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Influence of calcium salts of long chain fatty acids on the intake and digestibility of rations in female kids under heat stress

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ABSTRACT. This study aimed to evaluate the effect of the addition of calcium salts of long chain fatty acids (CSFA) on the intake and digestibility of diets. Twenty-five female goat kids housed in digestibility cages and subjected to heat stress of 32°C in a climatic chamber, were used. The female kids were distributed in a randomized block design with five treatments: control (without inclusion of CSFA) and 6.25; 12.50; 18.75 and 25.00 g CSFA kg^{-1} of DM. The inclusion of CSFA in rations did not influence water intake (3.08 L day^{-1}), dry matter (0.66 kg day^{-1}), organic matter (0.62 kg day^{-1}), crude protein (0.12 kg day^{-1}), neutral detergent fiber (0.27 kg day^{-1}) and total carbohydrate (0.47 kg day^{-1}). The results of the digestibility of dry matter (0.66 kg kg^{-1}), organic matter (0.67 kg kg^{-1}), crude protein (0.78 kg kg^{-1}), neutral detergent fiber (0.47 kg kg^{-1}) and total carbohydrate (0.63 kg kg^{-1}) were not affected by the treatments. However, there was a positive linear effect on the intake and digestibility of ether extract. Therefore, the addition of calcium salts of long chain fatty acids in the diets for female kids under heat stress of 32°C does not influence the intake and digestibility of dry matter and nutrients, except for ether extract, which is intrinsic to the product added to the rations.

Keywords: goats, environmental factors, water intake, protected fat.

Influência dos sais de cálcio de ácidos graxos de cadeia longa na ingestão e digestibilidade de rações em cabritas sob estresse térmico

RESUMO. Com o objetivo de avaliar o efeito da adição de sais de cálcio de ácidos graxos de cadeia longa (SCAG) na ingestão e na digestibilidade de rações foram utilizadas 25 cabritas, alojadas em gaiolas individuais e em câmara climática a uma temperatura constante de 32ºC. As cabritas foram distribuídas em delineamento em blocos casualizados com cinco tratamentos: controle (sem inclusão de SCAG) e com 6,25; 12,50; 18,75 e 25,00 g de SCAG kg^{-1} de MS. A inclusão de SCAG nas rações não influenciou as ingestões de água (3,08 L dia^{-1}), matéria seca (0,66 kg dia^{-1}), matéria orgânica (0,62 kg dia^{-1}), proteína bruta (0,12 kg dia^{-1}), fibra em detergente neutro (0,27 kg dia^{-1}) e carboidratos totais (0,47 kg dia^{-1}). Os resultados das digestibilidade da matéria seca (0,66 kg kg^{-1}), matéria orgânica (0,67 kg kg^{-1}), proteína bruta (0,78 kg kg^{-1}), fibra em detergente neutro (0,47 kg kg^{-1}) e carboidratos totais (0,63 kg kg^{-1}) não foram alterados. Houve efeito linear positivo na ingestão e digestibilidade de extrato etéreo. Portanto, a adição de sais de cálcio de ácidos graxos de cadeia longa em rações de cabritas sob estresse térmico de 32ºC não influencia a ingestão e digestibilidade da matéria seca e dos nutrientes, com exceção do extrato etéreo que é intrínseco ao produto adicionado nas rações.

Palavras-chave: cabritas, fatores ambientais, ingestão de água, gordura protegida.

Introduction

Although goats are considered hardy animals and naturally selected due to their places of origin that present adverse conditions of climate and adaptation, the association between high temperature, air humidity and radiation, featuring heat stress, can lead to behavioral and physiological changes in these animals (Silva et al., 2006; Medeiros et al., 2008).

Also, this association can induce a reduction in the intake and feed efficiency (Silanikove, 2000). Among the environmental factors, air temperature is considered the most important climate factor acting upon the physical environment of the animal, which in turn requires thermoneutral conditions for maximum production, which is not observed in adverse weather conditions (Neiva, Teixeira, Turco, Oliveira, & Moura, 2004).

In addition to the high temperatures, food intake also influences the heat production in ruminants and, the quantity and quality of food interfere in the production of endogenous heat, with consequent modification of the physiological variables. Baccari Junior, Gonçalves, Muniz, Polastre, & Head (1996) showed that Saanen goats subjected to temperatures of 32.5°C in climatic chamber, reduced the dry matter intake and increased the daily water consumption in the same way as Hirayama and Katoh (2004), working with animals under heat stress (35°C), who also observed an increase in the water consumption for stressed animals.

One way to ensure the intake of dry matter and nutrients and ease the effects of stress on the animals outside their thermal comfort zone is to provide a diet with higher energy density and low heat increment, enabling the heat reduction generated by the fermentation of food and metabolism of tissues.

Generally, lipids protected from ruminal fermentation are added to feed in order to increase the energy density of diet without compromising the digestibility of the fiber, allowing greater intake and better energy utilization efficiency.

Among the types of protected lipids are the calcium salts of long chain fatty acids (CSFA), obtained from the reaction of calcium ions with long chain fatty acids (saturated and unsaturated), in which the raw materials can be the soya oil or palm oil, according to the commercial product. Its principle is based on the passage of the calcium ions through the rumen without interfering with the fermentation processes (Sirohi, Walli, & Mohanta, 2010) and their cleavages in the acid conditions of the abomasum, making them available for digestion and absorption directly in the intestine (Silva, Rodrigues, Branco et al., 2007).

Goats can be reduced in the dry matter intake when large amounts of CSFA is provided. In general, the levels of inclusion of calcium salts of long chain fatty acids in the feed vary from 30 to 120 g kg^{-1} of DM (Teh et al., 1994; Sanz Sampelayo, Pérez, Alonso, Extremera, & Boza, 2002; Hosam, 2011), which can change the dry matter intake, interfering with the palatability of the feed ingredients altering the *flavor* for the animals. However, it is possible that minor inclusions of up to 25 g of CSFA kg^{-1} of DM do not result in negative effects on the intake (Molina et al., 2015).

Thus, the present study aimed at evaluating the intake and digestibility of dry matter and nutrient of diets containing increasing levels of calcium salts of fatty acids of long chains, by goats under moderate heat stress of 32°C.

Material and methods

The experiment was conducted at the Iguatemi Experimental Farm, belonging to the State University of Maringá (FEI/UEM), in the goat farming sector and in the sector of Bioclimatology, during a period of about 90 days of experiment, using 25 Boer x Saanen crossbred goats (24.97 ± 2.03 kg of body weight) with five months of age. Goats were housed in individual cages in a climatic chamber, subjected to a controlled temperature of 32°C and constant lighting, in order to simulate the daily variation of the light with incandescent lamps of 60W during the day, and pleasant lighting at night, dimmed with through dimmer 127V.

The animals were allotted to a randomized blocks, with five replicates per treatment. During the 90 days of experiment, the animals were relocated to individual cages for a period of six days of adaptation to feed. Later, five animals were relocated to blocks contained in digestibility cages inside the climatic chamber where they remained for 18 days, of which 12 days were intended for the adaptation to the conditions of the climatic chamber and rations, and six days were intended for the collection of feces and leftovers.

The climatic chamber was equipped with two 60,000 Btu Split Type Floor-Ceiling air conditioners, programmed for constant heating of 32°C, and temperature sensors that recorded in a computer system, the internal temperature of the climatic chamber at 5 minute intervals. The climatological variables (Air Temperature; Wind Speed and Relative Humidity) were daily measured between the 13th to 18th day of collection, at three points of the climatic chamber (beginning, middle and end) through a Thermo-Hygro-Anemometer Digital model Kestrel-3000®, and then their respective arithmetic means were obtained.

Basic ingredients for the composition of rations were: ground corn, soy bran, vitamin and mineral supplement, calcium salts of long chain fatty acids (CSFA), commercial product based on soya oil (Lactoplus® - Dalquim Chemical Industry Ltd, containing 1.760 g kg^{-1} of total digestible nutrients, 820 g kg^{-1} of ether extract, 100 g kg^{-1} of calcium, 260 g kg^{-1} of oleic acid and 420 g kg^{-1} of linoleic acid) and oat hay in a proportion of roughage: concentrate of 57:43. Each ration entitles its respective inclusion of CSFA (Lactoplus®): control (without inclusion of CSFA), and its respective inclusion of 6.25; 12.50; 18.75 and 25.00 g of CSFA per kg of dry matter (g kg^{-1} of DM). Rations were adjusted to correspond to 700 g of neutral detergent fiber and 155 g of crude protein, per kg of dry matter, respectively, according to the National Research Council [NRC] (2007) (Tables 1 and 2).

Table 1. Chemical composition of the ingredients used in rations[1].

Nutrients (g kg^{-1} DM)	Ingredients		
	Oat hay	Ground corn	Soy bran
Dry matter (g kg^{-1})	920.52	885.54	896.39
Organic matter	939.39	987.42	933.89
Ashes	60.61	12.58	66.11
Crude protein	78.50	86.82	515.88
Ether extract	15.68	35.50	17.00
Neutral detergent fiber	697.83	136.11	164.22

[1]Data from the Lab. Analysis of Food and Animal Nutrition of State University of Maringá (LANA/UEM).

Table 2. Proportion of ingredients and chemical composition of experimental rations.

Nutrients (g kg^{-1} DM)	Rations (g of calcium salts of fatty acid kg^{-1} DM)				
	0	6.25	12.50	18.75	25.0
Oat hay	570.00	570.00	570.00	570.00	570.00
Ground corn	232.40	229.02	225.64	222.27	218.89
CSFA		6.25	12.50	18.75	25.00
Soy bran	187.85	185.12	182.39	179.66	176.93
Mineral supplement[1]	9.75	9.61	9.47	9.32	9.18
Dry matter[2]	908.63	909.12	909.64	910.14	910.64
Organic matter	940.36	939.45	938.55	937.65	936.74
Ashes	59.64	60.55	61.45	62.35	63.26
Crude protein	161.83	160.13	158.43	156.73	155.02
Ether extract[3]	20.38	20.22	20.05	19.88	19.72
CSFA[4]		5.13	10.25	15.38	20.50
Neutral detergent fiber	460.24	459.33	458.43	457.52	456.61
Non-fiber carbohydrates	297.90	294.65	291.40	288.14	284.89
Total carbohydrates	758.14	753.98	749.82	745.66	741.50
Gross energy[5]	4.46	4.45	4.46	4.46	4.50

[1]Commercial product. Composition (per kg of product): Calcium 240 g; Phosphorus 71 g; Fluorine 710 mg (max); Magnesium 20 g; Potassium 28,20 g; Iron 2,500 mg; Copper 400 mg; Manganese 1,350 mg; Zinc 1,700 mg; Cobalt 30 mg; Iodine 40 mg; Selenium 15 mg; Chromium 10 mg; vit. A 135,000 UI; vit. D3 68,000 UI; vit. E 450 UI; [2]g kg^{-1} DM; [3]Obtained from the analysis of oat hay, ground corn and soy bran; [4]Estimated through the Lactoplus® manufacturer's manual (Dalquim Chemical Industry Ltd.) as a source of supplemental calcium salts of long chain fatty acids (CSFA); [5]Mcal kg^{-1} DM (NRC, 2007).

Feed management was carried out to supply ration once a day (at 8:00 a.m.), providing daily leftover of 10% on the given amount, also controls of ration intake and water intake were held. Water control was made daily with the aid of a beaker with a capacity of 1 litre, provided individually in plastic troughs for each animal, being 3 litres of water provided in the morning (8:00 a.m.) and 3 litres of water in the late afternoon (5:00 p.m.), and it was completed according to the needs of each animal. The intake of ration and water was then determined by the difference between the quantity delivered and the leftover. The weight control of the animals was performed at the beginning of each period, before the daily diet.

During the days of data collection, there were weighing and sampling of ration offered and leftovers, and these were homogenized to obtain composite samples per animal time^{-1}, which were analyzed for their content of dry matter and nutrients.

In order to determine the digestibility, feces samples were taken directly from the rectum exit for six consecutive days (between the 13th and the 18th day) at six different times: 8, 10, 12, 14, 16 and 18h.

The samples of leftovers and feces were stored in a freezer and, subsequently, forwarded to the Animal Food and Nutrition Analyses Lab (LANA) pertaining to the Department of Animal Science to carry out the chemical-bromatological analyses. In order to perform the analyses, the samples were thawed, pre-dried in a greenhouse with forced-air ventilation, at temperature of 55°C, for 72h; and then homogenized to obtain the composite samples per animal in each collection period.

The samples of food, leftover and feces were processed in a Willey type mill, using a 1 mm screen diameter. The dry matter (DM), ash, crude protein (CP) and ether extract (EE) were analyzed according to the AOAC, as described by Silva and Queiroz (2002) and the neutral detergent fiber was analyzed according to Van Soest, Robertson and Lewis (1991) as adapted by Souza, Nogueira, Sumi and Batista (1999). The organic matter was estimated by calculating the difference between the dry matter and the ash contents.

The total carbohydrates (TC) and total digestible nutrients (TDN) were estimated according to the equation described by Sniffen, O'connor, Van Soest, Fox and Russell (1992):

$$TC\ (g\ kg^{-1}\ DM) = 1000 - (CP + EE + ash)$$

$$TDN = CPd + (2.25 \times EEd) + TCd$$

where: CPd = digestible crude protein, EEd = digestible ether extract and TCd = digestible total carbohydrates.

The values for non-fibrous carbohydrates (NFC) were estimated according to the equation proposed by Van Soest et al. (1991):

$$NFC\ (g\ kg^{-1}\ DM) = 1000 - (NDF + CP + EE + ash)$$

The values for crude energy were determined via adiabatic bomb calorimeter (PARR Instruments Co. AC720, EUA).

For the estimation of fecal excretion, it was used indigestible acid detergent fiber (ADFi) as internal indicator (Cochran, Adams, Wallace, & Galyean, 1986), being this, estimated from the rumen of goats and obtained 240 hours after *in situ* incubation of feeds, leftover and feces with F57 filters. Subsequently, it was performed an analysis of fibers in acid detergent, according to the technique described by Ankom® (Ankom Technology Corporation, Fairport, NY, USA). The fecal flow was calculated according to the following equation proposed by Van Soest (1994):

$FE = CADFi / ADFiF$

where: FE = fecal excretion (kg day^{-1}); $CADF_i$ = consumption of ADFi (kg day^{-1}); ADF_iF = concentration of ADFi in the feces (kg kg^{-1}).

The statistical analysis of the variables was performed using the SAEG software (System for Statistical Analyses and Genetic, version 7.1), developed by the Federal University of Viçosa (UFV). The analyses of variance was performed using regression analyses on the basis of the inclusion levels 0; 6.25; 12.50; 18.75 and 25.0 g of calcium salts of long chain fatty acids per kg of dry matter. The data were analyzed according to the following statistical model:

$$Y_{ij} = b0 + b1G + b2G + e_{ij}$$

where: Y_{ij}= observation of the variable studied in the animal j receiving the diet i;
$b0$= general constant;
$b1$= coefficient of linear regression as a function of the level of CSFA;
G = inclusion of CSFA in the rations (0; 6.25; 12.50; 18.75 and 25.0 g of CSFA per kg of the total ration of dry matter);
$b2$= coefficient of quadratic regression as a function of the level of CSFA;
e_{ij} = random error associated to each observation.

Results and discussion

The values of climate variables observed for the air temperature and relative humidity ranged from 32.24 to 32.56°C and from 65.67 to 71.28%, respectively (Table 3).

According to Souza, Tinôco, Baêta, Ferreira and Silva (2002) and Marai, El-Darawany, Fadiel and Abdel-Hafez (2007), the values observed for the environmental variables do not characterize a proper comfort range. These same authors recommend intervals of 20-30°C and 50-70% for air temperature and relative humidity, respectively. When this zone is exceeded, the animals show heat stress, and this can trigger their thermoregulatory mechanisms, reducing the secondary activities such as dry matter intake and animal performance.

Table 3. Climatological data measured in the climatic chamber[1].

Data[2]	Sampling[3]				
	1ª	2ª	3ª	4ª	5ª
T°	32.56	32.33	32.33	32.38	32.24
AVG	0.14	0.13	0.09	0.07	0.05
RH	68.83	68.17	71.28	65.67	67.67

[1]Data from the Iguatemi Experimental Farm of State University of Maringá (FEI/UEM), and from the sector of Bioclimatology; [2]T° = Air Temperature (°C); AVG = Wind Speed (m s^{-1}); RH = Relative Humidity (%); [3]Arithmetic mean of the climatological data measured during the trial period.

The results for water intake of goats (3.08 L day^{-1}) was superior to those described by Hirayama and Katoh (2004), who observed ingestions of 2.40 L day^{-1} for Saanen goats, under thermal stress of 35°C (Table 4).

However, Barreto et al. (2011) reported values of 1.57 and 1.55 L day^{-1} for goats of the Moxotó race and 1.48 and 1.55 L day^{-1} for goats of the Canindé race, using 2.2 and 2.7 Mcal of ME kg^{-1} of DM, respectively, in a study in the Brazilian semiarid region. These lower values are assigned to smaller breeds of animals (Moxotó and Canindé) that are adapted to the climatic conditions of the Brazilian Northeast, that is, heat and drought, and hence, they have lower water intake.

The water intake observed can be explained by the needs of Boer x Saanen goats, which are not adapted to higher temperatures. Because of the continuous heat stress of 32°C, these animals had to cool the body by conduction and replenish the water evaporated by respiratory and skin routes.

According to Pereyra and Leiras (1991) one factor that increases the consumption of water is the dietary supplement, which can alleviate the stress caused by the heat. However, in this study the addition of CSFA in the diet did not affect the water intake in the same way as described by Barreto et al. (2011), who did not observe effects of adding 2.2 and 2.7 Mcal kg^{-1} of DM in the diet on the water intake of farming goats.

Table 4. Water intake of dry matter and nutrient goats receiving rations with increasing levels of calcium salts of fatty acids of long chain[1].

Intake (kg day^{-1})	Rations[2]					*P* Value	CV
	0	6.25	12.50	18.75	25.0		
Water (L day^{-1})	3.182	2.992	3.148	2.596	3.486	>0.05	37.55
Dry matter	0.701	0.627	0.667	0.653	0.657	>0.05	6.62
Organic matter	0.657	0.588	0.625	0.611	0.614	>0.05	6.62
Crude protein	0.128	0.115	0.122	0.121	0.115	>0.05	6.14
Ether extract	0.016	0.019	0.024	0.029	0.032	<0.01[3]	8.75
Neutral detergent fiber	0.296	0.266	0.276	0.258	0.275	>0.05	10.39
Total carbohydrates	0.513	0.454	0.478	0.461	0.467	>0.05	7.62
Total digestible nutrients	0.452	0.397	0.427	0.460	0.434	>0.05	11.11

[1]Data from the Lab. Analysis of Food and Animal Nutrition of State University of Maringá (LANA/UEM); [2]g of calcium salts of fatty acid kg^{-1} DM; [3]$\hat{Y} = 0.0157+0.0063x$; $R^2 = 0.89$; CV = coefficient of variation (%).

The DMI result was applied in the equation proposed by NRC (2007), wherein the total water intake (TWI) = DMI x 3.86 – 0.99, which resulted on an arithmetic average of 1.561 L of water day^{-1} kg^{-1} of DM for goats under thermal stress. This average intake was higher than the recommendations of the international committees of 0.732 L of water day^{-1} kg^{-1} of DM for goats (NRC, 2007). The increase in the consumption of water observed for goats is justified by the condition of the upper atmosphere, in which the animals were subjected to stress of 32°C. This is contrary to the recommendations of the NRC (2007) who consider that the animals have to be subject to mild climates, different from the tropical climate observed in Brazil, where temperatures of 32°C are usual.

The addition of calcium salts of long chain fatty acid (CSFA) in the diets did not affect ($p > 0.05$) the intake of water, dry matter and nutrients (Table 4), except for ether extract, corresponding to increasing levels of CSFA of soya oil added in the rations, in agreement with the foregoing by Souza et al. (2014). The CSFA was added to increase the energy level of diet of dairy goats during the periods of pre-calving and peripartum, being observed that the ether extract intake increased linearly in response to the addition of dietary fat.

The dry matter intake (DMI) was not influenced by the addition of fat in the diets (Table 4), which is in agreement with the findings of Molina et al. (2015), who supplemented with 25 g of calcium salts of long chain fatty acids kg^{-1} of DM; Hosam (2011), who supplemented with 50 g of calcium salts kg^{-1} of DM; Silva, Rodrigues, Branco et al. (2007), who used 6.5% EE of soya oil, soya bean and calcium salts; and Possamai et al. (2015), who used calcium salts of fatty acids in up to 2.8 Mcal of metabolizable energy kg^{-1} of DM in the diet of Saanen goats, without affecting the intake.

The results observed for the dry matter intake (0.66 kg day^{-1}) are below those obtained by Lima et al. (2011) and Possamai et al. (2015), who observed values of DMI of 0.75 and 0.77 kg day^{-1}, respectively, from Saanen goats. These data indicate that even the addition of CSFA does not interfere with the intake. The possibly thermal stress that the animals underwent resulted in lower consumption, which represents an instant of the homoeothermic body of goats, an answer to reduce the metabolic heat production and maintain the thermo-neutrality of the animal, since the ambient temperature, food, energy intake and performance are interconnected.

It was observed that the dry matter intake did not change and that the goats had a good acceptance of the addition of the CSFA at levels established of supplementation of up to 25.0 g kg^{-1} of DM. However, according to Sanz Sampelayo et al. (2002), studying lactating goats supplemented with CSFA with 0, 90 or 120 g kg^{-1} of DM, the negative effect of the intake can be justified by the CSFA odor, reducing the ration palatability. However, it is possible that minor inclusions do not exercise adverse effects on the intake (Molina et al., 2015).

Thus, by supplying rations with low amounts of dietary supplement, between 6.25 and 25.0 g kg^{-1} of DM, the risks of problems with the acceptability of rations by goats are reduced, since these animals are classified as intermediate selectors, sensitive to odor and palatability of ingredients constituent of the ration. Although the CSFA present characteristic features such as odor of soap (calcium soap of fatty acids), their inclusion in the diets did not restrict the dry matter intake, giving good acceptability to the product, without affecting the *flavor* for goats. In addition, they ensure a good mixing of the ingredients, which is essential to reduce the selection capacity and prevent the ingestion from being impaired, since the dry matter intake determines the intake of nutrients and, therefore, is considered a limiting factor for production in ruminants (Fonseca et al., 2006).

The addition of calcium salts of long chain fatty acids in the diets did not change ($p > 0.05$) the digestibility of the dry matter and nutrients (Table 5).

Table 5. Digestibility of dry matter, nutrients and goats TDN receiving rations with increasing levels of calcium salts of fatty acids of long chain[1].

Digestibility (kg kg^{-1})	Rations[2]					*P* Value	CV
	0	6.25	12.50	18.75	25.0		
Dry matter	0.66	0.63	0.66	0.69	0.66	>0.05	6.62
Organic matter	0.67	0.64	0.66	0.70	0.67	>0.05	6.62
Crude protein	0.77	0.76	0.77	0.80	0.78	>0.05	6.14
Ether extract	0.68	0.76	0.82	0.86	0.86	<0.01[3]	8.75
Neutral detergent fiber	0.48	0.44	0.47	0.51	0.47	>0.05	10.39
Total carbohydrates	0.64	0.60	0.62	0.66	0.62	>0.05	7.62
Total digestible nutrients	0.64	0.63	0.64	0.70	0.66	>0.05	11.11

[1]Data from the Lab. Analysis of Food and Animal Nutrition of State University of Maringá (LANA/UEM); [2]g of calcium salts of fatty aci kg^{-1} DM; [3]$\hat{Y} = 0.0070+0.0748x$; $R^2 = 0.74$; CV = coefficient of variation (%).

These results contradict those observed by Schauff, Elliott, Clark and Drackley (1992), when describing the inclusion of calcium salts, they can cause reduction in the digestibility of dry matter, organic matter and cellulose.

In addition, Maia et al. (2006) included three oil sources (canola, rice and soybean) in the diet of lactating goats at level of 5.1%, with reduction of 24% in the digestibility of neutral detergent fibers (NDF) and 18% in the total digestion of the non-fiber carbohydrates (NFC). Also, Possamai et al. (2015), when using CSFA with up to 2.8 Mcal of metabolizable energy kg^{-1} of DM noticed improvements to levels of 2.64 and 2.65 Mcal metabolizable energy kg^{-1} of DM in the digestibility of DM and OM in the diet of goats.

However, the digestibility of the ether extract was affected ($p < 0.05$), presenting positive linear effect, such as Souza et al. (2014) who observed positive linear effect for pre-calving goats supplemented with calcium salts of long chain fatty acids, rich in unsaturated fatty acids (FA). Palmquist and Mattos (2011) explain that the unsatured FA has digestibility superior than the saturated fatty acids, due to their micelle forming properties, making them more soluble in the intestine. This facilitates the application of the layer of water associated with the inert intestinal microvilli, increasing the absorption of these types of fatty acids.

The digestibility of dry matter did not suffer influence of the supplementation with calcium salts of long chain fatty acids (Table 5). However, Zambom et al. (2005), with the intention of raising the energy level of rations, added from 19.7 to 46.7 g of soya oil kg^{-1} of DM, and corresponding ether extract from 3.00 to 6.81%, respectively, and observed an increase in the digestibility of dry matter and nutrients. Nevertheless, this effect was associated with an increase in the concentrate portion of the diets of postpartum goats. Meantime, according to the authors, no limitation of ration intake was verified when a higher lipid content was used (6.81%), so that the lowest intakes were observed for animals fed rations with higher roughage diets.

The inclusion of calcium salts of long chain fatty acids (CSFA) in the rations of goats under thermal stress of 32°C did not affect the digestibility of the dry matter and nutrients. This contrasts with the exposed by Silva, Rodrigues, Florentino et al. (2007), where goats supplemented with calcium salts with inclusion of 4.5% more ether extract showed a reduction in the digestibility of organic matter, crude protein and total carbohydrates.

Conclusion

The addition of up to 25 g of calcium salts of long chain fatty acids per kg of dry matter in the rations of goats at a 32°C temperature does not influence the intake and digestibility of dry matter and nutrients, except for ether extract, which is intrinsic the inclusion of this product in the rations.

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