Vol. 51, n.6 : pp.1163-1169, November-December 2008
ISSN 1516-8913 Printed in Brazil

BRAZILIAN ARCHIVES OF BIOLOGY AND TECHNOLOGY

A N I N T E R N A T I O N A L J O U R N A L

Profile of Milk Fatty Acids from Moxotó Goats Fed with Different Levels of Manicoba (*Manihot Glaziovii* Muel Arg.) Silage

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ABSTRACT

*The objective of this work was to evaluate the effects of the manicoba silage use (*Manihot glaziovii* Muel Arg.) in different roughage:concentrate ratios (30:70; 40:60; 50:50 and 60:40 %) on the fatty acids profile of the milk from Moxotó goats. Eight multiparous goats with approximately 60 post-birth days and weigh 44 kg on average were used in a Double Latin Square with four treatments, four periods and four animals. Each period lasted 15 days with 10 days of adaptation to experimental diets and 5 days of milk collection. The results of the fatty acids analyses were submitted to the analysis of variance (ANOVA) and regression. An increasing linear effect for the miristic acid (C14:0) and decreasing for the linoleic acid (C18:3) was observed in function of the silage levels in diet. The milk fat presented high contents of desirable fatty acids (C18:0 + unsaturated acids), considered as nutritionally important due to their benefits to the human health. It could be concluded that the manicoba silage could be included in the diet with the participation of up to 60%, presenting a nutrient supply of high nutritional value.*

Keywords: Nourishment, Lipids, Milk quality, Native breed

INTRODUCTION

Despite the recognized socioeconomic value of the goat breeding for the Brazilian Northeastern region, not much has been made for the improvement on the quality of its products. The activity is characterized by the low technological level, irregular production and low participation on the urban consumer market (Almeida, 2003). Queiroga et al. (2003) sugested that the development of this activity needs policies and researches that could identify and act in the hindrances of this productive sector, thus contributing for a better technological utilization and providing subsides for goat breeders, governmental agencies and researchers.

Goats were introduced in America with the first European settlers and the best adaptation occurred

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at the tropical regions, where they were currently concentrated (Ribeiro et al., 2004). The adaptation to the adverse conditions of the Northeast semiarid region enabled the appearance of native breeds that developed appropriate defense biological mechanisms during their formation process, gaining with rusticity but losing with the milk productive capacity and body size (Madruga, 1999).

Among the native breeds, the Moxotó is considered as good meat and skin producer and has presented significant increase on the productivity when bred in adequate handling conditions (Azevedo, 1981). However, information on the chemical composition of the milk from Brazilian native goats is scarce, making the evaluation of the productive situation of these animals difficult (Queiroga and Costa, 2004).

The nutritional importance of the goat milk, when compared to the cow milk, is attributed to its high percentage of small-sized fat globules (1.5 µm), while the cow milk presents higher concentration of fat globules larger than 3.0 µm (Mir et al., 1999). The small size and the fragility of the fat membrane facilitate the attack from the gastric juices. Moreover, in the goat milk, about 20% of the fatty acids from the fat present short chain (C4:0-C12:0), therefore of easier digestion (Jenness, 1980).

Animal feeding is the fastest way to modify the milk composition; however, the relations between the food constituents and the milk composition are quite complexes. The most relevant changes have been observed in the milk fat concentration (Sutton, 1989). The asymmetric distribution of the fatty acids on the glycerol molecule modifies the physical properties of the fat and influences the characteristics and quality of the industrialized products in several aspects (Chilliard et al., 2001b), besides originating the differences on the texture of the cheeses in function of the size of the chain and the instauration degree of the fatty acids (Coulon and Priolo, 2002). The main factors that modify the fatty acids composition are the nature of the lipid source and the efficiency of fibers on diet (Morand-Feher et al., 2000). Studies on the utilization of foraging species from the scrub savanna conserved through the silage in the feeding of native goats are scarce, especially as the feeding strategy during the dry season. Among the foraging species, the manicoba (*Manihot glaziovii Muell* Arg.) is important due to its capacity to adapt to the semiarid edaphoclimatic conditions, to its high nutritional value and palatability.

The objective of the present work was to evaluate the effect of the manicoba silage in different roughage:concentrate ratios on the fatty acids profile of the from Moxotó goats.

MATERIAL AND METHODS

Eight multiparous goats with approximately 60 post-birth days were kept in confinement regimen in a covered coach house with individual stall and water *ad libitum*. The design selected was the Double Latin Square of order 4 with four animals, four periods and four manicoba silage levels.

The experiment began on July 16 2004 and finished on September 16 2004, being composed of 4 periods of 15 days, from which the first 10 days of each period were used for the adaptation of the animals to the experimental diet and the 5 remaining days were used for the collection of the milk samples. The silage was confectioned with the manicoba branches in the flowering vegetative stage and beginning of the fructification stage, being exposed to air for 4 h after the cutting. After pre-wilting period, the material was grinded in the foraging machine and compacted in the plastic bottles until the beginning of the experiment. The silage was mixed to the ration and offered to the animals twice a day shortly after milking (8:00 am and 5:00 pm). The consumption was *ad libitum* and the experiment was conducted allowing 20 % aforts.

The diets were formulated according to the recommendations from AFRC (1998) in order to achieve the nutritional requirements of the goats under lactation, with production of 2 kg/goat/day and 4% of fat in the milk. The experimental treatments were T1: 30% roughage + 70% concentrate; T2: 40% roughage + 60% concentrate; T3: 50% roughage + 50% concentrate and T4: 60% roughage + 40% concentrate. The morning production milk was conditioned in the flasks with the identification of each animal and kept under refrigeration for further mixture with the afternoon production milk, thus obtaining a composed sample/goat/day proportional to the production.

For the fatty acids profile analysis, a single sample was performed by mixing the milk obtained from two animals of each treatment at the four collection periods. After conditioned into adequate plastic sacks, the samples were treated through slow pasteurization thermal process at 65°C for 30 minutes and frozen at - 4 °C. A 100 mL sample of milk corresponding to the third collecting day was used, for the fatty acids identification and quantification according to the method described by Hartman and Lago (1973).

The transmethylated samples were analyzed in gas chromatograph model CG Master with flame ionization detector, capillary column (DB-WAX), poliethylenoglycol stationary phase (Carbowax 20M), with 30 m of length and 0.53 μm of inner diameter and 0.25 μm of film thickness. The fatty acids were quantified through the methyl ester areas normalization. The results of the fatty acids were expressed as area percent (%).

The results of the fatty acids analyses were submitted to the analysis of variance (ANOVA) and regression, using the following mathematical model:

$$Yij = \mu + Per\ j + Trat\ i. + eij$$

Where: Yij = observation of the animal in the period j receiving treatment k; μ = general average; Trat. = effect of the treatment; eij = random error associated to each observation.

RESULTS AND DISCUSSION

The fatty acids profile of the milk from moxotó goats is described in table 1. Twelve fatty acids were identified, among which eight were saturated, two monounsaturated and two polyunsaturated. The following saturated fatty acids, were important: capric acid (C10:0); miristic acid (C14:0); palmitic acid (C16:0) and stearic acid (C18:0), all values expressed as area percentile of 7.17; 6.88; 21.41 and 20.44 %, respectively. On the other hand, among the monounsaturated acids, the highest percent was found for the oleic acid (C18:1), with 24.33 %, while the linoleic acid (C18:3) was 1.42 %. The saturated and unsaturated fatty acids accounted for 66.26 and 27.76% in relation to the total, respectively.

An increasing linear effect was observed ($p<0.05$) in function of the manicoba silage levels (fig 1) on the miristic acid contents (c14:0). The roughage supply in the diet probably increases the proportion of acetate and β-hydroxybutyrate, important precursors for the synthesis of short and medium-chain fatty acids, which has probably contributed for the increase of this component. In the other hand, an inverse effect ($p>0.01$) was observed in relation to the linoleic acid (c18:3), which decreased as the silage participation in the diet was increased.

Polyunsaturated acids are not synthesized by the tissue of ruminants, so that their concentration in the milk strictly depends on the amount of the fat absorbed in the intestines and, therefore, on the amounts released in the rumen, where no bio-hydrogenation. Therefore, the increase in the silage level proportionally decreases the concentrated contents and hence the availability of unsaturated fatty acids to be used by the mammary gland in the synthesis of milk lipids (chilliard et al., 2001b, grummer, 1991). Fatty acids may be originated from the plasma (60%) or through the *de novo* synthesis in the mammary gland (40%) from the acetate and β-hydroxybutyrate originated from the rumen fermentation involving the acetyl CoA carboxylase enzymes and the fatty acid synthetase (chilliard et al., 2001b).

Table 1 - Average values, standard deviation and variation coefficient (VC) of fatty acids in the breed Moxotó goat milk in function of the Manicoba silage levels.

Variables	Roughage:concentrate ratio				Average ($\hat{Y}$)	VC (%)
	30:70	40:60	50:50	60:40		
C6:0	0.99 ± 0.72	2.22 ± 1.66	0.88 ± 0.70	1.03 ± 0.59	1.28	90.93
C8:0	2.18 ±0.75	2.16 ± 0.40	1.97 ± 0.68	1.93 ± 0.50	2.06	21.86
C10:0	7.27 ± 2.71	6.49 ± 1.46	7.40 ± 1.07	7.51 ± 0.95	7.17	16.99
C12:0	3.16 ± 1.12	2.91 ± 0.84	2.57 ± 1.52	3.66 ± 0.79	3.08	35.66
C14:0*	6.15 ± 1.76	5.77 ± 2.95	7.74 ± 0.85	7.85 ± 1.40	6.88	20.14
C16:0	19.80 ± 5.98	17.23 ± 9.37	24.06 ± 1.91	24.55 ± 2.45	21.41	23.11
C16:1	0.86 ± 0.39	0.79 ± 0.55	0.82 ± 0.44	0.47 ± 0.16	0.74	49.86
C18:0	22.58 ± 13.57	19.59 ± 3.17	18.60 ± 3.74	20.97 ± 4.91	20.44	31.72
C18:1	23.90 ± 13.15	27.25 ± 16.20	23.36± 12.97	22.81 ± 12.38	24.33	15.24
C18:2	3.39 ± 1.12	6.19 ± 3.48	4.07 ± 0.84	3.45 ± 1.16	4.28	47.81
C18:3**	2.13 ± 0.48	1.71 ± 0.21	1.10 ± 0.62	0.76 ± 0.21	1.42	31.74
C20:0	1.08 ± 0.97	1.35 ± 1.55	0.68 ± 0.15	0.66 ± 0.50	0.94	74.83
SAT	63.22 ± 3.05	57.73 ± 8.51	63.91 ± 3.68	68.18 ± 2.89	63.26	8.87
UNS	30.29 ± 12.62	35.94 ± 17.20	29.35 ± 11.16	27.50 ± 11.40	30.77	17.38
MONO	24.76 ± 13.28	28.04± 15.80	24.18 ± 12.54	23.88 ± 12.28	25.07	14.24
POLY	5.52 ± 1.31	7.90 ± 3.39	5.17 ± 1.41	4.22 ± 0.98	5.70	35.78
M/S	0.39 ± 0.21	0.51 ± 0.35	0.37 ± 0.19	0.35 ± 0.19	0.41	30.72
P/S	0.09 ± 0.02	0.15 ± 0.09	0.08 ± 0.03	0.06 ± 0.01	0.09	55.54
U/S	0.48 ± 0.21	0.66 ± 0.41	0.46 ± 0.17	0.41 ± 0.18	0.50	34.85
DFA	52.86 ± 19.66	55.53 ± 20.27	47.95 ± 14.58	48.47 ± 10.89	51.20	12.76

** significant at level of 1% of probability.
* significant at level of 5% of probability.
M/S – monounsaturated/saturated ratio.
P/S – polyunsaturated/saturated ratio.
U/S – unsaturated/saturated ratio.
DFA – desirable fatty acids (unsaturated acids + C18:0).

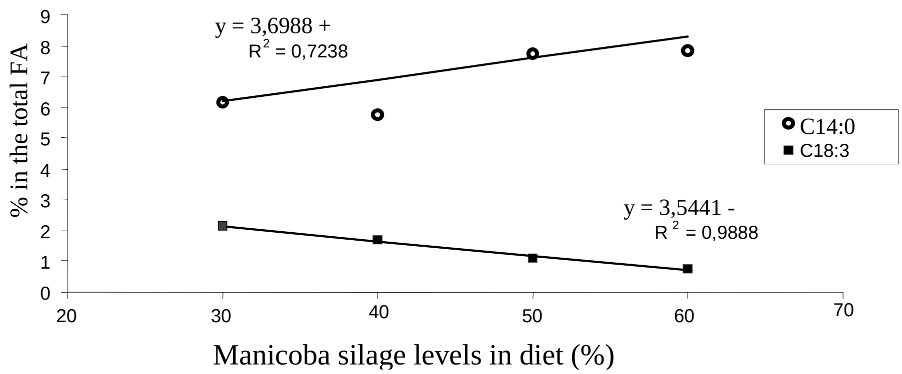

Figure 1 - Levels of fatty acids C14:0 and C18:3 in function of the manicoba silage levels in Moxotó goat.

The *de novo* synthesis results in the formation of short and medium-chain fatty acids (C4:0 to C16:0), and the long-chain fatty acids are derived from the blood triglycerides, which are originated from the intestinal digestion and absorption of the dietary lipids or from the rumen synthesis and from the mobilization of the fat tissue fatty acids (chilliard et al., 2001b).

The mammary gland of the ruminants cannot convert C16:0 into C18:0 through elongation of the carbonated chain; however, the mammary cells present strong activity of the delta-9-desaturase enzyme that converts the stearic acid (C18:0) into oleic acid (C18:1). However, most part of the fatty acids from the de novo lipogenesis are saturated (C4:0 to C16:0), once the mammary delta-9-desaturase enzyme presents weak activity on the fatty acids with less than 18 carbon atoms (Grummer, 1991, Chilliard et al., 2001b). According to Hartman (1993), the stearic acid (C18:0) is not related to the cholesterol increase. When ingested, it is metabolized into oleic acid (C18:1). The lauric (C12:0), miristic (C14:0), palmitic (C16:0) acids and the trans fatty acids have been epidemiologically associated to the cardiovascular diseases, once they induce to increases on the blood cholesterol, the reason why researches have been aimed at the decrease on the percentile of these Oliver (1997) and Lima et al. (2000), mentioned several studies that associated the acids to cardiovascular diseases and observed, for instance, that the intervention group presenting the polyunsaturated/saturated ratio of 1:1, compared with the control group, which diet presented the polyunsaturated/saturated ratio of 0.4:1, presented very lower coronary disease incidence. The monounsaturated fatty acids (MUFAs), for example the oleic acid, do not influence the cholesterol levels; however, there are evidences that the elaidic acid (C18:1), which results from the hydrogenation process of vegetal oils, could induce to hypercholesterolemia (Lima et al., 2000).

Mono-trans isomers naturally occur in the fat of the ruminant's milk as the result of the rumen's microbial activity formed during the biohydrogenation process of the linoleic acid (C18:3) from diet into stearic acid (C18:0). The *trans*-C18:1 fatty acids, although unsaturated, increase the concentrations of the LDL undesirable cholesterol and decrease the concentrations of the HDL desirable cholesterol. These acids are also produced by ruminants in lower percentage and with different isometric distribution, when compared with hydrogenated vegetal oils, particularly margarine, which has been associated to the increase on the incidence of coronary diseases (Ledoux et al., 2002; Medeiros, 2002).

Several studies have suggested that the increase in the consumption of polyunsaturated fatty acids decreases the risk of the cardiovascular pathologies. However, these acids are present in small amounts in the fat of the milk and therefore, the increase on their concentration through the modulation in the diet of animals has been exhaustively studied (Chilliard et al., 2001a, Medeiros, 2002).

For the following fatty acids C18:0 (12.42%); C18:1 (20.51%); C18:2 (1.90%) and C18:3 (0.89%), considered as desirable from the nutritional point of view, Queiroga (2004) found lower average values when compared to those observed in this work when studied the profile of fatty acids from the milk of Saanen goats during lactation phase. The goats were fed with full ration containing 50% of concentrate and 50% of Tifton grass *(Cynodon spp)* and presented 37.72% of desirable fatty acids (C18:0 + unsaturated acids). Lower percentages of these fatty acids were also reported by Chornobai (1998) studying the composition of the fatty acids from the fat during the lactation period of Saanen goats fed with African grass pasture (*Cynodnn lenfuensis*), corn silage and concentrate, with contents of C18:0 (13.48%); C18:1 (23.64%); C18:2 (1.89%) and C18:3 (0.42%) summing up 41.42% of desirable fatty acids.

The Goats from the breed Moxotó presented an average of 50.47% of desirable fatty acids when fed with the manicoba silage. Probably, the increment of these components was furthered by the food supply, demonstrating superiority from the nutritional point of view in relation to the exotic breeds.

CONCLUSION

The different manicoba silage levels used in the diets promoted an increasing linear effect on the miristic acid content (C14:0) and decrease for the linolenic acid (C18:3). The fat of the goat milk presented high contents of desirable fatty acids (C18:0 + unsaturated acids), considered as nutritionally important due to their benefits to the human health.

RESUMO

O objetivo deste trabalho foi avaliar os efeitos da utilização de silagem de maniçoba (*Manihot glaziovii* Muel Arg.) em diferentes relações volumoso:concentrado (30:70; 40:60; 50:50 e 60:40 %) no perfil de ácidos graxos do leite de cabras da raça Moxotó. Foram utilizadas oito cabras multíparas com aproximadamente 60 dias pós-parto, pesando em média 44 kg, em um Quadrado Latino duplo 4 x 4, com quatro tratamentos, quatro períodos e quatro animais. Cada período teve duração de 15 dias, com 10 de adaptação às dietas experimentais e cinco dias de colheita de leite. Foi verificado efeito linear crescente do ácido mirístico (C14:0) e decrescente para o ácido linolênico (C18:3), em função dos níveis de silagem da dieta. A gordura do leite apresentou elevado teor de ácidos graxos desejáveis (C18:0 + insaturados), considerados importantes nutricionalmente pelos seus benefícios à saúde humana.

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Received: April 10, 2006;
Revised: July 26, 2007;
Accepted: February 01, 2008.

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