Acta Scientiarum

http://www.uem.br/acta
ISSN printed: 1806-2636
ISSN on-line: 1807-8672
Doi: 10.4025/ actascianimsci.v39i4.35810

Physical and chemical characteristics of milk from goats supplemented with different levels of total digestible nutrients in the dry period

Thiago Vinicius Costa Nascimento[1*], Washington Luiz Gonçalves de Almeida Júnior[2], Edilson Soares Lopes Júnior[2], Daniel Ribeiro Menezes[2], Francesca Silva Dias[2] and Matheus Matiuzzi da Costa[2]

*[1]Universidade Federal da Bahia, Av. Ademar de Barros, 500, 40170-110, Salvador, Bahia, Brazil. [2]Universidade Federal do Vale do São Francisco, Petrolina, Pernambuco, Brazil. *Author for correspondence. E-mail: thiagovcn_vet@hotmail.com*

ABSTRACT. We evaluated the physical and chemical characteristics of raw milk from goats supplemented with levels of Total Digestible Nutrients (TDN) in the dry period. Samples from 20 goats were divided into 4 groups, 3 groups received 400g concentrate per animal with different levels of TDN (65, 75 and 85%), and the control group (without concentrate). Four samples of milk were used for each animal, in four sampling periods, which were subjected to physical and chemical analysis. There was no significant difference between the treatments for the parameters of acidity and fat. The diet without concentrate presented higher value for the cryoscopic index. Mean values of the four treatments were within the range set by the Brazilian legislation for all parameters evaluated. The use of concentrate, containing 85% TDN in goat supplementation, was favored the physical and chemical characteristics of the milk during the dry period.

Keywords: concentrate, legislation, raw caprine milk.

Características físico-químicas do leite de cabras suplementadas com diferentes teores de nutrientes digestíveis totais durante o período seco do ano

RESUMO. Este trabalho teve por objetivo avaliar as características físico-químicas do leite de cabras suplementadas com teores de Nutrientes Digestíveis Totais (NDT) no período seco do ano. Foram utilizadas amostras de leite de 20 cabras as quais foram divididas em quatro grupos, sendo que três grupos receberam suplementação de 400 g de concentrado por animal com diferentes teores de NDT (65, 75 ou 85%) e o grupo controle que não recebeu concentrado. Foram utilizadas quatro amostras de leite para cada animal, em quatros períodos de coleta, as quais foram submetidas à análise físico-química de acidez titulável, crioscopia e gordura. Não houve diferença entre os tratamentos para os parâmetros de acidez e gordura. As amostras de leite dos animais que receberam a dieta sem concentrado apresentaram maior valor para o índice crioscópico. As médias das amostras dos quatro tratamentos estavam dentro dos parâmetros fixados pela legislação brasileira para todos os parâmetros avaliados. A utilização de concentrado contendo teor de 85% de NDT na suplementação de cabras favoreceu as características físico-químicas do leite durante o período seco.

Palavras-chave: concentrado, legislação, leite cru caprino.

Introduction

The Brazilian semi-arid region has about 90% of the country's goat flock (Silva et al., 2016), and the breeding of these animals in the northeast region is related to their adaptability to adverse conditions, especially prolonged drought. In this region, the most diverse production systems can be found (Facó et al., 2011), however the supplementation should always be used to meet the nutritional needs of the animals.

The caprine agribusiness is expanding in the world, especially in relation to the milk and its derivatives (Yamazi, Moreira, Cavicchioli, Burin, & Nero, 2013; Gárcia, Rovira, Boutoial, & López, 2014); among the factors for the growth of the consumption of goat milk and derivatives, are their beneficial effects on human health, which are fully recognized by the scientific community (Gárcia et al., 2014) and is an important part of the economy in many countries (Medeiros et al., 2013).

Goat milk has high biological value and nutritional qualities due to its higher digestibility and its dietary characteristics with smaller diameter

fat globules. It presents a chemical composition composed of proteins of high biological value and essential fatty acids, besides its mineral and vitamin content (Haenlein, 2004; Park, Juárez, Ramos, & Haenlein, 2007).

The physical and chemical composition of the milk is directly influenced by the diets given to animals, the forage: concentrate ratio directly interferes with the volume of milk produced as well as the concentrations of the components, especially the fat content (Chilliard et al., 2014). The use of concentrate in diets aims to raise the energy and protein concentration of the diet, increasing the total digestible nutrient content of the diet, promoting a greater input of nutrients for milk production, increasing the volume produced as well as increasing the amount of total solids.

In addition to the great social and economic importance of dairy goat farming for the northeastern semi-arid region, since they are a source of subsistence and sustainability, research must be conducted to attest the quality of the milk produced, and thus contribute effectively to the expression of the product in the consumer market and overcome the barriers that impede the advance of the productive chain (Oliveira et al., 2011).

Studies to set the parameters for goat milk produced, as well as to evaluate the influence of nutrition on the production of goat milk mainly in the semi-arid region of the São Francisco River Valley are very scarce, since producers and consumers do not have information if the use of supplementation allows milk produced and even milk without supplementation to comply with current Brazilian legislation. Thus, this study evaluated the physical and chemical quality of raw milk, from goats supplemented with different levels of total digestible nutrient (TDN) in the diet.

Material and methods

The experiment was conducted in the municipality of Santa Maria da Boa Vista, State of Pernambuco, 8°48'S, 39°49'W, at an altitude of 447 m.

Twenty mongrel dairy goats with 45.05 ± 5.08 kg, newly calved, multiparous, were homogeneously distributed in four groups: Control Group composed of goats that had access only to Tifton 85 (*Cynodon* spp.) pastures, from 8 to 15 hours and after 4 kg/animal of cactus pear (*Opuntia ficus-indica* Mill.) fresh, crushed, in addition to water and mineral supplementation ad libitum. The animals of the other three groups were subjected to the same management of the Control Group, and received 400 grams of isoprotein concentrate, containing 20% crude protein and varying TDN (total digestible nutrients) content according to the treatment: Group 65% received concentrate containing 65% TDN, meeting the minimum energy requirement of goats in puerperium, as recommended by National Research Council (NRC 2007); Group 75% received concentrate containing 75% TDN; and Group 85% received concentrate formulated with 85% TDN (Table 1). The concentrate corresponded to approximately 0.89% body weight, the estimated forage: concentrate: ratio was 75:25, with total dry matter intake estimated at 1.6kg corresponding to approximately 3.6% body weight. The average milk production was 0.8 kg milk/animal/day.

Table 1. Proportion of ingredients in concentrate and chemical composition of ingredients.

Concentrate (% MN)			
Ingredients	65%	75%	85%
Ground corn	17.6	48.0	41.4
Soybean meal	13.0	16.0	28.2
Soybean oil	0	0	8.0
Soybean hull	32.4	0	0
Sodium chloride	3.0	3.0	3.0
Mineral salt	3.0	3.0	3.0
Calcarium	0.5	0.5	0.5
Urea	2.2	2.0	1.0
Wheat bran	28.3	27.5	14.9

Chemical Composition					
	Tifton85	Cactus pear	Concentrate		
			65%	75%	85%
DM	33.63	9.94	87.51	82.79	84.59
CP	7.89	2.91	22.44	22.14	22.03
NDF	61.45	28.98	38.57	22.98	18.23
ADF	32.09	18.53	22.55	9.86	8.69
EE	1.48	1.56	2.59	3.64	10.93
Ash	8.40	16.70	11.03	10.48	10.37
IVDDM	58.01	62.32	64.83	73.41	68.55
TDN*	63.22	65.13	65.95	75.63	84.91

*Estimated according to literature data.

From the 30th day postpartum, 5 goats from each experimental group were manually milked with pre- and post-milking asepsis according to the manual of good milk production practices described by Vallin et al. (2009). Milk samples were taken every 15 days, with 4 samples per goat, totaling 20 samples. The collected samples were stored in sterile tubes of 100 mL and frozen for the subsequent physical-chemical analyses.

The determination of titratable acidity and fat concentration (Gerber method) were performed as recommended by Normative Instruction number 68 of the Brazilian legislation published in 2006. The cryoscopic index was analyzed using the Microprocessed Electronic Cryoscope (MK 540 Flex) previously calibrated, where 2.5 mL sample was added to the reading apparatus and its value recorded.

A completely randomized design was used in a 4X4 factorial arrangement, with 4 treatments (0, 65, 75 and 85% TDN), with 5 replicates and 4 milk collection times (30, 45, 60 and 75 days postpartum), data were tested by ANOVA, and the means were compared by the Scott-Knott test ($p<0.05$). Statistical analysis was run using SISVAR® (Lavras, Brazil) version 4.5. Pearson correlation between acidity/cryoscopy ($p < 0.05$) and Principal Component Analysis (PCA) were run using XLSTAT 7.5.2® software (Addinsoft, New York, NY, USA).

Results

The acidity was influenced by the days of collection, however it was not affected by the treatments (Table 2). Regarding the time of collection, there was a difference between the initial collection and the others.

Table 2. Acidity of milk (ºD) from goats supplemented with concentrate of TDN levels.

	ACIDITY (°D)					
% TDN	Time (days)				Mean	SEM
	30	45	60	75		
0	16.00	12.40	10.00	11.60	12.50 ^{NS}	0.63
65	14.40	11.60	11.00	12.75	12.44 ^{NS}	0.48
75	12.80	12.40	11.60	12.00	12.20 ^{NS}	0.48
85	13.60	14.80	12.80	14.20	13.85 ^{NS}	0.67
Mean	14.20^{a}	12.80^{b}	11.35^{b}	12.64^{b}	12.75	0.45

^{a,b} different letters in the same row are significantly different ($p < 0.05$) by Scott-Knott test. ^{NS}: non-significant.

Similar results were found in Queiroga et al. (2007), Sahoo and Walli (2008), Araújo et al. (2009) and Silva et al. (2013) who used different percentages of energy in the diet. Differing from Costa et al. (2008), whose study found no variation for the acidity parameter. The results are in accordance with the recommended by the Brazilian law in the normative instruction number 37 of 2000 that determines that the titratable acidity ranges from 0.11 to 0.18% expressed in lactic acid, which correspond to 11 to 18 ºD.

For the fat parameter, there was no difference between the energy levels tested and also in relation to lactation time (Table 3), corroborating with other studies that evaluated milk fat (Zambom et al., 2005; Costa et al., 2008; Sahoo & Walli, 2008; Araújo et al., 2009). Morgan et al.(2003) obtained from goats reared in France, but according to this same work, breed and breeding conditions can cause a variation in the milk fat content from 5.1 to 3.2%. It is observed that the means of the groups comply with the Brazilian legislation in the normative instruction number 37 of 2000 that determines the minimum content of 2.9% fat in the goat milk.

Table 3. Quantification of milk fat from goats supplemented with concentrate of TDN contents.

	FAT (%)					
% TDN	Time (days)				Mean	SEM
	30	45	60	75		
0	3.76	3.26	3.16	3.78	3.49^{NS}	0.13
65	2.85	3.32	3.28	3.60	3.26 ^{NS}	0.16
75	3.42	3.70	3.86	3.72	3.67 ^{NS}	0.18
85	3.78	3.82	3.90	3.84	3.83 ^{NS}	0.26
Mean	3.45 ^{NS}	3.52 ^{NS}	3.55 ^{NS}	3.73 ^{NS}	3.56	0.10

$^{NS:}$ non-significant.

There were differences in the means between treatments with different energy levels for the cryoscopic index, in which milk samples from the control group had the highest mean (Table 4). The means of the treatments are in agreement with the standard established by the Brazilian legislation in the normative instruction 37 of 2000, which recommends a range between -0.550°Hovert to -0.585°Hovert, corroborating with Andrade, Souza, Penna and Ferreira (2008) and differing from the works of Mayer and Fiechter (2012) and Silva et al. (2013).

Table 4. Cryoscopy values of goat milk supplemented with concentrate of TDN contents.

	CRYOSCOPY (°H)					
% TDN	Time (days)				Mean	SEM
	30	45	60	75		
0	-0.558	-0.551	-0.555	-0.563	-0.557^{b}	0.002
65	-0.570	-0.572	-0.567	-0.569	-0.570^{a}	0.002
75	-0.569	-0.569	-0.567	-0.565	-0.567^{a}	0.002
85	-0.569	-0.573	-0.572	-0.571	-0.571^{a}	0.002
Mean	-0.566 ^{NS}	-0.566 ^{NS}	-0.565 ^{NS}	-0.567 ^{NS}	-0.566	0.001

^{a,b} different letters in the same row are significantly different ($p < 0.05$) by the Scott-Knott test. ^{NS}: non-significant.

Figure 1 illustrates the correlation between cryoscopy and acidity, in which it was possible to verify an inversely proportional relationship, i.e., as the acidity increases the cryoscopic index decreases.

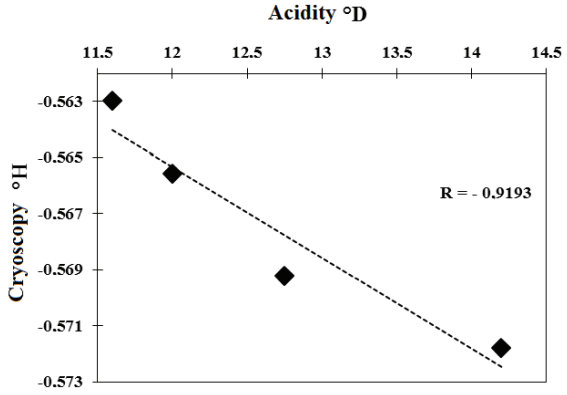

Figure 1. Correlation between acidity (°D) and cryoscopy (°H) of milk from goats supplemented with concentrate of NDT contents.

In this study, by means of principal components analysis (Figure 2), it was observed that the milk from goats that received concentrate with 85% TDN had better values for acidity and fat.

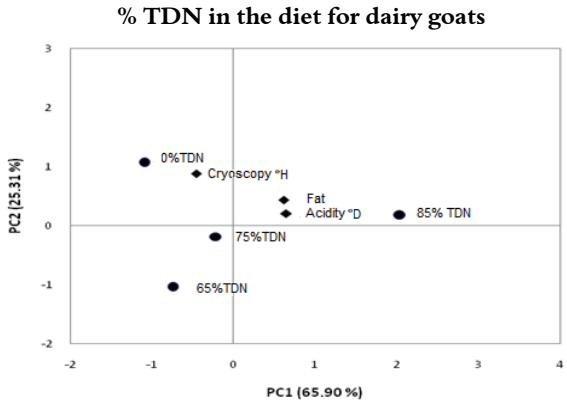

Figure 2. Principal Component Analysis (PCA) based on the percentage of TDN in the diet for dairy goats.

Discussion

The inclusion of energy sources, especially starch, can affect ruminal fermentation by increasing release of propionic acid in the rumen, produced by the degradation of starch. This is the precursor of lactose in the mammary gland, which through osmolality affects the amount of milk produced, because the concentration of lactose in milk is very little variable. Thus, the higher level of lactose in the mammary gland increases water drainage for milk production, resulting in increased milk volume (Cannas, Pulina, & Francesconi, 2008).

Goetsch et al. (2001) explains that the concentration of lactose in milk can be affected by the phases of lactation, as well as the content of fat and proteins, especially to meet the needs of the kids in the different post-partum phases.

According to the aforementioned, there is a possibility of variation of the data found for the milk acidity, resulting from the possible reduction in lactose concentration in the milk due to the advancement of the lactation curve and that added to the information that this sugar is fermented by microorganisms that transform a lactose molecule into 4 molecules of lactic acid (Kondyli, Svarnas, Samelis, & Katsiari, 2012; Fagnani, Battaglini, Beloti, & Araújo, 2016), which may be one of the possible explanations for the acidity variation along the collections.

This is a parameter that is directly linked to the milk storage, so the Brazilian legislation in the normative instruction number 37 as of 2000, accepts that raw frozen milk has a higher acidity variation than raw milk without freezing, thus all samples of the treatments presented acidity (Table 2) within the acceptable range by the aforementioned legislation.

The evaluation of milk acidity is a parameter that associated to others can help in the indirect verification of the microbiological quality and associated to other analyses can be indicative of possible adulterations by water or ammonia (Abrantes, Silva Campêlo, & Silva, 2015).

In this study, the concentration of energy in the concentrate of the treated groups (65, 75 and 85% TDN) (Table 1) had no influence on fat percentage, but Lu, Kawas and Mahgoub (2005) and Morand-Fehr, Fedele, Decandia and Frileux (2007) state that the fat content of goat milk is not related only to the dietary fiber content, but also the dietary fiber effectiveness, besides the energy intake by the goats and the production of volatile fatty acids in the rumen, as mentioned above. It was verified that the supply of concentrate with different TDN contents did not cause changes in the fat content of milk from supplemented goats and neither did the lactation phase or the combination of these factors (Table 3).

The lack of effect of supplementation of goats with concentrate containing different TDN contents can perhaps be explained by the forage: concentrate ratio in the diet, which was 75:25, not enough to affect the milk fat concentration. Morand-Fehr et al. (2007) supplied diets with different proportions of concentrate in the total diet: 40-60% and 60-80% and observed that the proportion representing 40 to 60% of the total diet causes a slight drop in the milk fat concentration, while the contents 60-80% cause an abrupt drop in the milk fat concentration.

The source of energy is another factor that combined with the forage: concentrate ratio may affect milk composition, both in fat content and in milk fatty acid profile (Costa, Queiroga, & Pereira, 2009).

Cryoscopy is a measure relative to the freezing temperature of milk and is influenced by the elements soluble in milk, especially lactose (Abrantes et al., 2015), so it can be inferred that among the main causes for reduction in the cryoscopic index of milk is the availability of energy in the diet of females, in the form of non-fiber carbohydrates, which are the precursors of lactose in milk.

There was an increased production of lactose by the mammary gland and consequent higher milk production in animals supplemented with concentrates, which are generally rich in non-fiber carbohydrates. Due to this fact, there may have been small variations in lactose concentration in the milk

of the supplemented animals, thus explaining the slight but significant difference ($p<0.05$) in the milk from goats supplemented with concentrate compared with the milk from goats of the control group, without concentrate (Table 4) (Gonzáles et al., 2004; Abrantes et al., 2015).

Vargas et al. (2015) reported that the season may enhance the stress condition of the animals, either by reducing dry matter intake so that the animals cannot reach their daily needs, mainly in energy, or because of the hormonal mechanisms triggered by the stress causing weak immune response to the microorganisms, making them susceptible to diseases, such as mastitis that can also affect the quality and physical and chemical parameters of milk.

The groups that had access to the diet with the highest energy level presented lower values for the cryoscopic index, which may be related to higher total milk solids production caused by the higher energy supply in the form of non-fiber carbohydrates, possibly raising lactose more specifically, which has a direct influence on the depression of the freezing point of milk, as evidenced by the cryoscopic index (Abrantes et al., 2015).

The inverse correlation detected between the variables acidity x cryoscopic index (Figure 1) can be explained stoichiometrically, as previously reported. The microorganisms, when carrying out the fermentation, transform a molecule of lactose into 4 molecules of lactic acid, thus increasing the quantity of dissolved particles and causing a decrease in the cryoscopic index (Fagnani et al., 2016).

According to the principal component analysis, the supplementation of goats with the concentrate containing 85% TDN was responsible for promoting a milk with more suitable physical and chemical characteristics, thus standing out from the other treatments (Figure 2).

The literature states that animals in dry periods have less availability of forage with adequate quality for milk production, and pastures are characterized by plants containing higher content of neutral and acid detergent fibers as well as lignin (Grant, Kreyling, Dienstbach, Beierkuhnlein, & Jentsch, 2014; Zhang, Whish, Bell, & Nan, 2017), resulting in lower intake of crude protein and non-fiber carbohydrates in the diets. Raynal-Ljutovac, Gaborit and Lauret (2005) emphasize that goat supplementation produces better quality milk, which will result in better quality products. As previously explained, the energy from the non-fiber carbohydrates that are degraded in the rumen. The non-fiber carbohydrates become energy source for the growth and microbial proliferation, resulting in the production of propionic acid, which is substrate for the production of lactose and thus can increase the volume of milk, as well as, increase the availability of protein since it will favor the greater contribution of bacteria in the abomasum, and thus increasing the total solids production of the milk.

Conclusion

The use of concentrate containing 85% TDN in goat supplementation favored the physical and chemical characteristics of the milk during the dry period.

Acknowledgements

This study was supported by the National Council for Scientific and Technological Development (CNPq-Brazil) and Foundation for Science and Technological Development of the State of Pernambuco (FACEPE).

A special acknowledgement to the group of Laboratory of Physiology and Biotecnology of Animal Reproduction (LAFIBRA), Nucleus of Study of Animal Products Origin (NEPOA) both from Federal University of San Francisco Valley.

References

Abrantes, M. R., Silva Campêlo, C., & Silva, J. B. A. (2015). Fraude em leite: Métodos de detecção e implicações para o consumidor. *Revista do Instituto Adolfo Lutz, 73*(3), 244-251.

Andrade, P. V. D.; Souza, M. R.; Penna, C. F. A. M. & Ferreira, J. M. (2008) Características microbiológicas e físico-químicas do leite de cabra submetido à pasteurização lenta pós-envase e ao congelamento. *Ciência Rural, 38*(5), 1424-1430.

Araújo, G. G. L. D., Bade, P. L., Menezes, D. R., Socorro, E. P. D., Sá, J. L., & Oliveira, G. J. C. D. (2009). Substituição da raspa de mandioca por farelo de palma forrageira na dieta de ovinos. *Revista Brasileira de Saúde e Produção Anima*l, *10*(2), 448-459.

Cannas, A., Pulina, G., & Francesconi, A. H. D. (2008). *Dairy goats feeding and nutrition*. Londres, UK: Cabi.

Chilliard, Y., Toral, P. G., Shingfield, K. J., Rouel, J., Leroux, C., & Bernard, L. (2014). Effects of diet and physiological factors on milk fat synthesis, milk fat composition and lipolysis in the goat: a short review. *Small Ruminant Research, 122*(1), 31-37.

Costa, R. G., Queiroga, R. C. R. E., & Pereira, R. A. G. (2009) Influência do alimento na produção e qualidade do leite de cabra. *Revista Brasileira de Zootecnia, 38*(4), 307-321.

Costa, R. G., Mesquita, I. V. U., Queiroga, R. C. R. E., Medeiros, A. N., Carvalho, F. F. R., & Beltrão, E. M., Filho. (2008). Características químicas e sensoriais do leite de cabras Moxotó alimentadas com silagem de maniçoba. *Revista Brasileira de Zootecnia, 37*(4), 694-702.

Facó, O., Braga Lôbo, R. N., Gouveia, A. M. G., Paiva Guimarães, M. P. S. L. M., Fonseca, J. F., Santos, T. N. M., Silva, M. A. A., Villela, L. C. V. (2011) Breeding plan for commercial dairy goat production systems in southern Brazil. *Small Ruminant Research, 98*(1-3), 164-169.

Fagnani, R., Battaglini, A. P. P., Beloti, V., & Araújo, J. P. A. (2016) Estabilidade do leite ao álcool: Ainda pode ser um indicador confiável? *Ciência Animal Brasileira, 17*(3), 386-394.

Gárcia, V., Rovira, S., Boutoial, K., & López, M. B. (2014). Improvements in goat milk quality: a review. *Small Ruminant Research, 121*(1), 51-57.

Goetsch, A. L., Detweiler, G., Sahlu, T., Puchala, R., & Dawson, L. J. (2001). Dairy goat performance with different dietary concentrate levels in late lactation. *Small Ruminant Research, 41*(2), 117-125.

Gonzáles, H. L., Fischer, V., Ribeiro, M. E. R., Gomes, J. F., Stumpf, W., Jr. & Silva, M. A. (2004) Avaliação da qualidade do leite na bacia leiteira de Pelotas, RS. *Revista Brasileira de Zootecnia, 33*(6), 1531-1543.

Grant, K., Kreyling, J., Dienstbach, L. F., Beierkuhnlein, C., & Jentsch, A. (2014). Water stress due to increased intra-annual precipitation variability reduced forage yield but raised forage quality of a temperate grassland. *Agriculture, Ecosystems & Environment, 186*(15), 11-22.

Haenlein, G. F. W. (2004) Goat milk in human nutrition. *Small Ruminant Research, 51*(2), 155-163.

Kondyli, E., Svarnas, C., Samelis, J., & Katsiari, M. C. (2012) Chemical composition and microbiological quality of ewe and goat milk of native Greek breeds. *Small Ruminant Research, 103*(2), 194-199.

Lu, C. D., Kawas, J. R., & Mahgoub, O. G. (2005) Fibre digestion and utilization in goats. *Small Ruminant Research, 60*(1), 45-52.

Mayer, H. K., & Fiechter, G. (2012). Physical and chemical characteristics of sheep and goat milk in Austria. *International Dairy Journal, 24*(2), 57-63.

Medeiros, E. J. L., Queiroga, R. C. R. E., Medeiros, A. N., Bonfim, M. A. D., Batista, A. S. M., Félex, S. S. S., & Madruga, M. S. (2013) Sensory profile and physicochemical parameters of cheese from dairy goats fed vegetable oils in the semiarid region of Brazil. *Small Ruminant Research, 113*(1), 211-218.

Morand-Fehr, P., Fedele, V., Decandia, M., & Frileux, Y. L. (2007). Influence of farming and feeding systems on composition and quality of goat and sheep milk. *Small Ruminant Ressearch, 68*(1), 20-34.

Morgan, F., Massouras, T., Barbosa, M., Roseiro, L., Ravasco, F., Kasndarakis, I., ... & Raynal-Ljutovac, K. (2003) Characteristics of goat milk collected from small and medium enterprises in Greece, Portugal and France. *Small Ruminant Research, 47*(1), 39-49.

National Research Council [NRC]. (2007). *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids, and New World Camelids*. Washington, DC: The National Academies Press

Oliveira, C. J. B., Hisrich, E. R., Moura, J. F. P., Givisiez, P. E. N., Costa, R. G., & Gebreyes, W. A. (2011), On farm risk factors associated with goat milk quality in Northeast Brazil. *Small Ruminant Research, 98*(1), 64-69.

Park, Y. W., Juárez, M., Ramos, M., & Haenlein, G. F. W. (2007). Physico-chemical characteristics of goat and sheep milk. *Small Ruminant Research, 68*(1-2), 88-113.

Queiroga, R. C. R. E., Costa, R. G., Biscotini, T. M. B., Medeiros, A. N., Madruga, M. S., & Shuler, A. R. P. (2007), Influência do manejo do rebanho, das condições higiênicas da ordenha e da fase de lactação na composição química do leite de cabras Saanen. *Revista Brasileira de Zootecnia, 36*(2), 430-437.

Raynal-Ljutovac, K., Gaborit, P., & Lauret, A. (2005). The relationship between quality criteria of goat milk, its technological properties and the quality of the final products. *Small Ruminant Research, 60*(1), 167-177.

Sahoo, B., & Walli, T. K. (2008), Effect of feeding undegradable protein with energy on nutrient utilization, milk yield and milk composition of crossbred goats. *Small Ruminant Research, 75*(1), 36-42.

Silva, D. C. D., Guim, A., Santos, G. R. D. A., Souza, E. J. D. O., Urbano, S. A., Mesquita, F. L. T. D., & Lafayette, E. A. (2016) Intake and digestibility of crossbred goats finished on caatinga grassland receiving feed supplementation during dry season. *Revista Brasileira de Saúde e Produção Animal, 17*(3), 484-496.

Silva, G. S., Ferrari, I. S., Silva, C. D. A., Almeida Júnior, W. L. G., Carrijo, K. F., Costa, M. M., … Dias, F. S. (2013). Microbiological and physical-chemical profile of goat milk in the semiarid region of the San Francisco valley. *Veterinária Notícias, 19*(1). Retrieved from http://www.seer.ufu.br/index.php/vetnot/article/view/22826

Vallin, V. M., Beloti, V., Battaglini, A. P. P., Tamanini, R., Fagnani, R., Angela, H. L., & Silva, L. C. C. (2009). Melhoria da qualidade do leite a partir da implantação de boas práticas de higiene na ordenha em 19 municípios da região central do Paraná. *Semina: Ciências Agrárias, 30*(1), 181-188.

Vargas, D. P., Nörnberg, J. L., Scheibler, R. B., Schafhauser Junior, J., Rizzo, F. A., & Wagner, R. (2015), Qualidade e potencial nutracêutico do leite bovino em diferentes sistemas de produção e estações do ano. *Pesquisa Agropecuária Brasileira, 50*(12), 1208-1219.

Yamazi, A. K., Moreira, T. S., Cavicchioli, V. Q., Burin, R. C. K., & Nero, L. A. (2013). Long cold storage influences the microbiological quality of raw goat milk. *Small Ruminant Research, 113*(1), 205-210.

Zambom, M. A., Alcalde, C. R., Martins, E. N., Santos, G. T. D., Macedo, F. D. A. F. D., Horst, J. A., & Veiga, D. R. D. (2005). Curva de lactação e qualidade do leite de cabras Saanen recebendo rações com diferentes

relações volumoso: concentrado. *Revista Brasileira de Zootecnia, 34*(6), 2515-2521.

Zhang, Z., Whish, J. P., Bell, L. W., & Nan, Z. (2017). Forage production, quality and water-use-efficiency of four warm-season annual crops at three sowing times in the Loess Plateau region of China. *European Journal of Agronomy, 84*, 84-94.

Received on March 8, 2017.
Accepted on May 10, 2017.

License information: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.