Effect of soybean hulls on lactation curves and the composition of goat milk

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ABSTRACT - This study aimed to evaluate the effects of soybean hulls (SBH) as a ground corn replacement (0, 50, and 100% SBH) on the parameters of the lactation curve and on lactation curves and milk composition. Fourteen multiparous Saanen goats were used during their lactation period, from kidding until the drying of their milk on the 228th day of lactation, and were distributed in a completely randomised design. The data was analysed using Bayesian methodology to minimise the effect of the low number of animals and to allow for comparison of the curve parameters estimated by Wood's nonlinear model. The SBH had no effect on the initial milk yield; nevertheless, the SBH reduced the rate of yield until lactation peak and accelerated the declining rate of yield after lactation. The treatments did not affect dry matter intake. The inclusion of SBH increased the fat content in the milk, which was also influenced by the lactation stage of the goats. Effects were observed on polyunsaturated fatty acids (PUFA), PUFA/total AG ratio, and the n-6:n-3 ratio of goat milk fat. The lactation stage changed the content of saturated fatty acid, monounsaturated fatty acid, and C18:2 (conjugated linoleic acid). The SBH can therefore be used as a ground corn replacement in the diets of lactating goats, as changes in the lactation curve parameters did not result in changes in total yields. Nevertheless, if the milk fat increases, then as quality rises, so could payment by quality, and thus an increase in profit margins per liter of milk sold.

Key Words: Bayesian methodology, dairy goat, peak production, persistence of lactation, Wood's nonlinear model

Introduction

Goat farming is of great social importance in the world and is bound inextricably to family-based farming. To provide an income to farmers, new food management alternatives are necessary to remunerate farmers and make the goat milk and its derivatives available in the market. NRC (2007) describes many kinds of alternative feeds and coproducts that are used to feed small ruminants. There is still a need for further research into new feeds to enlarge the set of potential food.

The soybean hull (SBH) is a thin skin surrounding soybean grains. For soybean oil extraction, the hull is separated from the grain. The soybean hull is a coproduct that, normally, is ground and added to soybean meal in different proportions according to the protein level required for the soybean meal. Due to market demand for the nutritional requirements of poultry and pork, for soybean meal with a higher protein concentration (48%), minor proportions of hull are added to the soybean meal. The soybean hull is thus a coproduct that may be used to feed ruminants in place of corn grain.

Goat milk yield and quality are associated with diet (Queiroga and Costa, 2004), breed, lactation stage, and climate, in addition to the combined action of these factors in the environmental conditions of each country or region. Ribeiro et al. (1997) and Queiroga and Costa (2004), studying dairy goats, showed that the contents of protein, fat, and lactose change during lactation. The study of lactation curves combined with the study of the effect of alternative feeds on dairy animals can help to plan nutritional management to optimise yield and quality and to provide an estimate of lactation persistence, time of peak

yield, and the milk yield in the peak, which are criteria used for animal selection.

There are different models for the study of goat lactation curves: Wood (1967), Cobby and Le Du (1978), Dhanoa (1981), and Cappio-Borlino et al. (1995). Wood's model has been adopted in the majority of lactation curve studies because it allows for the estimation of basic curve features, such as the highest milk yield, the time to reach this level of production, and its persistency, using only three parameters (Wood, 1967).

Macedo et al. (2001), studying crossbred Saanen goats, concluded that Wood's nonlinear model was the best to describe the lactation curve because it showed less variance than the other models tested. Takma et al. (2009) concluded that Wood's nonlinear model can be used to describe the goat yields.

To obtain more accurate estimates of frequentist analysis, without making changes into the data, Bayesian analysis has been increasingly used. Bayesian methodology has been successfully used in studies about lactation curves (Chang et al., 2001; Silva et al., 2005; Gomes et al., 2014), since it considers all parameters as random variables, which substantially reduces the number of atypical curves.

Studies evaluating the impact of alternative feeds, as of soybeans hulls, on lactation curves and milk quality are important for providing animal nutritional management strategies. This study evaluates the parameters from the lactation curve and lactation curves and milk composition of Saanen goats receiving diets with soybean hulls as a corn ground replacement.

Material and Methods

The experiment was conducted in Maringá, Paraná State, southern Brazil. Fourteen multiparous Saanen goats (75.17±9.96 kg), between four and five years of age, and in the third or fourth lactation were used, from parturition of goats until natural drying on the 228th day of lactation. Goats were distributed in a completely randomised design as follows: n = 3 for 0% SBH, n = 5 for 50% SBH, and n = 6 for 100% SBH. The different replicates of animals are due to the death of some animals soon after kidding. The criteria used to put the animals in the treatments were milk yield, body weight, age, and parity orders.

Animals were housed in individual stalls with *ad libitum* water and access to a solarium in the mornings for 2 h. Milking was done twice daily, at 07.30 and 15.00 h, followed by milk weighing, and goats were fed at 10:00 and 16:00 h.

Treatments were diets with SBH (with 926 g/kg of dry matter (DM); 154 g/kg of crude protein (CP); 36 g/kg of ether extract (EE); 607 g/kg of neutral detergent fibre (NDF); and 1.4 g/kg of starch) as a corn ground replacement (0, 50, and 100% SBH) (Table 1). Diets were calculated to attend the nutritional requirements of Saanen goats with body weights of 60 kg and a milk yield of 3.0 kg per day according to AFRC (1993) for energy and metabolizable protein and according to NRC (1981) for mineral requirements.

Feed intake and orts were measured daily and feed intake was adjusted weekly to provide approximately 10% orts. After parturition, goats and their kids were weighed and then were weighed biweekly.

Diets were collected and ground through a 1-mm sieve screen to evaluate: DM, ash, CP, and EE, as described by Silva and Queiroz (2002). The neutral detergent fibre and acid detergent fibre were evaluated as described by Van Soest et al. (1991); analyses of NDF were done without the use of sodium sulfite and with the inclusion of heat-stable α-amylase (alpha-amylase Termamyl 2x, Tecnoglobo®, Curitiba, PR, Brazil). Organic matter was estimated according to equations described by Sniffen et al. (1992). For starch, the enzyme method of Poore et al. (1989) was used, adapted by Pereira and Rossi (1995).

Table 1 - Ingredients and chemical composition of diets (g/kg DM)

Ingredient (g/kg)	Level of soybean hulls (SBH)[1]		
	0% SBH	50% SBH	100% SBH
Corn silage	400	400	400
Soybean meal	173	183	168
Ground corn	402	202	0
Soybean hulls	0	195	413
Salt	12.1	12.1	12.2
Limestone	6.30	2.50	0
Dicalcium phosphate	1.90	1.40	1.60
Mineral-vitamin supplement[2]	5.00	5.00	5.00
Chemical composition (g/kg DM)			
Dry matter (g/kg)	650	655	661
Organic matter	943	938	931
Crude protein	134	148	153
Neutral detergent fibre	313	396	489
Acid detergent fibre	161	238	322
Calcium	4.10	3.60	3.80
Phosphorus	2.60	2.40	2.30
Total digestible nutrients[3]	654	618	576
Metabolizable energy[4] (Mcal/kg of DM)	28.8	27.2	25.4

DM - dry matter.
[1] Level of soybean hulls as a corn ground replacement.
[2] Chemical composition (per kg of commercial product): 80.00 g Ca; 65.00 g P; 126.00 mg Co; 21.00 mg Mg; 4400.00 mg Mn; 185.00 mg Na; 4680.00 mg Zn; 45.00 mg Se; 60.00 mg I; 23.00 g S; 615.79 mg F (max.); 7000.00 mg niacin.
[3] Estimated according to the equation described by Sniffen (1992): TDN = CPd + (2.25 × EEd) + TCd, in which CPd = digestible crude protein, EEd = digestible ether extract, and TCd = digestible total carbohydrates.
[4] Estimated according to the equations described by NRC (2007).

Milk samples were collected monthly from each goat by two consecutive milking acts and pooled on a yield basis. Thus, eight milk samples per goat were carried out. To determine chemical composition, milk samples were stored at 4 ºC with a preservative (2-bromo-2-nitropropane-1,3-diol) until analysed for fat, protein, lactose, and total solids by infrared spectroscopy (Bentley model 2000; Bentley Instrument Inc., Chaska, MN). Milk somatic cell count were obtained using an electronic counter (Somacount 500, Chaska, MN), which was calibrated for cow milk analysis.

Another milk sample was collected and frozen at −20 ºC without the addition of preservatives to determine the milk fat composition and milk urea nitrogen.

Milk samples were centrifuged for 30 min at 3,000 × g at 4 °C and the serum was separated and frozen at –20 °C for subsequent analyses. The concentration of milk urea nitrogen was analysed using a commercial kit (urea-PP kit category 427; Gold AnalisaDiagnostica®) on a spectrophotometer (Shimadzu UV-1601 UV-Visible Spectrophotometer®) at wavelength of 600 nm.

Milk fat was extracted by centrifugation for 30 min at 3000 × g at 4 ºC and transesterified according to method no. 5509 (ISO, 2000) with KOH/methanol and n-heptane. Thereafter, the methyl ester composition of fatty acids (FA) was measured by gas chromatography (14-A (Shimadzu®) equipped with an auto sampler, a flame ionization detector at 240 ºC, and a cyanoalkyl polisiloquixano capillary column (100 m long, 0.25 mm internal diameter, and 0.20 m film thickness, CP-Sil 88 Chrompack®).

Fatty acids were quantified as g/100 g lipids, compared to the retention time of methyl ester fatty acids from the sample standard tricosanoic acid methyl ester (23:0) (Sigma-Aldrich®, Brazil). The column parameters were as follows: the initial column temperature of 60 ºC was maintained for 4 min; the temperature was then increased at a rate of 40 ºC/min to 140 ºC; this temperature was maintained for 10 min and then increased at a rate of 5 ºC/min to 225 ºC and maintained for 12 min. The injector and detector temperatures were 220 and 240 ºC, respectively. The gas flow was 1.2 mL/min for hydrogen (carrier gas), 30 mL/min for N_2 (auxiliary gas), 30 mL/min for H_2, and 300 mL/min for compressed air. With a microliter syringe, 1.0 µL of the samples were injected with a split ratio of 1:100. Fatty acid peaks were identified by comparison with the retention times of pure methyl ester standards (Sigma-Aldrich®, Brazil).

To obtain the tendency of milk yield data, the daily yield was adjusted by non-linear regression to predict the lactation curve parameters and the peak yield, time of peak yield, and lactation persistence according to Wood's

nonlinear model was assumed, according to the equation described by Wood (1967):

$$y_{ijk} = a_k t_{ijk}^{b_k} e^{-c_k t_{ijk}},$$

in which i-animal = 1, 2, ... N; j-time = 1, 2, ... J; k-treatment = 1, 2, ... K; y = milk yield (kg/day); a = the initial milk yield (kg); b = increased rate of yield until lactation peak; c = the declined rate of yield after lactation peak (persistency factor); t = days in lactation; e = exponential.

Using Wood's model, the following parameters were determined: peak yield (pp), time of peak yield (dpp), and lactation persistence (s) by the equations:

$$pp = a \left(\frac{b}{c}\right)^b e^{-b}$$

$$dpp = \frac{b}{c}$$

$$s = -(b + 1) \ln(c)$$

To reduce experimental bias due to the low repetitions of animals and to compare the lactation curve parameters among treatments, Bayesian analysis was used for the lactation curves and milk yield.

Normal distribution data were considered to analyse the lactation curve parameters, i.e. $y_i \sim N (f(t_i);\sigma^2)$, in which $f(t_i)$ is the nonlinear Wood function (1967). Non-informative *Priors* were considered for the parameters of the model. A gamma distribution was assumed for parameter *a* and a uniform distribution for parameters *b* and *c*: $a \sim Gamma(10^{-3}, 10^{-3})$; *b* and $c \sim Uniform(0,1)$; $\sigma^2 \sim Gamma(10^{-3},10^{-3})$ as Open BUGS parameterization.

To evaluate the total milk yield (kg), it was assumed that the response (Y_{ij}) had a normal distribution, i.e. $Y_{ij} \sim N(\mu_j,\sigma_j^2)$, $i = 1, 2, ...$ for the j-th levels of treatment. For each μ_j and σ_j^2 non-informative *Priors* were considered, respectively, $\mu_j \sim N(0,10^{-6})$ and $\sigma_j^2 \sim Gamma(10^{-3},10^{-3})$ as Open BUGS parameterization.

The model used to evaluate the total milk yield was as follows:

$$Y_{ij} = \mu + \alpha_i + e_{ij},$$

in which Y_{ij} = total milk yield of animal i at treatment j; µ = constant inherent in every observation; α_j = treatment effect j; j = 1, 2, 3 (0% SBH, 50% SBH, and 100% SBH); e_{ij} = random error associated with each observation.

The multiple comparison procedure was based on the *a posteriori* samples of the estimates of the parameters. Significant differences were considered at the level of 5% among the treatments if the zero value was not contained in the credibility interval of the desired contrast. The marginal posterior distributions for all parameters were taken by R software (R Development Core Team, 2015)

using the BRugs package. For each parameter, 1,100,000 values were generated in an MCMC (Monte Carlo Markov Chain) process, considering a sample discard period of 100,000 initial values. The final sample was taken with steps of 100, which means that for every 100 values taken, one was included in the sample, with 10,000 values generated. The convergence of the final chains was checked using the test described by Heidelberger and Welch (1983) and the R software by CODA package.

Body weight, dry matter intake, and milk composition were assumed as a normal distribution and all frequentist premises were attended for MANOVA (Multivariate Analysis of Variance), depending on the level of SBH as a corn ground replacement (0% SBH, 50% SBH, and 100% SBH); lactation stages (beginning, middle, and end) were statistically analysed by MANOVA through a Pillai Trace test; and multiple comparisons were made using the Bonferroni test at the 5% level of significance according to the model:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \alpha_i\beta_j + e_{ij},$$

in which Y_{ij} = the vector of multivariate responses; μ = general constant; α_i = effect of diets i; β_j = effect of lactation stage j; and e_{ij} = random error.

Results

The addition of SBH as a corn ground replacement to the diet of Saanen goats had no effect on initial milk yield (parameters a); however, the increased rate of yield until lactation peak (parameters b) and the declined rate of yield after lactation peak (parameters c) decreased due to the increased inclusion of SBH (Figure 1 and Table 2).
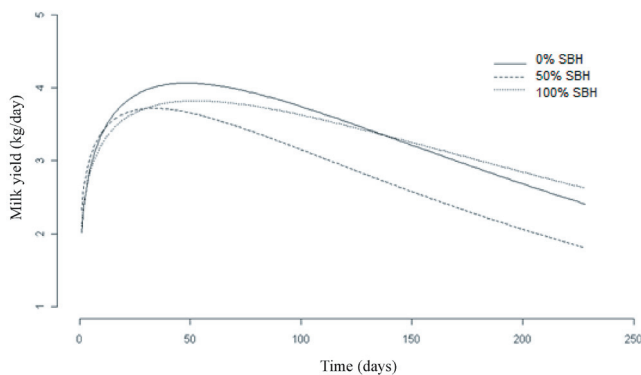
The goats that received diets with SBH as a corn ground replacement had changes in the increase and decline rates of milk yield; however, no effect on total milk yield was observed (Table 3).

Body weight was affected by treatments. Goats fed 50% SBH showed higher body weight (P<0.05) due to the higher milk yield from other treatments. Body weight was not affected by the lactation stage. The addition of SBH as a corn ground replacement for Saanen goats had no effect on dry matter intake (P<0.05).

When observing the major classes of fatty acids in milk, there was an effect on polyunsaturated fatty acids (PUFA), on PUFA:total FA, and n-6:n-3, while the lactation stage affected the content of saturated FA, monounsaturated, and conjugated linoleic acid (18: 2) (Table 5).

Table 2 - Values of Wood's nonlinear model parameters with their credibility intervals ($p_{2.5\%}$ - $p_{97.5\%}$), in level of 95%, for Saanen goats receiving diets with soybean hulls

Treatment[1]	Parameter[2]	Mean	SE	Median	$P_{2.5\%}$	$P_{97.5\%}$
0% SBH		2.0270	0.1400	2.0250	1.7610	2.3080
50% SBH	a	2.3370	0.1335	2.3370	2.0840	2.6000
100% SBH		2.1130	0.2423	2.1020	1.6650	2.6160
0% SBH		0.2417a	0.0222	0.2412	0.1996	0.2860
50% SBH	b	0.1851b	0.0190	0.1847	0.1493	0.2222
100% SBH		0.2002ab	0.0365	0.2004	0.1297	0.2733
0% SBH		0.0050ab	0.0003	0.0050	0.0044	0.0056
50% SBH	c	0.0055a	0.0003	0.0055	0.0049	0.0061
100% SBH		0.0038b	0.0005	0.0038	0.0028	0.0048
0% SBH		48.2900b	2.1260	48.3200	44.0100	52.3500
50% SBH	dpp	33.4100b	2.0090	33.4300	29.3600	37.1800
100% SBH		52.2400a	4.6350	52.3500	42.7200	61.1000
0% SBH		4.0560a	0.0478	4.0560	3.9620	4.1490
50% SBH	pp	3.7150b	0.0437	3.7150	3.6290	3.8010
100% SBH		3.8000b	0.0782	3.7990	3.6470	3.9540
0% SBH		6.5800a	0.0571	6.5790	6.4720	6.6930
50% SBH	s	6.1610b	0.0511	6.1600	6.0610	6.2620
100% SBH		6.6900a	0.0938	6.6880	6.5080	6.8800

[1] Level of soybean hulls (SBH) as a corn ground replacement.
[2] Wood's model parameters: a - initial milk yield; b - increase rate of yield until lactation peak; c - decline rate of yield in the after lactation peak; dpp - time of peak yield; pp - peak yield; and s - lactation persistence.
SE - standard error of the mean.
Different letters among diets indicate differences for means.

Level of soybean hulls (SBH) as a corn ground replacement (0, 50, and 100% SBH).

Figure 1 - Lactation curves adjusted for Saanen goats receiving diets with soybean hulls.

Table 3 - Total milk yield (kg) calculated from the Wood's nonlinear model parameters with their credibility intervals ($p_{2.5\%}$ - $p_{97.5\%}$), in level of 95%, for Saanen goats receiving diets with soybean hulls

Treatments[1]	Mean	SE	Median	$P_{2.5\%}$	$P_{97.5\%}$
0% SBH	751.70	170.50	763.30	383.50	1040.00
50% SBH	651.50	106.20	654.20	431.50	855.20
100% SBH	720.50	210.90	727.60	272.10	1122.00

[1] Level of soybean hulls (SBH) as a corn ground replacement.
SE - standard error of the mean.

Discussion

By evaluating the lactation curves of Saanen goats through Wood's nonlinear model, Takma et al. (2009) showed that the increased rate of yield until lactation peak was 0.13 and Gomes et al. (2014) showed a range from 0.03 to 0.13. Nevertheless, in this research, the rate of yield increased from 0.18 to 0.24, which agrees with Zambom et al. (2005), who found values ranging from 0.10 to 0.27, and Tufarelli et al. (2009), whose values ranged from 0.21 to 0.29 for the increased rate of yield until lactation peak. The largest values in this research may be related to animal genetics, intake of dry matter, or diet compositions.

The lactation peak has a negative correlation with lactation persistency and, therefore, animals with greater persistency tend to have a less pronounced lactation peak (Guimarães et al., 2006). Goats receiving diets with 50% SBH as a corn ground replacement showed an increased effect on the declined rate of yield after the lactation peak and a decrease in peak yield, which resulted in lower lactation persistency.

The higher increased rate of yield until lactation peak resulted in higher yield at peak for goats receiving diets without SBH (0% SBH), which may be explained by the energy level of diets. However, this effect did not influence the total milk yield (Table 3).

The addition of SBH in the diet of goats decreased diet energy, but did not influence total milk yield. This shows the potential of using SBH to replace ground corn in goat diets. Goats fed a diet with low energy level maintained the same milk yield that goats fed a diet with high energy level. Probably, the mobilization of body fat was greater for goats fed low energy diets to maintain the same production level of other goats.

The goat lactation peak occurred at 48 days with a milk yield of 2.65 kg/day. Zambom et al. (2005) fed goats diets containing 419 g/kg NDF, 153 g/kg CP, and 817 g/kg total digestible nutrients, and showed the lactation peak (calculated by nonlinear Wood's model) at 47 days close to the values found in the present study, however with a greater milk yield (3.35 kg/day) than the one found in the present research. According to AFRC (1993), the lactation peak of Saanen goats is approximately 45 days. It is noteworthy that the nutritional requirements in this study were according to AFRC (1993) for Saanen goats with body weights of 60 kg and a milk yield of 3.0 kg per day, and that the data obtained in this study was thus similar to that predicted by this nutrition council.

Table 4 - Body weight, dry matter intake, and milk composition for Saanen goats receiving diets with soybean hulls

	Treatment[1]			Lactation stage		
	0% SBH	50% SBH	100% SBH	Beginning	Middle	End
Body weight (kg)	74.13ab	81.87a	72.47b	72.28	76.99	79.20
Dry matter intake (kg/day)	2.43	2.19	2.49	2.36	2.55	2.21
Milk composition (%)						
Fat	3.11b	3.26a	3.62a	3.24b	3.11b	3.64a
Protein	2.87	2.93	2.83	2.88	2.83	2.91
Lactose	4.35	4.16	4.17	4.35	4.21	4.12
Total solids	11.20	11.20	11.48	11.37	11.05	11.45
Somatic cell count (log 10)	2.90	3.17	2.94	2.85	3.05	3.11
Urea nitrogen (mg/dL)	19.00b	17.69b	23.29a	15.46b	23.27a	21.24a

[1] Level of soybean hulls (SBH) as a corn ground replacement.
a,b,c - Different letters indicate differences in the 5% level of significance after Pillai trace by Bonferroni test.
Note: There was no interaction effect; it was therefore removed from the model.

Table 5 - Fatty acids (FA) in milk for Saanen goats receiving diets with soybean hulls

g/100 g of fatty acids	Treatment[1]			Lactation stage		
	0% SBH	50% SBH	100% SBH	Beginning	Middle	End
Short and medium-chain	20.49	20.97	20.95	19.99	20.91	21.51
Long-chain	77.17	77.25	77.41	78.05	77.31	76.47
Saturated FA	66.04	67.83	68.98	65.30b	70.60a	66.95ab
Monounsaturated FA	39.50	38.77	37.45	39.88a	36.62b	39.23ab
Polyunsaturated FA (PUFA)	3.71a	3.21b	3.56a	3.57	3.36	3.55
PUFA/total FA	0.056a	0.048b	0.052ab	0.055	0.048	0.053
Conjugated linoleic acid	0.50	0.47	0.54	0.42b	0.50ab	0.59a
n-6:n-3	12.82a	12.23a	6.60b	12.52	11.23	7.88

[1] Level of soybean hulls (SBH) as a corn ground replacement.
a,b,c - Different letters indicate differences in the 5% level of significance after Pillai trace by Bonferroni test.
Note: There was no interaction effect; it was therefore removed from the model.

The milk yield at the beginning of lactation (2.16 kg/day) and at the peak (3.86 kg/day) was lower than reports of other studies for Saanen goats under tropical climate conditions, as mentioned by Gomes et al. (2014) and Souza et al. (2014), and close to that reported by Macedo et al. (2001) and Zambom et al. (2005). These differences must be due to the variations in the ingredients and compositions of diets.

The addition of SBH to the diet increased the milk fat content, which is probably a result of the higher NDF in the feed (SBH 607 g/kg of NDF), which in turn promotes an increase in ruminal acetate (Zambom et al., 2007). Zervas et al. (1998), studying lactating sheep, and Ipharraguerre et al. (2002) and Hindrichsen et al. (2006), studying dairy cows, found no differences in dry matter intake and milk yield for animals receiving SBH. However, these authors identified a quadratic effect on the milk fat content when SBH was added to the diet.

Evaluation of the influence of lactation stage on milk quality demonstrated that there was difference across the months in milk fat content. This is explained by the dilution effect: the lower milk yield results in a higher concentration of fat content. However, that increase in milk fat content may result in an increase in profit margins for each litre of milk marketed when payment is made by quality.

Milk urea or milk urea nitrogen (urea × 0.466) is an indicator of an adequate protein diet and, thus, is directly related to dietary protein content and energy intake and the interaction between these factors. The recommended milk urea nitrogen ranges from 8 to 14 mg/dL (17 to 30 mg/dL of urea); lower values of milk urea nitrogen indicate a deficiency of protein in the diet and higher values indicate excessive protein in the diet. As soybean hulls increased in the diet, the milk urea content also increased due to the SBH inclusion, which increased the protein content of the diet (Table 1), or the rumen synchronization between protein and carbohydrates, since the SBH have a lower amount of soluble carbohydrates than the ground corn (Goes et al., 2008). Goats at the beginning of lactation showed 15.46 mg/dL milk urea, which indicates protein use efficiency during the beginning of lactation, highlighting the importance of adjusting dietary protein content throughout each lactation stage.

The differences in concentrations of FA in milk may be associated with several factors, such as food processing, physiological stage, breed, and interaction among factors. Changes in the FA in milk are therefore commonly reported in the literature. When observing the major classes of FA in milk, there was an effect on PUFA, PUFA:total FA, and n-6:n-3, while the lactation stage affected the content of saturated FA, monounsaturated, and conjugated linoleic acid, (18: 2) (Table 5).

The changes observed in FA in the milk shows that the inclusion of SBH affects the *de novo* synthesis of some FA. The SBH may have influenced the production of acetate and beta-hydroxybutyrate, both precursors of FA via the *de novo* synthesis by the epithelial cells of the mammary gland (Palmquist et al., 1993). The value of 18:2 (conjugated linoleic acid) was close to that achieved by Lock and Garnsworthy (2003), which was 0.55 g/100 g total lipid in cow milk.

Nowadays, in studies evaluating the influence of FA intake with human health, suitable intake levels of FA n-6, n-3, and n-6:n-3 are noted. According to Holman (1998) and Simopoulos et al. (1999), diets must provide a n-6:n-3 ratio of 4:1 or 5:1. Goats receiving the 100%SBH diet showed an n-6:n-3 ratio close to that recommended in the literature. Ground corn replacement by SBH can thus be one strategy to improve milk quality.

Conclusions

This experiment demonstrates that soybean hulls can be used in diets as a ground corn replacement for lactating goats. Although there are changes in curve parameters, they do not result in changes in total milk yield.

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