstein dairy cows were used, arranged in three 4 x 4 Latin squares distributed according to the lactation period. After analysing the variance, we proceeded to compare the non-orthogonal contrasts. There was no difference (P>0.05) for the consumption of dry matter/material (DM), organic matter (OM), crude protein (CP), ether extract (EE), total carbohydrates (CHO), non-fibrous carbohydrates (NFC), neutral detergent fiber (NDF), and DM (g/kg $^{0.75}$) between diets. Between different levels of urea, a linearly decreasing effect for the consumption of NDF kg/day and NDF (% body weight) was verified. There was no difference (P>0.05) for apparent digestibility coefficients of DM, OM, CP, EE, NDF, and NFC when comparing different diets. There was linear increase between treatments of urea for CHO digestibility and total nutrient digestive. The soybean meal in the concentrate is not necessary in diets based on sugarcane supplemented with urea. The inclusion of urea is not necessary in diets based on sugar cane supplemented with a base concentrate of soybean meal for dairy cows producing 20 kg/day.

Key words: Dairy cows; Protein nutrition; *Saccharum officinarum*; Tropical forage.

RESUMEN

El presente trabajo se desarrolló con el objetivo de verificar el efecto sobre el consumo y la digestibilidad de las dietas basadas en la caña de azúcar, cuyos niveles de CP fueron suplementadas con concentrado a base de harina de soja o diferentes niveles de urea, alimentado a las vacas lecheras. Se utilizaron doce vacas lecheras Holstein, dispuestos en tres 4 x 4 cuadrados latinos distribuidos de acuerdo con el período de lactancia. Tras el análisis de la varianza, se procedió a comparar los contrastes no ortogonales. No hubo diferencias (P> 0,05) para el consumo de materia seca (DM), materia orgánica (MO), proteína cruda (PC), extracto etéreo (EE), el total de carbohidratos (CHO), carbohidratos no fibrosos (NFC), fibra detergente neutro (FDN) y DM (g / kg 0.75) entre las dietas. Entre los diferentes niveles de urea, se verificó un efecto lineal decreciente para el consumo de FND kg / día y FDN (% del peso corporal). No hubo diferencias (P> 0.05) para los coeficientes de digestibilidad aparente de la MS, MO, PC, EE, NDF, y NFC cuando se comparan diferentes dietas. Hubo aumento lineal entre los tratamientos de urea para CHO digestibilidad y total de nutrientes digestibles. La harina de soja en el concentrado no es necesaria en dietas basadas en caña de azúcar suplementado con urea. La inclusión de urea no es necesario en dietas basadas en caña de azúcar suplementado con un concentrado base de harina de soja para vacas lecheras que producen 20 kg / día.

Palabras clave: Las vacas lecheras; nutrición proteína; *Saccharum officinarum*; forrajeras tropicales.

INTRODUCTION

Among the options for supplementary forage, sugar cane has a consolidated position. In simulations comparing the sources of roughage for the herd, sugar cane is often suggested as an alternative that satisfies the most interesting conditions. Few plants have received as much special attention as sugarcane, which has been studied extensively with large investments in research targeted at culture and nutrition of animals with a view to formulating diets with it (Schmidt and Nussio, 2005; Siqueira *et al*., 2012). According to Landell *et al*. (2002), approximately 500 000 hectares of sugar cane are destined for animal feed, primarily for dairy herds (Freitas *et al*., 2011; Carvalho *et al*., 2011).

Using a dynamic and mechanistic model of digestion able to predict the absorption of nutrients in cattle fed diets based on sugar cane, Pereira and Collao-Saenz (2004) simulated the response of 200 and 300 kg heifers to the inclusion of urea in their diets with dietary levels ranging from 0 to 1 kg per 100 kg of sugar cane. The authors concluded that nothing is gained in the flow of nutrients absorbed nor available to the animal's organism when supplementation exceeds 50 grams / day, equivalent to 300 g of urea per 100 kg of raw sugar cane, i.e. 1% dry matter, considering there was a content of 30% dry matter.

As sugar cane varies with the variety, crop year, and stage of maturity, among others, Preston (1977) recommended a simple method to estimate the urea level to be added to the sugar cane with the formula: urea in sugar cane (g urea / kg of raw sugar cane) = 0.6 Brix (94.8 to 1.12 Brix) / (100 - Brix). The level of 1% corresponds to 17 ° Brix. Considering the increase in sugar yield of new varieties of sugar cane used for sugar industries (Smith *et al*., 2012; Nassif and Martin, 2013) which are available for use by cattle, perhaps today the need for adding urea would be no less, but greater than 1%, that is 1.15 and 1.25%. If this is verifiable, it would be an economically beneficial tool for producers.

Thus, an assessment is needed in order to test levels of urea in diets based on sugar cane for dairy cows of higher production potential, the results of which are still generally insufficient in Brazil. One of the current challenges being to increase participation levels of sugar cane for cows producing 20 to 25 liters. For a full understanding of the advantages and disadvantages of using a supplement, it's necessary to get information that goes beyond the production and composition of milk, consumption, and digestibility of nutrients.

The present work was developed aiming to verify the effect on intake and digestibility of diets based on sugar cane, whose CP levels were supplemented with concentrate based on soybean meal or different levels of urea, fed to dairy cows.

MATERIALS AND METHODS

The experiment was conducted at the Unidade de Ensino, Pesquisa e Extensão de Bovinocultura Leiteira (UEPE-GL), Departmento de Zootecnia (DZO), the Universidade Federal de Viçosa (UFV).

The Viçosa city is located in the Zona da Mata, State of Minas Gerais, 649 m altitude, geographically defined by the coordinates of 20º45'20'' south latitude and 42º52'40''west longitude. The climate is Cwa, according to the classification proposed by Köppen, with two defined seasons: dry from April to September, and wet from October to March. The average annual rainfall is 1341.2 mm. The mean maximum and minimum temperatures are 26.1 and 14.0°C respectively.

Twelve Holstein cows were used, purebred and crossbred, distributed in three 4 X 4 Latin squares design, according to the lactation period. The animals were subjected to four treatments in which raw volume sugar cane was used (*Saccharum officinarum*, L., RB range 73-9735), whose protein content was adjusted to a concentrate based on soybean meal and three other diets containing 0.4, 0.8, and 1.2% of urea with ammonium sulfate mixture (9:1), based on *in natura* forage. Concentrated sodium bicarbonate and magnesium oxide (2:1) was added to all diets. Diets were formulated to be isonitrogenous, according to the NRC (2001) for dairy cows with 600 kg of body weight (BW), producing 20 kg/day of milk with 3.5% fat content in milk (Table 1 and Table 2). The amount of concentrate was 1 kg for every 2 kg of milk produced, which corresponded to the total diet forage volume:concentrate ratio of 45:55, at the beginning of the experiment. The adjustment in the concentrate supply was made in the fifth and tenth day of each adjustment period. The Table 1 presents the proportions of the ingredients used in the concentrated mixture. The chemical composition of sugar cane and the concentrate used is shown in Table 2.

Table 1. Proportion of ingredients of the concentrated feed, expressed as a percentage of dry matter

Ingredients, g/100 g	Soybean Meal	Level of urea (%) in raw sugar cane		
		0.4	0.8	1.2
Corn meal	37.58	37.71	45.48	53.05
Soybean meal	31.45	0.00	0.00	0.00
38% Cottonseed meal	0.00	31.28	23.24	15.40
Wheat bran	27.27	27.27	27.27	27.27
Mg of sodium bicarbonate	1.09	1.09	1.09	1.09
Mineral mix	2.60	2.65	2.92	3.19
Total	100.00	100.00	100.00	100.00

[1] 67% sodium bicarbonate and 33% magnesium oxide; [2] Dicalcium phosphate (22.99, 9.16, 11.91, 14.12 %), limestone (42.81, 55.04, 50.03, 45.95 %), common salt (32.83, 34.24, 31.21, 28.73 %), sulphur flowers (0.95, 1.10, 0.78, 0.52%), zinc sulphate (0.3424, 0.3421, 0, 3389; 0.3361 %), copper sulfate (0.0515, 0.0981, 0.0999, 0.1012 %), potassium iodate (0.0037, 0.0038, 0.0035, 0.0033 %).

Table 2. Levels of average analytical fractions obtained for sugar cane and experimental concentrates.

Items	Concentrates		Level of urea (%) in raw sugar cane		
	Sugar cane	Soybean meal	0.4	0.8	1.2
Dry matter (%)[1]	29.29	87.95	87.83	88,75	88,34
Organic matter[1]	95.53	95.24	94.63	95.23	95.81
Crude Protein[1]	2.47	23.34	21.58	18.79	16.07
INNDF[2*]	43.72	15.31	18.03	18.95	21.28
INADF[2*]	25.12	6.31	6.02	5.06	4.92
Ether extract[1]	0.70	2.75	2.75	2.80	2.84
Total Carbohydrates[1]	90.36	70.15	70.30	73.63	76.89
NDF[1*]	45.69	21.35	29.39	27.28	25.22
Non-fiberous Carbohydrates [1]	44.67	48.80	40.91	46.35	51.67
ADF[1*]	24.85	9.06	10.47	9.35	8.25
Lignin[1]	7.10	1.93	2.50	2.25	2.00

[*] Insoluble Nitrogen in Neutral Detergent (INNDF); Insoluble Nitrogen in Acid Detergent (NIADF); Insoluble Fiber in Neutral Detergent (NDF) and Insoluble Fiber in Acid Detergent (ADF).
1 Values in percentage of MS.
2 Values as a percentage of total nitrogen.

The experiment consisted of four periods, each lasting 17 days each, with the first ten days of diet adaptation and the other for assessment of consumption, nutrient digestibility, milk production and composition, and the variation of weight.

The total digestible nutrients (TDN) were calculated according to Weiss (1999), by the equation: TDN (%) = DRP + DNDF + DNFC + 2.25 DEE, where DRP = digestible crude protein; DNDF = digestible neutral detergent fiber; DNFC = digestible non-fiber carbohydrates; and DEE = digestible ether extract.

The animals were housed in individual Tie Stalls, where they were fed *ad libitum* feed twice a day daily, at 8 and 17 h o'clock. The quantities of food provided and the treatment for consumption were weighed daily. Daily monitoring of consumption was made in order to keep the remaining food on the order of 10% of the total offered based on natural materials. At feeding time during the experimental period, samples of food and leftovers, which were placed in plastic bags and frozen for subsequent analysis were taken.

The preparation of composite samples of supplied feed and daily leftovers and analysis of dry matter (DM), organic matter (OM), mineral matter (MM), total nitrogen compounds (NT), nitrogen insoluble in neutral detergent (NIND) nitrogen insoluble in acid detergent (NIAD), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF) and

lignin (LIG) followed the specifications described by Silva and Queiroz (2002).

The total carbohydrates (TC) were calculated according to Sniffen *et al*. (1992), wherein CHO = 100 - (% crude protein +% fat +% ash) with NFC being obtained by the formula NFC = 100 - [(% CP - % CP urea + % urea) +% EE +% MM].

The total amount of excreted fecal DM used to evaluate the apparent digestibility of foods was estimated through the indigestible acid detergent fiber (iADF), obtained after ruminal feed incubation, leftovers, and feces were put in Ankom bags (filter bag 57) for a period of 144 hours, following adaptation of the technique described by Cochran *et al*. (1986). Feces were collected in the 13th and 16th days of each experimental period, always before morning and afternoon milking, and placed in plastic bags which were stored in a freezer at -15^{o}C and at end of the collection period a composite sample was made per animal based on the dry weight in air.

After variance analysis, we proceeded to compare the sum of squares for treatments in non-orthogonal contrasts related to concentrate based on soybean meal against urea levels, and the effects of linear and quadratic order relating to varying levels of urea through the Scheffé test. For all statistical procedures, 0.05 was adopted as the critical level of probability type I error.

RESULTS

Dry matter consumption did not differ (P>0.05) among diets. Diet with concentrate based on soybean meal showed an average consumption of 18.05 kg DM/day, while diets with urea showed an average 19.19 kg DM/day (Table 3).

The lack of differences in consumption of OM, EE, CHO, NFC, and TDN (kg/day) may be explained by similar DM consumption and approximately similar composition of the components of the experimental diets. However, the consumption of CP and NDF differed (P<0.05) between diets and urea levels.

Consumption of NDF, in kg/day and BW% was lower (P<0.05) for treatment with concentrate based on soybean meal compared to treatments with levels 0.4 and 0.8% urea. Between diets in which urea was used in its composition, there was a decreasing linear effect (P<0.05) as it raised the level of urea.

Table 3. Means and coefficients of variation (CV) and contrasts obtained for the daily intake of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), total carbohydrates (CHO), fiber in neutral detergent (NDF), non-fiber carbohydrates (NFC), total digestible nutrients (TDN) obtained for diets with sugar cane supplemented with concentrate based on soybean meal (SBM) or three levels of urea

Items	Diets with sugar cane				CV (%)	Contrasts[a]				
	FS	Levels of urea (%)								
		0.4	0.8	1.2		SBM *vs* 0.4%	SBM *vs* 0.8%	SBM *vs* 1.2%	L	Q
Consumption (kg/day)										
DM	18.05	19.55	19.41	18.60	7.53	ns	ns	ns	ns	ns
OM	17.30	18.51	18.34	17.52	7.48	ns	ns	ns	ns	ns
CP	2.23	2.76	2.72	2.66	11.28	**	**	**	ns	ns
EE	0.34	0.37	0.37	0.35	9.47	ns	ns	ns	ns	ns
CHO	14.72	15.37	15.25	14.50	6.88	ns	ns	ns	ns	ns
NDF	5.83	7.01	6.79	6.30	7.02	**	**	ns	**	ns
NFC	8.89	8.36	8.45	8.19	7.10	ns	ns	ns	ns	ns
TDN	10.71	10.81	11.25	11.13	21.04	ns	ns	ns	ns	ns
Consumption (% BW)										
DM	2.95	2.98	2.97	2.95	4.93	ns	ns	ns	ns	ns
NDF	0.98	1.17	1.11	1.02	7.90	**	**	ns	**	ns
Consumption (g/kg$^{0.75}$)										
DM	145.67	147.82	147.71	146.97	4.68	ns	ns	ns	ns	ns

[a/] FS vs. U, L and Q = contrasts of the comparison between soybean meal and different levels of urea and linear and quadratic effects associated with the level of urea, respectively.
Ns: not significant.
** P <0.05.

In Table 4, the estimated values of protein and energy requirements are presented for lactating cows with average body weight of 600 kg and average daily production of 20 kg at 3.5% fat and weight gain of 0.30 kg/day, according to the NRC (2001).

The digestibility of nutrients did not differ between diets with concentrate based on soybean meal compared to diets containing different levels of urea, for DM, OM, CP, EE, NDF, and NFC (Table 5).

The digestibility of total carbohydrates (DCHO) and total digestible nutrients observed (TDN_{obs}) were higher (P<0.05) for the diet containing soybean meal in relation to the diet with 0.4% urea. For diets in which urea was used in its composition, there was increased linearity (P<0.05) with increasing levels of urea to DCHO and TDN_{obs} (Table 5). The TDN_{obs} was higher (P<0.05) when comparing the concentrate based on soybean meal to the level of 0.4% urea. With the increase of levels of urea content in the diet, there was a significant effect on TDNobs (P<0.05).

DISCUSSION

Diet with concentrate based on soybean meal showed an average consumption of 18.05 kg DM/day, while diets with urea showed an average 19.19 kg DM/day. The literature points out when the percentage of concentrate in sugar cane based diets reached 60% dry base, there was DM consumption similar to that found in this study (Costa *et al*., 2005; Oliveira *et al*., 2007). Also the values recommended by the NRC (2001) for DM, 18.30 kg/day and 3.05% of body weight for dairy cow weighing 600 kg body weight, producing 20 kg of milk corrected to 3.5% fat and gaining approximately 0.300 kg/day, are similar to the average values found in this study, of 18.90 kg/day and 2.96% of body weight.

Table 4. Values observed and requirements of crude protein (CP) and total digestible nutrients (TDN), according to the NRC (2001) for lactating cows with 600 kg of body weight, producing 20 kg/day on average with 3.5% fat, with weight gain of 0.30 kg/day, expressed as kg/day.

Items	Requirements	Sugar cane Diets			
		Soybean	Level of urea (%)		
			0.4%	0.8%	1.2%
CP (kg/day)	2.62	2.23	2.76	2.72	2.66
Difference		-0.39	+ 0.14	+0.10	+ 0.04
TDN (kg/day)	10.55	10.72	10.82	11.25	11.14
Difference		+0.17	+0.27	+0.70	+0.59

Table 5. Means, coefficients of variation (CV) and contrasts obtained for the coefficient of digestibility of dry matter (DDM), organic matter (DOM), crude protein (DCP), ether extract (DEE), total carbohydrates (DCHO) fiber in neutral detergent (DNDF) and non-fiber carbohydrates (DNFC), obtained for the diets supplemented with concentrate based on soybean meal (SBM) or three levels of urea.

Items	Sugar cane diets				CV (%)	Contrasts[a]				
	FS	Levels of urea (%)				SBM *vs* 0.4%	SBM *vs* 0.8%	SBM *vs* 1.2%	L	Q
		0.4	0.8	1.2						
DDM	58.54	51.31	58.01	58.88	12.36	ns	ns	ns	ns	ns
DOM	58.72	54.15	57.51	59.18	18.06	ns	ns	ns	ns	ns
DCP	55.60	50.96	53.59	56.73	19.61	ns	ns	ns	ns	ns
DEE	81.80	77.23	76.72	79.47	12.87	ns	ns	ns	ns	ns
DCHO	58.65	54.13	57.74	59.11	20.28	**	ns	ns	**	ns
DNDF	26.80	26.24	26.26	23.63	51.15	ns	ns	ns	ns	ns
DNFC	79.82	77.31	78.03	86.55	23.13	ns	ns	ns	ns	ns
TDN_{obs}	59.28	54.72	57.98	59.69	17.58	**	ns	ns	**	ns

[a/] FS vs. U, L and Q = contrasts of the comparison between soybean meal and different levels of urea and linear and quadratic effects associated with the level of urea, respectively.
[ns] not significant.
** P <0.05.

Consumption a crude protein was lower (P<0.05) for the diet with sugar cane supplemented with a concentrate based on soybean meal compared to diets with urea, at all levels of inclusion studied. Probably the difference in crude protein consumption was due to the source of dietary protein, among other things the diet with sugar cane supplemented with a concentrate of bran had soybean meal as the main source of nitrogen, while diets based on urea had this ingredient added to sugar cane. The addition of urea to sugar cane seems to contribute to the greater consumption of nitrogen, probably due to sugar cane representing a larger volume of natural matter in the cows' diets.

The average NDF consumption, expressed as a percentage of body weight was lower than recommended by Mertens (1985) of 1.25 ± 0.1%, to optimize DM ingestion and energy of lactating cows receiving mixed diets. Lower but similar to the values found in this study were observed by Valvasori *et al*. (1995), Costa *et al*. (2005), and Mendonca *et al*. (2004), and Santos *et al*. (2011) attributed this to the high lignin content in diets with sugar cane. The largest share of this component in the sugar cane reduces the rate and extent of NDF digestion, giving an increase in digestion retention time in the reticulum-rumen, negatively affecting the NDF consumption (Magalhães *et al*., 2006; Menezes *et al*., 2011; Oliveira *et al*., 2011; Santos *et al*., 2011). Both, the possibility to include urea in diets based on sugar cane supplemented with a concentrate of soybean meal. When urea was added to sugar cane, the concentrates did not include soybean meal, but cottonseed meal. Lascano *et al*. (2012) observed an increase in consumption of ADF when dairy cows were fed urea associated with sugar cane compared to cows fed soybean meal associated with the same volume.

The estimated values of protein and energy requirements are presented for lactating cows shown in the table 4 a deficit of dietary protein, which used the concentrate based on soybean meal for supplementation of sugar cane. This can be explained by the lower CP consumption in the soybean meal diet compared to treatments with different levels of urea.

In this research, the variation of body weight (BW) was 0.270, 0.373, 0.321, and 0.311 for the diet with soybean meal, and 0.4, 0.8, and 1.2% urea, respectively. Positive body variation has been observed in cows fed with diets based on sugar cane, used in concentrate of 40:60, similar to that used in this work (Costa *et al*., 2005; Oliveira *et al*., 2007). Mendonça *et al*. (2004) observed no increase in DNDF to raise the level of urea from 0.35% to 1% in diets based on sugar cane using concentration ratio of 60:40. Costa *et al*. (2005), working with diets based on sugar cane supplemented with 1% urea and ammonium sulphate (9:1), found DNDF higher than those found in this work for a 40:60 diet.

In diets based on sugar cane supplemented with urea, the increase in TDN_{obs} consumption can be explained by the improved food quality, as the level of urea increased, as verified by numerical improvement in the digestibility of all the non-fiber components, which goes against the suggestion of Pereira and Collao-Saenz (2004), according to which nothing is gained in the flow of absorbed nutrients nor available to the animal organism when supplementation exceeds the equivalent of 300 g of urea per 100 kg of raw sugar cane, with 30% DM.

CONCLUSION

The soybean meal in the concentrate is not necessary in diets based on sugarcane supplemented with urea. The inclusion of urea is not necessary in diets based on sugar cane supplemented with a base concentrate of soybean meal for dairy cows producing 20 kg/day.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

Carvalho, G.G.P., Garcia, R., Pires, A.J.V., Detmann, E., Silva, R.R., Ribeiro, L.S.A., Chagas, D.M.T., Pinho, B.D., Domiciano, E.M.B. 2011. Metabolismo de nitrogênio em novilhas alimentadas com dietas contendo cana-de-açúcar tratada com óxido de cálcio. Revista Brasileira de Zootecnia, 40:622-629.

Cochran, R.C., Adams, D.C., Walace, J.D., Galyean, M. L. 1986. Predicting digestibility of different diets with internal markers: evaluation of four potential markers. Journal of Animal Science, 63:1476-1483.

Correa, C.E.S., Pereira, M.N., Oliveira, S.G., Ramos, M.H. 2003. Performance of Holstein cows fed sugarcane or corn silages of different grain textures. Scientia Agricola, 60:621-529

Costa, M. G., Campos, J.M., Valadares Filho, S. C., Valadares, R. F. D., Mendonça, S. S., Souza, D. P., Teixeira, M. P. 2005. Desempenho produtivo de vacas leiteiras alimentadas com diferentes proporções de cana-de-açúcar e concentrado ou silagem de milho na dieta. Revista Brasileira de Zootecnia, 34:2437-2445.

FNP (2004). Disponível em: <http://www.fnp.com.br>. Acesso em: ago de 2014.

Freitas, A.W.P., Rocha, F.C., Zonta, A., Fagundes, J.L., Fonseca, R., Zonta, M.C.M. 2011. Desempenho de novilhos recebendo dietas à base de cana-de-açúcar *in natura* ou hidrolisada. Revista Brasileira de Zootecnia, 40:2532-2537.

IDF – International Dairy Federation. 1996. Whole milk determination of milkfat, protein and lactose content. Guide fir the operation of mid-infra-red instuments. Bruxelas: 1996. 12p. (IDF Standard 141 B).

Landell, M.G.A., Campana, M.P., Rodrigues, A.A., Cruz, G.M., Batista, L.A.R., Figueiredo, P., Silva, M.A., Bidoia, M.A.P., Rossetto, R., Martins, A.L.M., Gallo, P.B., Kanthack, R.A.D., Cavichioli, J.C., Vasconcelos, A.C.M., Xavier, M.A. 2002. A variedade IAC86-2480 como nova opção de cana-de-açúcar para fins forrageiros: manejo de produção e uso na alimentação animal. Boletim Técnico IAC, n. 193, 36 p.

Lascano, G.J., Velez, M., Tricarico, J.M., Heinrichs, A.J. 2012. Nutrient utilization of fresh sugarcane-based diets with slow-release nonprotein nitrogen addition for control-fed dairy heifers. Journal of Dairy Science, 95:370–376.

Magalhães, A.L.R., Campos, J.M.S., Cabral, L.S., Mello, R., Freitas, J.A., Torres, R.A., Valadares Filho, S.C., Assis, A.J. 2006. Cana-de-açúcar em substituição à silagem de milho em dietas para vacas em lactação: parâmetros digestivos e ruminais. Revista Brasileira de Zootecnia, 35:591-599.

Marin, F., Nassif, D.S.P. 2013. Mudanças climáticas e a cana-de-açúcar no Brasil: Fisiologia, conjuntura e cenário futuro. Revista Brasileira de Engenhria Agricola e Ambiental, 17:232–239.

Mendonça, S.S., Campos, J.M.S., Valadares Filho, S.C., Valadares, R.F.D., Soares, C.A., Lana, R.P., Queiroz, A.C., Assis, A.J., Pereira, M.L.A. 2004. Consumo, produção e composição de leite, variáveis ruminais de vacas leiteiras alimentadas com dietas à base de cana-de-açúcar. Revista Brasileira de Zootecnia, 33:481-492.

Menezes, G.C.C., Valadares Filho, S.C., Magalhães, F.G., Valadares, R.F.D., Pardos, L.F., Detmann, E., Pereira, O.G., Leão, M.I. 2011. Intake and performance of confined bovine fed fresh or ensilaged sugar cane based diets and corn silage. Revista Brasileira de Zootecnia, 40:1095-1103.

Mertens, D.R. 1985. Factors influencing feed intake in lactating cows: From theory to application using neutral detergent fiber. In: GA Nutrition Conference, 46, 1985, Athens. Proceedings... Athens: University of Georgia. 1-18.

National Research Council – NRC. 2001. Nutrient requirements of dairy cattle. 7. ed. National Academic Press, Washington, DC, USA.

Oliveira, A.S., Campos, J.M.S., Valadares Filho, S.C., Assis, A.J., Texeira, R.M.A., Valadares, R.F.D., Pina, D.S., Oliveira, G.S. 2007. Substituição do milho por casca de café ou de soja em dietas para vacas leiteiras: consumo, digestibilidade dos nutrientes, produção e composição do leite. Revista Brasileira de Zootecnia, 36:1172-1182 (supl.).

Oliveira, A.S., Detemann, E., Campos, J.M.S., Pina, D.S., Souza, S.M., Costa, M.G. 2011. Meta-análise do impacto da fibra em detergente neutro sobre o consumo, a digestibilidade e o desempenho de vacas leiteiras em lactação. Revista Brasileira de Zootecnia, 40:1587-1595.

Pereira, M.N., Collao-Saenz, E.A. 2004. Algumas considerações sobre a velha cana com ureia. Disponível em: <http://www.milkpoint.com.br>. Acesso em: maio de 2004.

Preston, T.R. 1977. Nutritive value of sugarcane for ruminants. Tropical Animal Production., v. 2, p. 125-142, 1977.

Santos, S.A., Valadares Filho, S.C., Detmann, E., Valadares, R.F.D., Ruas, J.R.M., Amaral, P.M. 2011. Different forage sources for F1 Holstein×Gir dairy cows. Livestock Science, 142:48–58.

Schimidt, P., Nussio, L.G. 2005. Produção e utilização de cana-de-açúcar para bovinos leiteiros: novas demandas. Anais... Bovinocultura de Leite: Nutrição, Reprodução e Fertilidade em Bovinos, 2005.

Silva, J.D., Queiroz, A.C. 2002. Análise de alimentos (Métodos químicos e biológicos). 3. ed. Viçosa: Editora UFV, 2002. 235 p.

Siqueira, G.R., Roth, M.T.P., Moretti, M.H., Benatti, J.M.B., Resende, F.D. 2012. Uso da cana-de-açúcar na alimentação de ruminantes. Revista Brasileira de Saúde e Produção Animal, 13:991-1008.

Sklan, D.; Ashkenazi, R.; Braun, A., Devorin, A., Tabori, K. 1992. Fatty acids, calcium soaps of fatty acids and cottonseeds fed to high

yielding cows. Journal Dairy Science., 75:2463-2472.

Sniffen, C.J.; O'Connor, J.D.; Van Soest, P.S., Fox, D. G., Russell, J. B. 1992. A net carbohydrate and protein system for evaluating cattle diets. II. Carbohydrate and protein availability. Journal of Animal Science, 70:3562-3577.

Universidade Federal de Viçosa. 1997. Departamento de Engenharia Agrícola. Estação meteorológica. Dados climáticos. Viçosa, MG:UFV..

Valadares Filho, S.C.; Rocha Júnior, V.R.; Cappelle, E.R. 2002. Tabelas brasileiras de composição de alimentos para bovinos. Viçosa: UFV/DZO/DPI, 297 p.

Valvasori, E., Lucci, C.S.L., Pires, F.L., Arcaro, J.R.P., Arcaro Jr, I. 1995. Avaliação da cana-de-açúcar em substituição à silagem de milho para vacas leiteiras. Brazilian Journal of Veterinary Research Animal Science, 32:224-228.

Weiss, W.P. 1999. Energy prediction equations for ruminant feeds. In: Cornell Nutrition Conference for Feed Manufacturers, 61, 1999, Proceeding, Ithaca: Cornell University, p.176-185

.

Submitted February 20, 2015 – Accepted March 27, 2015