Supplementation of Cassava Hay to Replace Concentrate Use in Lactating Holstein Friesian Crossbreds

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ABSTRACT : Exp. I, the study was conducted to examine the supplementation levels of cassava hay (CH) in dairy cows. Six multiparous Holstein-Friesian crossbreds were paired and randomly assigned in a change-over design to receive three levels of CH supplement at 0, 0.8 and 1.7 kg DM/hd/d. Concentrate was supplemented at the same level (1:2; concentrate:milk yield) while urea-treated (5%) rice straw was offered on *ad libitum* basis. The results revealed that supplementation of CH could significantly reduce concentrate use resulting in similar milk yield (12.5, 12.12 and 12.6 kg/hd/d) and significantly enhanced 3.5% FCM (14.21, 15.70, 14.9 kg/d, respectively). Moreover, CH supplementation significantly increased milk fat and milk protein percentages especially at 1.70 kg/hd/d. Concentrate use could be significantly reduced by 27% at 1.7 kg/hd/d CH supplementation. Exp. II, supplementation of cassava hay to replace concentrate use was studied in lactating-Holstein Friesian crossbreds grazed on Ruzi grass. Six multiparous cows in mid-lactating periods were paired and randomly assiged according to a change-over-design to receive three dietary treatments, T_1=0 kg cassava hay (CH) in 1:2 concentrate supplementation (CS) to milk yield (MY), T_2=1.0 kg DM CH/hd/d in 1:3 CS to MY, T_3=1.7 kg DM CH/hd/d in 1:4 CS to MY, respectively. The results were found that milk yield were similar among treatments while protein, lactose and solids-not-fat percentages were highest ($p<0.05$) in cows receiving CH at 1.0 kg/hd/d. Most significant improvement from CH supplementation was the ability to reduce concentrate use by 42% which could provide a higher income for small-holder dairy farmers. In addition, milk thiocyanate was enhanced from 5.3 to 17.8 ppm ($p<0.05$) in the control and in the CH supplemented group (1.7 kg/hd/d), respectively. Moreover, CH supplementation could significantly reduce concentrate level for diary feeding thus resulted in more economical return. Cassava hay demonstrated as a potential and high-quality on-farm feed resource especially for dry season feeding in the tropics. (***Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 5 : 600-604***)

Key Words : Cassava Hay, Dairy Cattle, Milk Yield and Quality, Concentrate, Tannin-Protein, Milk Thiocyanate, Tropics

INTRODUCTION

Seasonal variation has a great impact on quantity and quality of feeds for ruminants in the tropics. In order to achieve sufficient productivity especially for milk, strategic supplement needs to be given to the ruminants. In the prevailing dairy feeding practice by small-holder dairy farmers in Thailand, high level of concentrate supplementation has been offered, as a consequence high production cost has resulted. Cassava (Manihot esculenta, Crantz) has been shown to be a promising dry season feed especially the whole crop, CH which has high levels of digestibility, protein and high ruminal by-pass protein (tannin-protein complex) (Wanapat et al., 1997, 2000). Concentrate supplementation for lactating dairy cows has been practiced by smallholder farmers in the tropics by using ratio 1:2 concentrate to milk yield per day, as a rule of thumb, without taking into account the basal roughage use and actual requirements (Wanapat and Devendra, 1992). In some areas of Thailand, concentrate use was found to be even higher at 1:1 concentrate to milk yield, which could possibly result in rumen acidosis especially when effective fiber was unavailable. High concentrate use eventually resulted in higher production cost up to 70% of the total production cost (Wanapat, 1990; Chantalakhana, 1994; Office of Livestock Extension, 1998). It is, hence, very imperative to find means in reducing feed cost. Cassava *(Manihot esculenta, Crantz)* hay was reported to be a good source of high protein roughage and was used as a supplement of improve milk production and quality (Wanapat et al., 1997, 2000). However, the use of CH in various levels of concentrate supplementation has not yet been substantiated. Therefore, the objectives of the experiments were to study the effect of CH supplementation with various levels of concentrate to milk yield use on milk yield and compositions as well as economical use of concentrate level in lactating Holstein-Friesian cross-breds during their midlactations.

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MATERIALS AND METHODS

The experiment was conducted on farmers dairy farm as a participatory research during which researchers and farmer worked closely. Six multiparous Holstein-Friesian in their mid-lactating periods, were randomly in pair to receive three dietary treatments according to a change-over design. Exp. I, treatments were T_1=no chopped CH, T_2=0.8 kg/hd/d CH supplementation, T_3=1.7 kg/hd/d CH supplementation. Cassava hay was made from whole cassava crop at 3 month maturity, sun-dried for 2 days before chopping (2-4 cm), enrichment, storage and feeding. The chopped CH was enriched by spraying with solution containing molasses, water, sulfur and urea at 81, 18, 0.5, 0.5 and applied to chopped CH at 1:1 by weight. Further details on CH making could be found in Wanapat et al. (1997 and 2000). Concentrate was formulated using local feed ingredients and given to cows according to milk yield per day at 1:2. All concentrate and CH were given in two equal parts at morning and afternoon milking times at 1:2 of concentrate:milk yield. Urea-treated (5%) rice straw was offered to all cows on *ad libitum* basis and in addition, they were allowed to graze on dry Ruzi grass field. Each feeding period lasted for 21 days before changing into respective treatments. Milk yields were recorded every day and at the end of each period, milk samples were taken to be analyzed for fat, protein and lactose percentages using Milko Scan. Feed samples were chemically analyzed. All data were subjected to Analysis of variance and treatment means were compared using Duncans New Multiple Range Test (SAS, 1985).

Exp. II, six multiparous Holstein-Friesian crossbreds in their mid-to-late lactating periods were randomly paired and assigned to receive respective dietary treatments according to a change-over design. The dietary treatments were T_1=0 kg cassava hay (CH) in 1:2 concentrate supplementation (CS) to milk yield (MY), T_2=1.0 kg CH/hd/d in 1:3 CS:MY, T_3=1.7 kg CH/hd/d in 1:4 CS:MY. All cows were adjusted to respective feeds for one week before actual feeding periods were imposed for 21 days each. Concentrate was given according to their respective treatments in two equal amount during morning and afternoon milking times. In addition, all cows were allowed to graze during the days on pasture of Ruzi gras (*Brachiaria ruziziensis*). Milk yield from all cows were recorded daily and samples of milk were taken both from morning and afternoon milk for analyses of fat, protein, lactose, solids-not-fat (SNF), total solids by Milko-Scan, during the last day of each period, Samples of concentrate and cassava hay were taken for dry matter (DM), ash, crude protein (CP), neutral-detergent fiber (NDF), acid-detergent fiber (ADF) analyses. Cassava hay and urea-treated rice straw were all prepared as reported earlier by Wanapat et al., (1998) and samples were chemically analyzed using standard procedures. All data were subjected to analysis of variance and treatment means were compared using Duncan's New Multiple Range Test (SAS, 1985).

RESULTS AND DISCUSSION

Exp I, feed ingredients and their chemical compositions are presented in table 1. Cassava chip was used mainly as a ruminal readily degraded energy source while a combination of protein meals and urea were formulated as intact protein and non-protein nitrogen sources. Concentrate mixture, CH and urea-treated rice straw contained 12.4, 24.5, 8.2% CP and 20.5, 35.4, 71.8% NDF, respectively. The CH harvested at three months after planting contained high level of protein, relatively low levels of cell wall (NDF) and condensed tannin. The intakes of both concentrate and CH were well consumed by the cows at all times.

Table 1. Ingredient mixtures and chemical compositions of concentrate (Conc.) cassava hay (CH), urea-treated rice straw (UTRS) and Ruzi grass (RG) (Exp. I)

Item	% by weight			
Cassava chip	50.0			
Rice bran	20.0			
Corn	8.0			
Soybean meal	10.0			
Coconut meal	4.5			
Palm kernel cake	5.0			
Urea	2.0			
Sulphur	0.2			
Mineral mix	0.3			
	Conc.	CH	UTRS	RG
	% DM			
DM	91.2	87.8	52.0	90.6
Ash	5.2	10.2	12.5	7.7
CP	12.4	24.5	8.2	7.2
NDF	20.5	35.4	71.8	68.5
ADF	12.5	27.3	47.0	40.0
ADL	4.3	3.9	7.6	6.4
Condensed tannin	-	0.35	-	-

As earlier reported by Reed et al. (1982), Kumar and Singh (1984), and Onwuka (1992) that dried cassava leaves contained high level of condensed tannin (3-5% DM) which adversely attributed to intake, digestibility and performance of ruminants. In addition, ruminal volatile fatty acid production during *in vitro* fermentation fermentation was greatly reduced when the substrate contained more than 6% condensed tannin (Van Hoven and Furstenburg, 1992). The use of CH as a supplement at 1.70 kg/hd/d could reduce level of concentrate from 0 to 1.5 kg/hd/d without changing level of milk yield (12.5 vs 12.6 kg/d). Most significantly, the cost of concentrate was reduced by 27% and highest saving of concentrate was found in the highest supplementation level of CH (1.70 kg/hd/d). Milk fat and protein were significantly enhanced from 4.06 to 4.61% ($p<0.5$) and from 3.40

to 3.5% ($p<0.05$) as levels of CH supplement increased (table 2 and figure 1). Since milk fat were significantly increased, the 3.5% FCM were consequently enhanced from 14.2 to 15.7 and 14.9 kg/d, respectively. As reported earlier that CH had a remarkable high DM digestibility (71%) and high ruminal by-pass protein since it contained tannin-protein complex (Wanapat et al., 1997, 2000), which could have a profound effect on milk yields and compositions. CH supplementation in urea-treated rice straw based-roughage exerted its potentiality in reducing concentrate level in the present feeding system.

Table 2. Effect of levels of chopped cassava hay on milk yield and compostion of Holstein Friesian crossbreds fed urea-treated (5%) rice straw on *ad libitum* basis (Exp. I)

Item	Chopped cassava hay, kg/d			SEM
	0	0.8	1.70	
Concentrate DM intake, kg/d	5.53	5.00	4.03	0.25
Concentrate saving, kg/d (% control)	0	0.53 (10%)	1.50 (27%)	0.30
Milk yield, kg/d	12.50	12.12	12.62	0.57
3.5% FCM, kg/d	14.21^{a}	15.70^{b}	14.93^{b}	0.67
Milk composition				
Fat, %	4.06^{a}	4.15^{b}	4.61^{c}	0.19
Protein, %	3.40^{b}	3.34^{a}	3.50^{c}	0.08
Lactose, %	4.64^{a}	4.82^{b}	4.62^{a}	0.05
Solids-not-fat, %	8.74	8.80	8.81	0.09
Total solids, %	13.56	13.18	13.76	0.32

^{a,b,c} Values with different superscripts differ ($p<0.05$).

Since dairy farmers could benefit more on higher milk fat above 3.5%, it is obvious that CH could have such increases both fat and protein. As the price of commercial concentrate increases variably, it is imperative to find alternative sources like CH especially to establish it as an on-farm feed resource for small holder farmers.

Exp. II, table 1 presents feed ingredients used in a concentrate mixture as well as chemical compositions of concentrate, Ruzi grass and CH used in the experiment. Crude protein and NDF contents of concentrate Ruzi grass and CH were 17.3, 7.0 21.3% and 48.9, 72.3, 54.7%, respectively, In regards to CP and condensed tannin percentages of CH, they were found to be in similar range with those reported by Wanapat et al. (1997, 1998 and 2000), as CH was harvested at a younger stage of growth (3-4 months) or regrowth (1-2 months).

As levels of CH supplementation increased from 0, to 1.0 to 1.7 kg DM/hd/d, concentrate supplement

Table 3. Ingredient mixtures and chemical compositions of concentrate (Conc.), Ruzi grass (RG) and cassava hay (CH) used in the experiment (Exp. II)

Item	% by weight		
Cassava chip		50.0	
Rice bran		26.0	
Rubber seed meal		12.3	
Soybean meal		8.0	
Urea		2.0	
Sulphur		0.2	
Salt		1.0	
Mineral mix.		0.5	
	Conc.	RG	CH
		% DM	
DM	94.3	92.6	92.3
Ash	8.6	8.4	7.3
CP	17.3	7.0	21.3
NDF	48.9	72.3	54.7
ADF	16.7	38.0	32.8
Condensed tannin	-	-	0.40

decreased from 4.56 to 3.20 and to 2.64 kg/hd/d or 30 and 40% of the control treatment, respectively (table 4). The decline use of concentrate still resulted in similar milk yield and improved milk compositions (table 4). The use of CH could reduce concentrate levels and resulted in similar milk yield, 10.72, 10.19 and 10.42 kg/hd/d for T_1, T_2, T_3, respectively. Significant enhancements of protein, lactose and SNF percentages were obtained in T_2. It was also notably observed that milk fat in CH supplemented groups and in lower concentrate supplementation were higher than the control. Cassava hay may have provided a substrate which would improve rumen fermentation efficiency as earlier reported by Wanapat et al. (1997, 1999a, b). The tannin-protein complex contained in CH could not be degraded in the rumen since rumen pH is normally at 6.5-7.0 when high roughage was fed and could serve as rumen by- pass protein and be available in the lower gut since pH is lower than 3. Jones and Mangan (1977), Barry and Manley (1984) reported tannins may form complex with protein at rumen pH and be protected from microbial enzymes and were unstable at pH of the lower gut. Milk thiocyanate has been reported by Claesson (1994) that level of up to 20 ppm was required to activate peroxidase system in preserving milk Quality and prolonging milk storage especially under hot condition. Under this experiment, CH supplementation increased milk thiocyanate from 5.3 to 13.3 and to 17.8 ppm ($p<0.05$) in 1.0 kg/d CH and 1.7 kg/d CH supplemented cows. In spite of this result, further details regarding effect of CH on milk thiocyanate should also be studied.

Results on economical return of CH supplementation to reduce concentrate in dairy feeding were

Table 4. Effect of cassava hay (CH) supplementation on concentrate use, milk yield and compositions (Exp. II)

Conc.:Milk	1:2	1:3	1:4	SEM
CH Suppl., kg DM/d	0	1.0	1.7	
Concentrate DM Intake, kg/d	4.56[a]	3.20[b]	2.64[c]	0.25
Concentrate saving, kg (% control)	0	1.36 (30)	1.92 (42)	-
Milk yield, kg/d	10.72	10.19	10.42	0.58
3.5% FCM, kg/d	12.65	12.51	12.64	0.75
Milk compositions				
Fat, %	4.61	4.98	4.80	0.13
Protein, %	3.36[a]	3.60[b]	3.45[ab]	0.10
Lactose, %	4.47[a]	4.66[b]	4.53	0.07
Solids-not-fat, %	8.80[a]	8.95[b]	8.68[c]	0.09
Total solids	13.41	13.54	13.50	0.24
Thiocyanate, ppm	5.3[a]	13.3[b]	17.8[b]	0.77

[a,b,c] Values with different superscripts differ ($p<0.05$).

presented in table 5. Simple economical analysis showed that as level of CH supplementation increased, return of milk sale income was improved and was highest in cows receiving CH at 1.7 kg/hd/d. As earlier stated, lower concentrate cost would be utmost importance in providing income for small-holder dairy farmers in Thailand. The profound effect of CH feeding could be attributed by its tannin-protein complex which would render higher ruminal by-pass protein and intermediate rate of rumen fermentation as indicated by volatile fatty acid production (Wanapat et al., 1997, 2000). Providing a good source of roughage like CH could possibly increase ratio of protein to energy, hence could increase productivity in ruminants as indicated by Leng (1981 and 1997).

Table 5. Effect of cassava hay supplementation on economical return of milk yield (Exp. II)

Conc.:Milk	1:2	1:3	1:4
CH Suppl., kgDM/d	0	1.0	1.7
3.5% FCM, kg/d	12.65	12.51	12.64
Milk sale, Baht	141.68	140.11	141.57
Concentrate intake, kg/d	5.15	3.62	2.97
Concentrate cost, B/d	60.90	21.72	17.82
Cassava hay intake, kg/d	0	2.85	4.02
Cassava hay cost, B/d	0	1.92	2.01
Total feed cost	30.90	23.64	19.83
Income over feed, B/hd/d	110.78	116.47	121.74
B/hd/m	3,324	3,494	3,652
$US	92.3	97.1	101.4

1 kg Milk=11.20 B, kg Conc.=6.00 B, kg Cassava hay=0.50 B, 36B=1 $US.

The findings resulted from these experiments reveal interesting and promising role of cassava hay, as a high protein roughage in dairy feeding in the tropics. However, further researches in regards to tannin level in cassava hay on rumen microbiology, rumen fermentation and tannin-protein complex, remain to be investigated.

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