Feeding of Sugar Cane Silage to Dairy Cattle during the Dry Season

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ABSTRACT : A study was conducted to determine the effect of feeding sugar cane silage compared to chopped whole sugar cane or grass silage on performances of lactating dairy cows during the dry season. Twenty four Holstein Friesian crossbred (>87.5% Holstein Friesian) lactating dairy cows in mid lactation; averaging 15.4±3.2 kg of milk, 120±23 days in milk, 50.5±6.5 months old and 432±39 kg live weight, were stratified for milk yield, days in milk, age, stage of lactation and body weight, and then randomly allocated to three treatment groups (8 cows in each group). All cows were fed 7.5 kg/d commercial concentrate plus *ad libitum* roughage according to treatment groups, which were grass silage, sugar cane silage or chopped whole sugar cane respectively. All cows consumed similar DM and produced similar milk and milk composition yields. However, cows on grass silage lost more weight than the other cows. The present study indicated that, during the dry season, sugar cane silage can be fed to lactating dairy cows, while giving similar milk yield to grass silage or chopped whole sugar cane. *(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 8 : 1125-1129)*

INTRODUCTION

During the dry season in Thailand, fresh roughage shortage generally occurs. Lactating dairy cows are fed local low quality roughage such as rice straw together with an expensive meal concentrate. Raw milk production cost is increased by this feeding regime. However, there are many types of roughage that can be fed to lactating dairy cows. Sugar cane is widely planted in Thailand for sugar production. This type of sugar cane is cut at more than 10-12 mo. after planting, thus it contains high fiber and low protein content (Kawashima et al., 2002). Some dairy farmers feed this sugar cane as chopped whole sugar cane to their cows during the dry season. There are some studies examining use of younger sugar cane (6-7 months old) to feed lactating dairy cows (Suksombat and Mernkrathoke, 2005). However, the 6-7 months old sugar cane is in the middle of rainy season, the practice is to ensile sugar cane for making silage and use it later during the dry season.

Researches on feeding whole sugar cane and sugar cane silage to lactating dairy cows are very limited. Alvarez and Preston (1976) and Alvarez et al. (1977; 1978) fed whole sugar cane to Brown Swiss×Zebu cross lactating dairy cows together with 500 g/d rice polishing and allowed the cows to graze on *Leucaena leucocephala* pasture 3 h daily. They found a reduction in milk yield and live weight of the cows. This is because when the cows consumed *Leucaena leucocephala* they ate less rice polishing, resulting in decreased milk yield. Recently, Kawashima et al. (2002) fed chopped sugar cane together with rice straw or rice straw

alone as roughage for dairy cattle and found no significant difference in milk yield between the two groups. Suksombat and Mernkrathoke (2005) fed chopped whole sugar cane to lactating dairy cows compared with corn silage and found no significant differences in performance between the two groups. They also found a reduction in final live weight and live weight change of cows on corn silage since cows on chopped whole sugar cane consumed more energy than cows on corn silage. Thus whole sugar cane or sugar cane silage could be fed to lactating dairy cows when roughages are in short supply.

The aim of the present study is to determine the effect of feeding sugar cane silage compared to chopped whole sugar cane or grass silage on performance of lactating dairy cows in mid lactation during the dry season.

MATERIALS AND METHODS

Twenty four Holstein Friesian crossbred (>87.5% Holstein Friesian) lactating dairy cows in mid lactation; averaging 15.4±3.2 kg of milk, 120±23 days in milk, 50.5±6.5 months old and 432±39 kg live weight, were stratified for milk yield, days in milk, age, stage of lactation and body weight, and then randomly allocated to three treatment groups (8 cows in each group). The first group was fed grass silage (GS) together with commercial concentrate, the second group was fed sugar cane silage (SS) plus commercial concentrate and the third group was fed chopped whole sugar cane (CS) plus commercial concentrate. The experiment lasted for 10 weeks (2 weeks for adjustment period and 8 weeks for measurement period).

All cows were individually housed in a 2×3 m² pen and were individually fed 7.5 kg concentrate daily, divided into

Table 1. Chemical and nutrient composition of feeds used in the experiment

Nutrient	CC	GS	SS	CS
DM	95.38	28.23	30.74	37.49
CP	17.10	6.52	6.50	3.68
EE	4.97	2.44	2.32	1.84
Ash	6.95	10.20	4.92	3.37
CF	11.38	23.85	29.15	35.15
ADF	14.62	33.29	42.10	51.44
NDF	40.55	50.42	67.07	77.15
ADL	4.36	5.14	6.41	7.53
ADIN	2.40	0.69	0.72	0.26
NDIN	2.57	0.87	0.87	0.42
TDN_{1X}	70.29	57.68	55.72	52.91
DE_P	2.89	2.45	2.39	2.31
ME_P	2.47	2.02	1.97	1.88
NE_{LP}	1.55	1.23	1.19	1.13
dg of CP	0.81	0.58	0.47	0.44

CC = commercial concentrate; GS = grass silage; SS = sugar cane silage; CS = chopped whole sugar cane; DM = dry matter; CP = crude protein; EE = ether extract; CF = crude fiber; ADF = acid detergent fiber; NDF = neutral detergent fiber; ADL = acid detergent lignin; ADIN = acid detergent insoluble nitrogen; NDIN = neutral detergent insoluble nitrogen; TDN_{1X} = total digestible nutrient at maintenance level; DE_P = digestible energy at production level; ME_P = metabolizable energy at production level; NE_{LP} = net energy for lactation at production level; [1] = estimate recommended by NRC (2001); *dg* = degradability.

three equal meals, at 07.00, 11.30 and 16.30 h. Grass silage, sugar cane silage or chopped whole sugar cane were fed at *ad libitum* amounts. Grass silage was made from fresh cut guinea grass (*Panicum maximum*) at 45 days after regrowth, which was in the stage appropriate for making silage. Sugar cane silage was made from fresh cut whole sugar cane at 6-7 months after regrowth which was ensiled in concrete bunker silo covered with plastic sheet. Whole sugar cane was cut at 10-12 months after regrowth and then chopped into small pieces of approximately 50 mm long before feeding to the cows. Feed consumptions were measured on two consecutive days each week. On the day of measuring feed intake, samples of feed offered and left after eating were taken, dried at 60°C for 36 h, ground through 1 and 2 mm screen and then kept in airtight containers until used. Samples of feed ground through 1 mm sieve were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), crude fiber (CF), acid detergent insoluble nitrogen (ADIN), neutral detergent insoluble nitrogen (NDIN) and ash by the method of AOAC (1990), while acid detergent fiber (ADF), neutral detergent fiber (NDF) and acid detergent lignin (ADL) by the method of detergent analysis (Goering and Van Soest, 1970). Samples of feed ground through 2 mm sieve were used to determine crude protein degradability (Ørskov and McDonald, 1979; Lindberg, 1985).

Four non-lactating dairy cows, ruminally cannulated, were used to study the nylon bag degradation. They were fed, at maintenance level, 6 kg DM of roughage mixed

rations (10% CP, 9 MJME/kgDM), given as two equal meals per day, at 0800 and 1600 h. The rumen degradation value was obtained by weighing approximately 3 g DM of individual sample into each of the nylon bags (80×110 mm; pore size 47 μm, Estal Mono, Switzerland). Bags were suspended in the rumen of each cow prior to the morning feeding. A bag of each sample per feed per animal was incubated in the rumen for 0, 4, 8, 12, 24, 48 and 72 h, and then removed and washed in an automatic washing machine with gentle speed for 15 min., and then dried at 60°C for 36 h. After weighing each bag individually, four bags (one from each feed from each animal) of each sample were pooled to make one representative sample large enough for CP determination.

After chemical and detergent compositions were analyzed, these data were used to calculate energy concentration in the feeds as recommended by NRC (2001) as follows.

TDN_{1X} = total digestible nutrient at maintenance level)
$\quad$ = tdNFC+tdCP+(tdFA×2.25)+tdNDF-7
Where, tdNFC = 0.98 (100-[NDF-NDICP]+CP
$\qquad$ +EE+ Ash]).
$tdCP_f$ (truly digestible CP for forages)
$\quad$ = CP×exp$^{[-1.2×(ADICP/CP)]}$
$tdCP_c$ (truly digestible CP for concentrates)
$\quad$ = [1-(0.4×(ADICP/CP))]×CP
tdFA = FA where FA = EE-1.0 If EE<1 then FA = 0
tdNDF = 0.75 (NDF_N-Lignin) [1-(Lignin/NDF_N)$^{0.667}$]
DE_P = digestible energy at production level
$\quad$ = DE_{1X}×[TDN_{1X}-[(0.18×TDN_{1X})-10.3])
$\qquad$ ×Intake)] /TDN_{1X}
Where DE_{1X} = [(tdNFC/100)×4.2]+[(tdNDF/100)×4.2]
$\qquad$ +[(tdCP/100)×5.6]+[(tdFA/100)×9.4]-0.3
Intake = intake above maintenance
ME_P = metabolizable energy at production level
$\quad$ = [1.01×(DE_p)-0.45]+0.0046×(EE-3)
NE_{LP} = net energy for lactation at production level
$\quad$ = [0.703×ME_p)]-0.19

All cows were milked twice a day at 05.00 and 15.00 h. Milk yields were individually recorded daily. Samples of milk from individual cows were collected on two consecutive days weekly and then subjected to laboratory analysis. Fat, protein, lactose, solid not fat (SNF) and total solid (TS) contents of milk were analyzed by Milko Scan (Foss Electric, Denmark). Live weights of all cows were individually recorded on two consecutive days immediately after morning milking at the start and at the end of the experiment.

All measured data were then subjected to analysis of variance (Steel and Torrie, 1986) using Statistical Analysis

Table 2. Mean values for dry matter, crude protein and net energy consumption of the experimental cows

Intake	GS	SS	CS	Pr>F	SEM
DM (kg/d)					
Concentrate	7.14	7.14	7.14	-	-
Roughage	5.97	5.90	5.55	0.9599	0.74
Total	13.11	13.04	12.69	0.7558	0.55
CP (g/d)					
Concentrate	1,220	1,220	1,220	-	-
Roughage	389[a]	384[a]	204[b]	0.0001	33
Total	1,609[a]	1,604[a]	1,424[b]	0.0001	33
NE_{LP} (Mcal/d)					
Concentrate	11.07	11.14	11.14	-	-
Roughage	7.34[a]	7.02[a]	6.27[b]	0.0001	0.10
Total	18.41[a]	18.09[a]	17.34[b]	0.0001	0.18

Means with different superscripts within rows significantly differed.
GS = grass silage; SS = sugar cane silage; CS = chopped whole sugar cane; DM = dry matter; CP = crude protein; NE_{LP} = net energy of feed at production level; SEM = standard error of the mean.

System (SAS, 1985) procedure of general linear model (GLM). Mean comparison was done using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Grass and sugar cane silages contained high moisture contents (Table 1). The CP and crude fat contents were higher in GS and SS than in CS since both silages were made from younger grass and sugar cane (45 d and 6 mo respectively) compared to chopped whole sugar cane (10-12 mo). Kawashima et al. (2002) reported CP and crude fat contents of whole sugar cane of 2.0 and 0.4% respectively. The lower CP and crude fat contents reported in Kawashima et al. (2002) are due to those sugar canes being cut after they had been grown for more than one year, and were already matured. Ash contents were higher in GS than in SS and CS while CF, ADF, NDF, ADL contents were higher in

CS than in SS and GS. The higher ash content in GS is probably due to the fact that when grasses were cut by forage harvester, it up took some soil from ground level to mix with the grasses. The higher fiber contents in CS is due to the CS being cut at a greater age than GS and SS. Energy values were higher in GS than in SS and CS.

Although all cows consumed similar amounts of concentrate, roughage and total DM (p>0.05), cows on grass silage or sugar cane silage consumed more roughage and total CP (p<0.001), and roughage and total NE_{LP} (p<0.001) than those cows on chopped whole sugar cane (Table 2). The higher consumption of CP and NE_{LP} in cows fed grass silage or sugar cane silage can be attributed to the higher content of CP and NE_{LP} in both silages than in chopped whole sugar cane.

All cows gave similar milk and milk composition yields (Table 3). There also were no significant differences in milk composition between the three groups of cows. All cows showed similar final live weights but cows on SS and CS lost less live weight than cows on GS. Kawashima et al. (2002) fed chopped sugar cane together with rice straw or rice straw alone as roughage for dairy cattle and found no significant difference in milk yield between the two groups. However, they found higher solid-not-fat of cows given chopped sugar cane stalk. Similar result was observed when Suksombat and Mernkrathoke (2005) fed chopped whole sugar cane compared to corn silage.

By combining the data for milk yield and live weight change, it was possible to compare the influence of different roughages on the apparent utilization of NE_{LP} intake (Table 4). The GS and SS cows consumed more NE_{LP} than the CS cows. The partitioning of energy between milk production and live weight change was similar.

All groups of cows had considerable supply of NE_{LP} but the milk yields were lower than would have been predicted

Table 3. Mean performance values of the experimental cows

Intake	GS	SS	CS	Pr>F	SEM
Milk yield (kg/d)	12.47	12.33	12.26	0.9770	1.22
4% FCM (kg/d)	11.85	10.98	10.61	0.7519	1.03
Fat yield (g/d)	461	455	428	0.6753	38
Protein yield (g/d)	308	314	293	0.7235	26
Lactose yield (g/d)	570	551	553	0.8938	44
SNF yield (g/d)	989	977	994	0.7328	89
Total solid yield (g/d)	1,450	1,432	1,421	0.8141	123
% Fat	3.70	3.69	3.49	0.6670	0.27
% Protein	2.47	2.55	2.39	0.3190	0.14
% Lactose	4.57	4.47	4.51	0.5936	0.11
% SNF	7.93	7.92	8.11	0.4822	0.26
% Total solid	11.63	11.61	11.59	0.9948	0.24
Final live weight (kg)	415	430	442	0.3762	23
Body weight change (g/d)	-217[b]	-12[a]	-33[a]	0.0175	8.43

Means with different superscripts within rows significantly differed.
GS = grass silage; SS = sugar cane silage; CS = chopped whole sugar cane.
4% FCM = 4% fat-corrected-milk; SNF = solid-not-fat; SEM = standard error of the mean.

Table 4. Estimates of the partitioning of net energy intake.

	GS	SS	CS	Pr>F	SEM
NE_{LP} intake (Mcal/d)	18.41[a]	18.09[a]	17.34[b]	0.0001	0.18
NE_{LM} (Mcal/d)	7.47	7.56	7.72	0.6248	0.32
NE_{LG} (Mcal/d)	-0.54	-0.03	-0.08	0.9618	0.49
NE_{LL} (Mcal/d)	8.37	8.31	7.93	0.7590	0.74
NE_{LR} (Mcal/d)	15.30	15.84	15.57	0.8591	0.88
Efficiency of energy utilization	0.83	0.88	0.90	0.3462	0.05

Means with different superscripts within rows significantly differed.
GS = grass silage; SS = sugar cane silage; CS = chopped whole sugar cane; NE_{LP}= net energy for lactation at production level; NE_{LM} = net energy requirement for maintenance = $0.08 \times LW^{0.75}$; NE_{LG} = net energy requirement for gain = Reserve energy×(0.64/0.75)); NE_{LL} = net energy requirement for lactation = $0.0929 \times \%$ Fat+$0.0547 \times \%$ CP+$0.0395 \times \%$ Lactose; NE_{LR} = net energy retention; Efficiency of energy utilization = NE_{LR}/NE_{LP} intake, SEM = standard error of the mean.

Table 5. The estimated supply of rumen degradable protein and rumen undegradable protein

	GS	SS	CS	Pr>F	SEM
RDP_{req} (g/d)	1,293	1,269	1,218	0.3168	60
RDP_{sup} (g/d)	1,213[a]	1,164[b]	1,074[c]	0.0001	16
Deficit/surplus	-80	-105	-144	0.2679	49
RUP_{req}	208	375	342	0.6294	92
RUP_{sup}	384[b]	421[a]	357[b]	0.0029	20
Deficit/surplus	+176	+46	+15	0.5029	95

Means with different superscripts within rows significantly differed.
GS = grass silage; SS = sugar cane silage; CS = chopped whole sugar cane; RDP_{req} = rumen degradable protein requirement = 0.15294×TDN Act Total; RDP_{sup} = rumen degradable protein supply = TotalDMFed× 1,000×Diet CP×CP_RDP; RUP_{req} = rumen undegradable protein requirement = TotalCPReq-(MPBact+MPEndo))/DietRUPDigest; RUP_{sup} = rumen undegradable protein supply = CP Toal-RDP $_{sup}$, SEM = standard error of the mean.

from NE_{LP} intakes. The respective intakes of 18.4, 18.1 and 17.3 Mcal daily by the GS, SS and CS cows, in theory, should have been able to produce approximately 17.0, 15.7 and 15.0 kg milk/d. The lower milk yield than that would be expected from NE_{LP} available can be attributable to the probable under estimates of NE_M for dairy cows in the tropics. Since the dairy cows in the tropics were fed lower quality feeds than those cows in the United States, the use of the equation suggested by the NRC (2001) might be inappropriate. AAC (1990) recommended that dairy cattle consuming feeds containing energy lower than 10 MJ ME/kg DM needed more energy for maintenance. The present study used a net energy maintenance value of 0.080 Mcal/kg $BW^{0.75}$ for predicting NE_M. If the hypothesis by AAC (1990) is true, with the assumption that the average net energy values of milk and live weight change are unaffected by the quality of feeds as in case of NE_M, the average net energy maintenance value of 0.106 Mcal/kg $BW^{0.75}$ should be used in this study. This is approximately 32% higher than NRC (2001) recommendation. Before a conclusion can be reached, further research is needed.

Using the protein degradability values of each feed (determined by nylon bag technique), the estimated supplies of RDP and RUP to the cows was calculated (Table 5; NRC, 2001). The cows on GS ration ate more RDP than the cows on SS or CS rations but consumed less RUP than the cows on SS ration. All cows received inadequate RDP but adequate RUP. Feeds of higher CP degradability, such as urea, are needed to increase RDP supply.

The present study clearly shows that chopped whole sugar cane or sugar cane silage can be fed to lactating dairy cows particularly during the shortage of fresh forage. However, the economics of using chopped whole sugar cane or sugar cane silage for dairy cows depends on the costs of sugar cane, harvesting, ensiling and feeding methods, and these factors should be considered before using these feeds.

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