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Tifton 85 bermudagrass (*Cynodon sp.*) silage as a replacement for Tifton 85 hay to feed lactating cows

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ABSTRACT - The objective of the study was to evaluate the replacement of Tifton 85 hay (TH) for Tifton 85 silage (TS) in the diets of lactating cows. Five Holstein cows in middle of lactation were allocated in a 5 × 5 Latin square design and each experimental period lasted 18 days (12 days for adaptation and six days for collection). Treatments consisted of replacement of 0, 25, 50, 75, and 100% of TH for TS. The intake and digestion of nutrients, microbial protein synthesis, milk yield and composition, and the economic viability of the diets were evaluated. The intakes of dry matter, organic matter, and ether extract had a positive linear effect and the digestibility of dry matter, organic matter, crude protein, neutral detergent fiber, acid detergent fiber decreased linearly with increasing participation of TS. Milk production and composition and microbial protein synthesis were not affected. Regarding economic viability, the treatment with 100% hay produced better results, with better gross margin. The Tifton 85 silage can be used as a replacement for Tifton 85 hay up to 100% without changing the milk production and composition of Holstein cows.

Key Words: digestibility, forage conservation, intake, milk composition

Introduction

The utilization of conserved forages is important for the supply of nutrients during feed shortage periods (Martins et al., 2006) such as droughts, excessive rainfall, or frost. Among these sources of roughage, grasses of the *Cynodon* genus are highlighted, which are widely used due to their good dry matter (DM) production and high nutritional value. Tifton 85 (*Cynodon* spp.) is a hybrid strain of bermudagrass selected from the cross of Tifton 68 grass (*Cynodon nlemfuensis* Vanderyst) with an introduction from South Africa, registered as PI 290884 (*Cynodon dactylon* [L.] Pers) (Burton et al., 1993). This cultivar presents a rapid growth rate and good digestibility (Castro et al., 2010), as well as thin stems and, thus, can be used for production of hay and silage (Souza et al., 2006).

The silage is an alternative that makes the harvest of this feed more flexible, when the climate conditions, as frequent rains or high humidity, do not allow hay production, avoiding the harvest of forages with advanced stages of maturity (Evangelista et al., 2000). However, there are still few studies developed for the purpose of ensiling this genus (Bumbieris Junior et al., 2007). Different forage conservation methods, such as haymaking and ensiling, can change the nutritional value of the forage, which exert influence on parameters such as chemical composition, intake (Halmemies-Beauchet-Filleau et al., 2013b), and nutrient digestibility (Shingfield et al. 2002; Jobim et al., 2007). The objective of this study was to evaluate the effects of increasing levels of Tifton 85 bermudagrass silage (TS) as a replacement for Tifton 85 hay (TH) for lactating Holstein cows.

Material and Methods

The experiment was conducted in Marechal Cândido Rondon, PR, Brazil (24°31'55.3" S latitude, 54°01'08.0" W longitude, and 392 m altitude). The animal experimentation protocol was approved by the local Ethics Committee on Animal Use (case no. 16/14).

The area for roughage harvest was on a glebe of 1.6 ha established with Tifton 85 (*Cynodon sp.*). The roughage was harvested to 5 cm above the soil, with a shredder

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coupled to the tractor. Firstly, TH was produced with 54 days of regrowth, with estimated yield of 3400 kg DM ha^{-1}. In the next harvest, the ensiling of the material was carried out, with 50 days of regrowth, with estimated yield of approximately 2950 kg DM ha^{-1}.

To TH production, the material was dehydrated in the sun until it reached approximately 804 g kg DM^{-1} (Table 1); then, it was packed in rectangular bales of 12 kg and stored in covered installations. For animal feeding, it was chopped to a size of approximately 5 cm in a stationary chipper attached to the tractor.

For the silage production, the roughage was harvested and pre-wilted in the sun, reaching approximately 370 g kg^{-1} of DM; the material was crushed to a size of approximately 5 cm and inoculant dissolved in water was applied at the time of shredding. The inoculum used was composed of *Lactobacillus plantarum* with guaranteed levels from the manufacturer of 4.0×10^{10} log cfu g^{-1}, *Pediococcus acidilatici* with 1.0×10^{10} log cfu g^{-1}, and cellulase, used in the proportion of 2 g per ton of fresh roughage. Silage was stored in a trench silo covered with a plastic sheet with the black color facing the internal side and the white color facing the external side of the silo and with a 1-cm layer of soil and tiles as ballast. The silo was opened after 90 days of storage.

Five Holstein cows with 83±18.4 days in milk, average body weight (BW) of 604±53.0 kg (mean ± standard deviation), and an average initial milk yield of 23.5±2.92 kg day^{-1} were distributed in a 5 × 5 Latin square design. The experiment lasted 90 days and consisted of five experimental periods of 18 days (12 for animal adaptation and six for data and sample collection). The animals were subjected to a period of 10 days before the experiment of adaptation to the management and barn. The treatments were levels of 0, 25, 50, 75, and 100% replacement of Tifton hay (TH) for Tifton silage (TS). Diets were formulated according to NRC (2001) to meet the maintenance and production requirements of the cows. The roughage:concentrate ratio was 50:50 for all treatments to meet the energy requirement of the animals (Table 2).

The animals were housed in a covered barn-type tie-stall, with individual troughs for measuring feed intake. Feed was provided in TMR (total mixed ratio) twice daily (08:30 and 17:00 h) in the ratios of 70 and 30% of offered DM, respectively. The refusals in the trough were weighed and adjusted to provide remains between 5 and 10% of offered feed. Milking was held twice a day at 08:00 and 16:30 h. The weighing of animals was performed at the beginning and at the end of each period before the morning feed and after morning milking.

From days 13 to 18 in each period, individual dry matter intake was measured by weighing the amount of feed offered and refusals. Daily samples of feed provided and the refusals were collected and stored for further analysis. In each period, feces samples in an amount of 165 g were collected directly from the rectum in the following schedule: day 13 (07:50 h), day 14 (10:00 h), day 15 (12:00 h), day 16 (14:00 h), day 17 (15:50 h), and day 18 (18:00 h); on days 13 and 17, the collections were carried

Table 1 - Chemical composition, *in vitro* digestibility of dry matter (IVDDM), and protein and carbohydrate fractionation of ingredients (g kg^{-1} of DM)

Composition	Tifton 85 silage	Tifton 85 hay	Ground corn	Soybean meal
Composition and *in vitro* digestibility (g kg^{-1} DM)				
Dry matter	366	804	872	874
Organic matter	910	919	986	932
Ether extract	24.6	14.3	35.9	8.75
Crude protein	127	124	94.0	542
Neutral detergent fiber	710	770	131	166
Acid detergent fiber	388	377	48.3	113
Lignin	53.3	55.0	23.3	26.7
IVDDM	643	672	937	945
Fractionation of protein (g kg^{-1} CP)				
Fraction A	626	369	228	169
Fraction B_1	24.0	15.0	43.0	77.6
Fraction B_2	138	155	607	676
Fraction B_3	123	397	70.0	35.3
Fraction C	89.0	64.0	52.0	42.1
Fractionation of carbohydrates (g kg^{-1} of total carbohydrates)				
Fraction A+B_1	132	118	880	658
Fraction B_2	699	713	54.8	174
Fraction C	169	169	65.2	168

DM - dry matter; CP - crude protein.

Table 2 - Ingredients and chemical composition of experimental diets (g kg^{-1} of dry matter)

Ingredient	Utilization level of Tifton 85 silage				
	0%	25%	50%	75%	100%
Tifton 85 hay	500	375	250	125	0
Tifton 85 silage	0	125	250	375	500
Ground corn	377	380	383	386	392
Soybean meal	106	103	100	97.0	94.0
Mineral mix[1]	10.0	10.0	10.0	10.0	9.80
Calcium limestone	7.00	7.00	7.00	7.00	1.90
Dicalcium phosphate	-	-	-	-	2.30
Chemical composition					
Dry matter	840	785	731	676	621
Organic matter	934	933	932	932	932
Ether extract	22.5	23.7	25.0	26.4	28.8
Crude protein	153	153	150	150	152
Neutral detergent fiber	456	447	441	429	425
Acid detergent fiber	215	213	216	218	216

[1] Mineral mix (chemical composition): Ca, 166 g kg^{-1}; P, 80 g kg^{-1}; Na, 118 g kg^{-1}; Fe, 2680 mg kg^{-1}; Cu, 805 mg kg^{-1}; Mn, 2300 mg kg^{-1}; Zn, 4100 mg kg^{-1}; Co, 150 mg kg^{-1}; I, 150 mg kg^{-1}; Se, 20 mg kg^{-1}; F, 800 mg kg^{-1}; Cr, 10 mg kg^{-1}.

out 10 min before the other days, to not coincide with the milking time. Subsequently, the samples were dried in a forced-air oven (55 °C, 72 h), ground to 1-mm sieve screen. A pool consisting of samples of each feed, refusals, and feces resulting in a single sample per animal per period was performed.

The samples were analyzed according to AOAC (1990) methodology for DM (method 934.01), ash (method 938.08), crude protein (CP; method 981.10), ether extract (method 920.85), and the determination of neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to Van Soest et al. (1991). The amounts of organic matter (OM) were calculated as the difference between ash content and total DM. The total digestible nutrient (TDN) intake was calculated according to equations proposed by Sniffen et al. (1992): TDN = DCP + 2.25 DEE + TCD, in which DCP = digestible crude protein, 2.25 = correction factor, DEE = digestible ether extract, and TCD = total digestible carbohydrates.

To estimate daily fecal excretion, the indigestible neutral detergent fiber (iNDF) was used as an internal indicator. The iNDF was determined in samples of offered feed, refusals, and feces, which were incubated (by the *in situ*/*in sacco* method) for 240 h, as described by Casali et al. (2008).

Daily milk production (MP) of cows was recorded in the data collection period, using gauges attached to the milking equipment. The fat corrected milk (FCM) to 35 g kg^{-1} was calculated by the equation described by Sklan et al. (1992): FCM = (0.432 + 0.1625 × F) × kg of milk, in which F = % milk fat. The milk samples were collected on days 13 and 14 of each period, which were composed proportionally by morning and afternoon milking. The samples were packed in polyethylene bottles containing Bromopol® preservative (2-bromo-2-nitropopano-1,3-diol). For chemical analysis, the milk samples were mailed to laboratory and analyzed for fat, protein, lactose, milk urea nitrogen (MUN), and total solid content by infrared spectroscopy (Bentley model 2000; Bentley Instrument Inc., Chaska, MN) (IDF, 2000). The milk production efficiency (MPE) was computed for each cow, dividing the average of milk production by the average of DM intake of each data collection period.

The milk samples intended for allantoin analysis were deproteinized using 5 mL of 25% trichloroacetic acid, filtered through qualitative filter paper, and stored at −20 °C. Subsequently, the filtrate was used for allantoin determination by the method of Chen and Gomes (1992).

For microbial synthesis measurement, spot urine samples were taken approximately 4 h after the morning feeding on day 14 of the trial period. An aliquot of 10 mL of urine was separated and diluted with 40 mL of sulfuric acid (0.036 N) that was intended for quantification of urinary creatinine, allantoin, and uric acid concentrations by a colorimetric method. The average daily excretion of creatinine, in amount of 24.05 mg kg^{-1} BW (Chizzotti et al., 2007), enabled the estimation of the daily production of urine. Excretion of total purine was estimated by the sum of the amounts of allantoin excreted in urine and milk and uric acid excreted in urine. The absorbed microbial purine was estimated by using the equation proposed by Verbic et al. (1990): PA (mmol/day) = TP – (0.385 × $BW^{0.75}$)/0.85, in which PA = purines absorbed, TP = total proteins, and $BW^{0.75}$ = metabolic weight. The protein microbial flow (g day^{-1}) was estimated from the equation of Chen and Gomes (1992): MN (g day^{-1}) = (70 × PA)/(0.83 × 0.116 × 1000), in which MN = microbial nitrogen.

For the economic analysis of diets, the production cost calculations used were only those relating to animal diets between May and August of 2014. The average dollar value for this period was R$ 2.24. To make hay and silage, an outside labor service provider was hired and to estimate the costs with TH and TS, the costs with fertilizing, labor, and fuel were taken into account. The price paid for liter of milk was US$ 0.49; Tifton 85 silage cost US$ 0.08 per kg of DM; Tifton 85 hay, US$ 0.11 per kg of DM; soybean meal, US$ 0.57 kg of DM; corn grain, US$ 0.24 kg of DM; mineral supplement, US$ 1.17 kg of DM; calcium limestone, US$ 0.09 kg of DM; and dicalcium phosphate, US$ 0.96 kg of DM.

The cost per kg of feed (US$ kg^{-1} DM) was calculated from the proximate composition of the diets. The average cost of feed was obtained by multiplying the average feed cost by the average intake of the total diet of the animals in each treatment. Gross margin was calculated as the difference between gross income and the average feed cost. The equilibrium point was calculated by dividing the ration cost by the value of liter of milk. The equilibrium point shows the exact production volume when there is zero return, i.e., when the gross revenue is equal to the feed cost.

The data were analyzed as a 5 × 5 Latin square design using the MIXED procedure of SAS (Statistical Analysis System, version 9.2). The mathematical model used was:

$$\gamma_{ijk} = \mu + \tau_i + p_j + c_k + e_{ijk},$$

in which γ_{ijk} = observation, μ = population mean, τ_i = diet effect (i = 1 to 5), p_j = period effect (j = 1 to 5), c_k = cow effect (k = 1 to 5), and e_{ijk} = residual error. The effects of increasing TS participation were evaluated by orthogonal polynomials testing linear and quadratic effects. Significance was declared at P≤0.05.

Results

The replacement of hay (TH) for TS promoted a quadratic effect on BW of the animals (P<0.05) (Table 3). The dry matter intake (DMI), expressed in g kg^{-1} day^{-1}, presented a quadratic effect as a function of the hay replacement level for silage; however, when expressed in kg day^{-1} and metabolic weight (MW), the DMI increased linearly (P<0.05) with the increasing levels of TS (Table 3). Organic matter, EE, and CP intakes showed a positive linear effect (P<0.05). The ADF intake was not affected (P>0.05) by increasing levels of TS.

Dry matter, OM, CP, NDF, and ADF digestibility decreased linearly (P<0.05) with increasing levels of TS (Table 4). Daily production of microbial CP and microbial synthesis efficiency were not affected (P>0.05) by replacement of TH for TS.

Milk production and 3.5% FCM were not changed (P>0.05) by replacing TH by TS and showed mean values of 23.9 and 24.8 kg day^{-1}, respectively (Table 5). For milk production efficiency (MPE), there was a linear decrease (P<0.05) with increasing TS levels. Milk fat, protein, lactose, and total solids were not influenced (P>0.05) by treatments. Milk urea nitrogen content decreased linearly (P<0.05) with increasing TS levels.

Regarding the economic evaluation (Table 6), treatment with 100% hay achieved a better gross margin. The equilibrium point also was the lowest for treatment with

Table 3 - Body weight and daily intake of dry matter and nutrients of Holstein cows fed diets replacing Tifton 85 hay by Tifton 85 silage

Variable	Tifton 85 silage level in roughage					P-value		SEM
	0%	25%	50%	75%	100%	L	Q	
BW (kg)[1]	617	601	604	623	620	0.113	0.018	8.45
DMI (kg day^{-1})[2]	17.8	19.2	18.7	19.4	19.8	0.019	0.198	0.79
DMI (g kg^{-1} day^{-1})[3]	29.2	31.9	31.1	31.2	32.0	0.056	0.029	1.21
DMI (g $kg^{-0.75}$ day^{-1})[4]	145	158	154	156	159	0.042	0.048	6.03
OMI (kg day^{-1})[5]	16.7	17.9	17.5	18.1	18.5	0.017	0.214	0.71
EEI (kg day^{-1})[6]	0.42	0.47	0.48	0.53	0.59	<0.001	0.416	0.02
CPI (kg day^{-1})[7]	2.80	3.02	2.87	2.99	3.10	0.017	0.599	0.11
NDFI (kg day^{-1})	7.48	7.95	7.68	7.54	7.82	0.744	0.202	0.40
NDFI (g kg^{-1} day^{-1})	12.3	13.2	12.8	12.2	12.6	0.796	0.056	0.65
NDFI (g $kg^{-0.75}$ day^{-1})	61.0	65.5	63.2	60.7	63.0	0.899	0.079	3.24
ADFI (kg day^{-1})	3.54	3.79	3.68	3.69	3.86	0.277	0.244	0.23
TDNI (kg day^{-1})	11.4	12.1	11.9	12.0	12.0	0.124	0.051	0.38

BW - body weight; DMI - dry matter intake; OMI - organic matter intake; EEI - ether extract intake; CPI - crude protein intake; NDFI - neutral detergent fiber intake; ADFI - acid detergent fiber intake; TDNI - total digestible nutrient intake; L - linear; Q - quadratic; SEM - standard error of the mean.
[1] $\hat{Y} = 613.4400 - 0.3648x + 0.0048x^2$.
[2] $\hat{Y} = 18.126 + 0.0168x$.
[3] $\hat{Y} = 29.6574 + 0.0531x - 0.0003x^2$.
[4] $\hat{Y} = 149.9909 + 0.0588x$.
[5] $\hat{Y} = 16.940 + 0.0155x$.
[6] $\hat{Y} = 0.4171 + 0.0016x$.
[7] $\hat{Y} = 2.8432 + 0.0023x$.

Table 4 - Apparent dry matter and nutrient digestibility (g kg^{-1}) and microbial protein synthesis of Holstein cows fed diets replacing Tifton 85 hay by Tifton 85 silage

Variable	Tifton 85 silage level in roughage					P-value		SEM
	0%	25%	50%	75%	100%	L	Q	
	Apparent digestibility (g kg^{-1})							
Dry matter[1]	648	634	638	624	604	0.028	0.511	20.81
Organic matter[2]	668	654	657	643	627	0.027	0.609	19.29
Ether extract	668	641	652	659	693	0.532	0.262	44.61
Crude protein[3]	635	641	618	603	591	0.004	0.408	21.77
Neutral detergent fiber[4]	533	492	492	456	442	0.004	0.866	27.66
Acid detergent fiber[5]	503	411	453	385	383	0.001	0.461	27.56
	Microbial protein synthesis (g day^{-1})							
Microbial protein	1843	1913	1894	1747	1700	0.265	0.473	166.7
Microbial protein kg^{-1} TDN	162	162	161	149	141	0.077	0.343	12.86

L - linear; Q - quadratic; TDN - total digestible nutrients.
[1] $\hat{Y} = 648.840 - 0.3909x$.
[2] $\hat{Y} = 668.318 - 0.3745x$.
[3] $\hat{Y} = 642.7526 - 0.5025x$.
[4] $\hat{Y} = 526.4468 - 0.8665x$.
[5] $\hat{Y} = 480.1918 - 1.0614x$.

100% of Tifton hay: 8.00 kg of milk per day was necessary to cover the cost of feed.

Discussion

The lowest DM intake in hay treatment as a forage source (0%) may have occurred due to the higher NDF content of hay, which was 60 g kg^{-1} of DM, higher than that of silage (Table 1). Furthermore, the use of roughage with a lower water content can be limited by the amount of saliva necessary for its moistening and subsequent swallowing (Luginbuhl et al., 2000).

There was an increase in OM and CP intake with increasing levels of silage due to increased DM intake. Moreira et al. (2001) evaluated coastcross (*Cynodon dactylon* L. Pers) hay for lactating cows and observed a protein intake of 2.79 kg per day, corroborating the values obtained in this study for treatment with hay (2.80 kg CP day^{-1}). The increase of ether extract intake with increasing levels of TS occurred due to the higher contents of this nutrient in silage (24.6 g kg^{-1}) in relation to hay (14.3 g kg^{-1}) (Table 1) and was also influenced by the increase of DMI.

With respect to NDF intake, Mertens (1994) suggested that dietary NDF levels did not interfere with the production of cows in mid lactation, when the maximum daily intake of NDF did not exceed 12.0 g kg^{-1} day^{-1} of BW. In the present study, average values of 12.3 g kg^{-1} day^{-1} of BW were found, corroborating those reported by this author.

The TDN intake was not altered with TS inclusion; the highest DMI with TS may have compensated the lower digestibility of this feed. A probable cause of the reduction in digestibility may have been the increased passage rate caused by higher DMI with increasing TS levels. This higher feed passage rate through the gastrointestinal tract means a lower retention time of the food in the rumen, which reduces the time of action of the ruminal microorganisms on the nutrients, and consequently, its degradation (Morais et al. 2007).

The CP digestibility was lower with increasing levels of silage, which is undesirable; this reduction is associated with the occurrence of Maillard reactions in silage due to mass heating. This fact can be confirmed by observing the levels of the fraction C of the protein fractionation that corresponded to 64.0 g kg^{-1} of total CP for TH and 89.0 g kg^{-1} of the total CP for TS (Table 1). According to Capuano et al. (2008), the Maillard reaction is a non-enzymatic reaction that occurs in the presence of water, heat, and complex sugars with amino acids, making this protein unavailable.

The digestibility of NDF and ADF were also reduced with increasing levels of silage utilization in relation to

Table 5 - Milk production and composition of Holstein cows fed diets replacing Tifton 85 hay by Tifton 85 silage

Variable	Tifton 85 silage level in roughage					P-value		SEM
	0%	25%	50%	75%	100%	L	Q	
MP (kg day^{-1})	24.3	23.6	23.8	24.0	23.8	0.236	0.272	0.38
FCM (kg day^{-1})	24.7	24.5	24.9	24.9	24.9	0.486	0.619	0.51
MPE[1]	1.37	1.24	1.27	1.26	1.22	0.004	0.018	0.05
Fat (g kg^{-1})	36.0	37.5	37.8	37.0	38.0	0.164	0.106	0.85
Fat (kg day^{-1})	0.87	0.88	0.90	0.90	0.90	0.167	0.837	0.02
Protein (g kg^{-1})	31.0	31.1	31.2	30.7	31.3	0.669	0.547	0.37
Protein (kg day^{-1})	0.75	0.73	0.74	0.74	0.74	0.453	0.512	0.01
Lactose (g kg^{-1})	44.3	44.4	44.1	45.0	44.3	0.656	0.918	0.50
Lactose (kg day^{-1})	1.08	1.05	1.06	1.09	1.06	0.535	0.427	0.02
Total solids (g kg^{-1})	121	123	123	122	123	0.064	0.125	0.94
Total solids (kg day^{-1})	2.93	2.89	2.93	2.95	2.93	0.777	0.659	0.05
MUN (mg dL^{-1})[2]	15.3	14.4	13.9	13.1	12.6	<0.001	0.734	0.64

MP - milk production; FCM - fat corrected milk; MPE - milk production efficiency; MUN - milk urea nitrogen; L - linear; Q - quadratic; SEM - standard error of the mean.
[1] $\hat{Y} = 1.3273 - 0.0011x$.
[2] $\hat{Y} = 15.2176 - 0.0269x$.

Table 6 - Economic analysis of diets for Holstein cows replacing Tifton 85 hay by Tifton 85 silage

Variable	Tifton 85 silage level in roughage				
	0%	25%	50%	75%	100%
Ration cost (US$ kg^{-1} DM)	0.22	0.21	0.21	0.21	0.20
Feed cost (US$ day^{-1})	3.92	4.02	3.93	4.07	3.96
Gross revenue (US$ day^{-1})	11.9	11.6	11.7	11.8	11.7
Gross margin (US$ day^{-1})	7.99	7.54	7.74	7.72	7.70
Equilibrium point (kg of milk day^{-1})	8.00	8.21	8.01	8.30	8.08

DM - dry matter.

hay, influenced by the higher silage intake, which may have influenced the passage rate, reducing the digestibility of this fraction.

The efficiency of microbial protein synthesis was not altered (P>0.05) by treatments, but for all levels tested, the values remained above those established by the NRC (2001) of 130 g of microbial protein kg^{-1} of TDN. The absence of an effect on microbial production indicates that the recycling of nitrogen in the rumen was sufficient to maintain microbial synthesis independent of treatment. According to Santos et al. (2001), when the degradability of dietary protein increases, higher production of ruminal ammonia occurs and, consequently, the excretion of urea nitrogen through milk by incorrect energy for protein ratio. Therefore, the MUN levels obtained in all treatments can be considered as indicative of an adequate nitrogen supply for ruminal microorganisms.

Milk production was not altered by the Tifton 85 conservation method; although DMI was higher with increased levels of TS, the reduction in digestibility was responsible for the lack of changes in these variables. West et al. (1998) also did not observe differences in milk production in kg day^{-1} and FCM when evaluating the effects of Tifton hay and silage in diets.

The reduction in MPE with increasing TS levels is associated with its lower digestibility. The MPE values obtained for the treatment in which only hay was used as roughage was 1.37, a lower value than that observed by Jobim et al. (2002), which was 1.51, also working with Tifton 85 hay as roughage.

Milk composition did not change with the treatments; this result may be related to the use of the same proportions of forage and concentrate in all diets as well as the same forage species. These data corroborate those of Halmemies-Beauchet-Filleau et al. (2013b), who also observed no effect on milk composition when evaluating hay or timothy grass (*Phleum pratense*) silage and meadow fescue (*Festuca pratensis*). Studies comparing the use of hay and silage have demonstrated higher concentrations of ruminal acetate when hay is used (Shingfield et al., 2002; Halmemies-Beauchet-Filleau et al., 2013a), which could provide an increase in milk fat content, although this did not occur in the present study.

The lowest values of MUN may be related to the reduction in protein of microbial ruminal degradation of silage in relation to hay, due to the occurrence of the Maillard reaction. However, despite the undesirable effects of this reaction, diets using silage presented the concentrations of MUN within a range of 10 to 14 mg dL^{-1}, described as adequate by Almeida (2012), while the diet with only hay presented values of 15.3 mg dL^{-1}, indicating a lower synchronization of carbohydrates and proteins.

Regarding the economic evaluation (Table 6), treatment with 100% hay achieved better performance due to higher digestibility and lower intake, presenting the lowest equilibrium point, with 8.00 kg of milk per day required to cover the cost of feed.

Conclusions

Tifton 85 silage can replace Tifton 85 hay up to 100% without changing the milk production and composition of Holstein cows. The increasing participation of Tifton 85 silage reduces the digestibility of diets and the use of Tifton 85 conserved as hay results in higher economic return.

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