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Partial replacement of soybean meal by urea on production and milk physicochemical composition in Saanen goats

Substituição parcial do farelo de soja por uréia na produção e composição físico-química do leite de cabras Saanen

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SUMMARY

The effect of the partial replacement of soybean meal by urea in the diet of lactating goats on the dry matter consumption, milk production and physicochemical composition was evaluated. Eight Saanen goats, in an experimental design in Latin square (4 x 4), were used. The urea levels used in experimental diets were 0, 0.8, 1.6 and 2.4% and, soybean meal level were 25, 19, 13 and 7%, respectively. The animals were evaluated in four periods of 15 days, each, and 10 days were used for adapting to diet, and the last five days, to collect data. There was a reduction on the dry matter consumption as the urea level in the diet increased. The average values of acidity, protein, density, total solids, defatted total solids, ash and lactose in milk showed no significant difference (P>0.05) among treatments. However, the fat content presented increasing linear effect (P<0.05). It is recommended the inclusion of up to 1.6% of urea, replace soybean meal in order not to change dry matter intake, milk production and milk composition.

Keywords: dry matter intake, lactating goats, nonprotein nitrogen

RESUMO

Avaliou-se o efeito da substituição parcial do farelo de soja por uréia na dieta de cabras em lactação sobre o consumo de matéria seca, produção e composição físico-química do leite. Foram utilizadas oito cabras Saanen, distribuídas em um delineamento experimental em quadrado latino (4 x 4), com duas repetições. Os níveis de uréia utilizados nas dietas experimentais foram de 0; 0,8; 1,6 e 2,4% e para farelo de soja foram de 25; 19; 13 e 7%, respectivamente. Os animais foram avaliados em quatro períodos de 15 dias cada, sendo 12 dias para adaptação à dieta e os últimos três dias para a coleta de dados. Houve redução do consumo de matéria seca, à medida que se aumentava o nível de uréia na ração. Os valores médios para acidez, proteína, densidade, extrato seco total, extrato seco desengordurado, cinzas e lactose no leite não apresentaram diferença significativa (P>0,05) entre os tratamentos. Já o teor de gordura do leite apresentou efeito linear crescente (P<0,05). Recomenda-se a inclusão de até 1,6% de uréia em substituição ao farelo de soja, no intuito de não alterar a produção de leite.

Palavras-chave: cabras lactação, leite de cabra, nitrogênio não protéico

INTRODUCTION

Dietary protein plays an important role in the nutrition of ruminants, since besides providing aminoacids; it is also a source of nitrogen for the synthesis of microbial protein. Therefore, it is considered the most important nutrient and also the most expensive, which must be efficiently used (SAHOO & WALLI, 2008).

Strategies to reduce the feed cost without interfering negatively in production have been constantly researched (PERES, 2001). Soybean meal is an important source of protein in diets for lactating goats. However, its price is established by international market, thus fluctuations of the U.S. currency have resulted in constant increases in its price.

Urea is a source of nonprotein nitrogen (NPN) widely used in the diet of ruminants. Ruminal microorganisms are capable of transforming nonprotein nitrogen provided by urea into true protein of high biological value. These reactions allow the animal to save nitrogen compounds and get protein from sources of NPN, which can be used as a supplementary source in the diet of these animals (RAMALHO et al., 2006). In addition, sources of NPN are cheaper than sources of protein, considering the same amount of nitrogen.

The production and composition of goat milk have received attention in recent years, since its nutritional quality is a direct requirement of consumers, which influences directly on the industrial performance. Some authors have evaluated the effect of urea in the diet of lactating cows on the milk production and composition characteristics. Pereira et al. (2001) reported that the balance between the amounts of rumen-degradable protein (RDP) and rumen non-degradable protein (RNDP) seems to have influenced on the milk composition. According to Sampelayo et al. (1999), most rapidly protein in rumen is the fraction associated with the milk protein production.

Considering the lack of information on the use of urea as source for protein in lactating goats, the objective, this study, was to evaluate the effect of the partial replacement of soybean meal by urea on the dry matter consumption, milk production and physicochemical characteristics the of goat milk.

MATERIALS AND METHODS

The experiment was conducted in the Setor de Caprinocultura of the Centro de Ciências Humanas Sociais e Agrárias, Universidade Federal da Paraíba, December 2007 to February 2008.

Eight primiparous Saanen goats with average live weight of 35 ± 4 kg and average daily milk production of 1.6 ± 0.3kg were used. The test with the experimental diets had 60 days and was composed of four periods of fifteen days. The first 10 days of each period were used for adaptation to experimental diets and the following five days, for data collection. The animals were kept in confinement in individual boxes (1.26 m^2), provided with food trough and water *ad libitum*.

The ration was offered twice a day at 6:30 am and 3:30 pm. Treatments consisted of a partial replacement of soybean meal by urea (Table 1). Diets were formulated to have the same protein content (17% DM), according to recommendations from NRC (1981), to meet the requirements of lactating goats with milk production of 2 kg/day with 4% fat.

Table 1. Percentage composition of ingredients in the diets (%DM) and chemical composition of rations according to urea levels

Ingredients	Urea levels (%DM)			
	0	0.8	1.6	2.4
Corn meal	20.0	19.0	20.0	20.0
Soybean	25.0	19.0	13.0	7.0
Wheat	5.0	11.2	15.4	20.6
Elephant grass hay	47.0	47.0	47.0	47.0
Urea	0.0	0.8	1.6	2.4
Mineral supplement	1.5	1.5	1.5	1.5
Limestone	1.5	1.5	1.5	1.5
	Chemical Composition			
Dry Matter (%)	88.83	88.82	88.87	88.88
Crude Protein (%)	17.06	17.31	17.46	17.65
Neutral Detergent Fiber (%)	49.97	51.47	52.07	53.12
Acid Detergent Fiber (%)	31.22	31.36	31.25	31.27
Ether Extract (%)	2.93	3.05	3.21	3.34
Calcium (%)	1.03	1.02	1.01	0.99
Phosphorus (%)	0.52	0.55	0.56	0.58

Diets were provided in the form of complete mixture in quantity calculated to promote 20% of surpluses. During the last five days of each trial period, surpluses were weighted and samples were collected. Hay and concentrate samples from each one of the treatments were wrapped in plastic bags and stored at -20 °C, until the completion of bromatological analyses, after determining dry matter, raw protein, ether extract, calcium, phosphorus, neutral detergent fiber and acid detergent fiber, according to Silva (1990).

Goats were manually milked twice a day (6:00 am and 3:00 pm), with daily milk control conducted through individual milk weighing (g/day). To correct the milk production to 4% fat, the Sklan et al. (1992) formula was used, where: MPC (4%) = (0432 + 0.1625 x F) x MP, F is the fat percentage in the milk and MP is the milk production in g/day.

Milk samples were individually collected, during manual milking, in sterilized containers, after filtering, to be, later, conditioned in polyethylene bottles of 250 mL, considering the aliquot proportional to the milking shift.

The physicochemical analyses were performed in the Food Quality Control Laboratory/UFPB. To determine the defatted total solids, total solids, density, protein, acidity, ash content levels, fat and lactose, the methodology developed AOAC (1998) was used.

The experimental design used was a double Latin square (4 x 4), with eight animals, four periods and four soybean meal/urea replacement levels. Data were submitted to the analysis of variance, regression and analysis of averages was conducted through the Tukey test at 5% probability, with the statistical program SAS version 6.2.

RESULTS AND DISCUSSION

There was a linear reduction ($\hat{Y}$=2069.9-124.15x) in the DMI, in terms of increasing urea levels in the diet. The higher urea level (2.4%) reduced the dry matter intake by goats. These data corroborate with Silva et al. (2001), who assessed the partial replacement of soybean meal by urea in the diet of dairy cows and also found a reduction in the DMI with the increased nonprotein nitrogen in the diet, and attributed the metabolic effects of urea and/or the little palatability of food as probable causes. Huber & Cook (1972) also related the reduction on the consumption of diets with high levels of urea in concentrated of dairy cows (1 to 3%) to its low palatability. However, Wilson et al. (1975) attributed the decrease on the DMI in diets containing more than 2% of urea to intermediate catabolites in the urea metabolism (Table 2).

Although no level of intoxication has been observed, it must be taken into consideration that the excessive or inadequate RDP intake, respectively, leads to reductions in consumption by impairing the activity of cellulolytic bacteria or by producing, excessively, ammonia, with consequences on the motility and ruminal fermentation (FAVERDIN, 2003).

Similarly, the milk production (MP) was, significantly, reduced ($P<0.05$) with the higher urea level (2.4%) in the diet of the animals, presenting linear reduction ($\hat{Y}$=2121.7-186.88x), probably due to the lower DM ingestion as the NPN levels were increased. Animals supplemented with 2.4% of urea also showed lower MPC (4%), with an average of 1213.6 g/day. This fact may be related to the reduction on the DMI by goats, due to the high NPN levels. However, Carmo et al. (2005) observed that the reduction on the milk production may be more related to the lactation stage than the DMI reduction itself, suggesting that cows, at the final third of lactation, have not their consumption reduced, due to the urea supplementation and, thus, the goats are able to maintain the milk production.

Oliveira et al. (2004) used different urea levels in the diet of dairy cows and also described a negative linear effect of increasing levels on the milk production. Aquino et al. (2007) tested the replacement of soybean meal by urea in the diet of dairy cows and found no change in the milk production.

The analysis of the milk composition is a way to assess the milk adequacy to the dairy processing industry. In this study, no difference was observed ($P>0.05$) between treatments for acidity, protein, density, total solids, defatted total solids, ash and lactose, which average values ranged from 13.43 to 14.82 ° D, from 2.90 to 3.18%, from 1030.47 to 1031.60 g/cm^3, from 10.26 to 10.55%, from 7.11 to 7.66%, from 0.77 to 0.80% and from 3.73 to 3.88%, respectively. The replacement of the true protein source by nonprotein nitrogen in the diet did not change the milk protein production capacity, fact also observed by Aquino et al. (2007). The fat content of the goat milk ranged from 2.82 to 3.43%, with significant difference ($P<0.05$) between treatments, presenting increasing linear effect ($\hat{Y}$=2.53 +0.19x). A possible beneficial effect of urea in the ruminal pH could explain this result. The alkalizing power of urea could not only aid in the maintenance of a higher ruminal pH through this diet and favour the fiber digestion in the rumen.

Table 2. Dry matter intake, Milk production, milk production corrected to 4% fat, and milk composition according to urea levels

Parameters	Urea levels (% DM)				Effect	R^2	SE
	0	0.8	1.6	2.4			
Dry Matter Intake (g/day)	1920.2[a]	1830.6[ab]	1755.8[ab]	1531.3[b]	Ŷ=2069.9-24.15x	0.92	351.77
Milk Production (g/day)	1843.5[a]	1896.7[a]	1537.5[ab]	1340.3[b]	Ŷ=2121.7-186.8x	0.84	432.05
Milk Production Corrected 4% fat (g/day)	1502.6[ab]	1572.7[a]	1303.3[ab]	1213.6[b]	Ŷ=1682.2-113.7x	0.76	356.69
Acidity (ºD)	14.19	13.43	13.87	14.82	Ŷ=14.08	-	1.03
Fat (%)	2.82[b]	2.86[b]	2.95[ab]	3.43[a]	Ŷ=2.53 +0.19x	-	0.40
Protein (%)	3.10	2.97	3.18	2.90	Ŷ=3.03	-	0.34
Lactose (%)	3.73	3.88	3.81	3.78	Ŷ=3.8	-	0.36
Density (g/cm^3)	1031.60	1031.50	1030.57	1030.47	Ŷ=1031.03	-	1.80
Total solids (%)	10.26	10.52	10.52	10.55	Ŷ=10.46	-	0.85
Defatted total solids (%)	7.44	7.66	7.57	7.11	Ŷ=7.44	-	0.63
Ashes (%)	0.77	0.78	0.80	0.79	Ŷ=0.79	-	0.06

[a, b, ab]No similar letters in the lines are significantly different according to Tukey test at 5%.

A greater availability of precursors (acetate), as well as the reduction of inhibiting factors (trans-chain fatty acids) of the fat synthesis in the mammary gland, may explain the higher fat levels in the milk of goats receiving diet with 2.4% of urea (GAYNOR et al., 1994).

Similarly, Susmel et al. (1995) and Carmo (2005) obtained the highest fat levels in, when urea was the supplement of rations for dairy cows, which, according to these authors, could be the consequence of better use of dietary fiber, which provides the precursors for the synthesis of lipids in the mammary gland. The bacteria that induce the fermentation of fibrous carbohydrates use ammonia as their sole source of nitrogen (PIRES et al., 2004).

Although difference in the milk fat content has been found, there was no effect of the addition of urea on the levels of protein, lactose and ash, which probably reduced the probability of change in the total solids concentration, as well as in the defatted total solids.

Between protein and fat, the latter is more strongly influenced by nutrition. In extreme cases, the protein content varies around 0.4%, while fat could range from 2 to 3%. Like protein, the milk lactose content is hardly changed (CARVALHO, 2000). This stability among the four treatments was foreseeable, because lactose is the milk component that suffers less change in function of diet, due to its important osmotic role in milk.

In conclusion, it could be added up to 1.6% of urea to replace soybean meal without affecting the milk production of goats. Additions above this level reduce both the dry matter intake and the milk production.

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