ผลของการให้อาหารหยาบผสมคุณภาพสูง เพื่อเพิ่มผลผลิตโคนม ในฟาร์มเกษตรกรรายย่อย ในเขตภาคตะวันออกเฉียงเหนือของไทย

Effect of high quality mixture roughage to improve dairy production in smallholder dairy farms in the northeastern region of Thailand

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บทคัดย่อ: วัตถุประสงค์ของการศึกษาครั้งนี้คือ เพื่อศึกษาผลของการให้อาหารหยาบคุณภาพสูงที่ผสมระหว่าง ถั่วมัน *(Phaseolus calcaratus*, PC) และหญ้ารูซี่ในอัตรา 1:1 ในโคนมพันธุ์ลูกผสมโฮสไตน์ฟรีเซี่ยนโดยทำการศึกษาในฟาร์มเกษตรกรรายย่อย 15 ฟาร์ม จำนวนโครีดนม 60 ตัว ใช้แผนการทดลองแบบ Randomized complete block design (RCBD) โดยโคนม 4 ตัวในแต่ละฟาร์มถูกแบ่งเป็น 2 กลุ่ม ซึ่งกลุ่มแรกกำหนดให้ได้รับอาหารหญ้ารูซี่เป็นอาหารหยาบหลัก (กลุ่มควบคุม) ส่วนกลุ่มที่สองให้ถั่วมันผสมหญ้ารูซี่และให้กินแบบเต็มที่ โดยให้อาหารข้นในอัตรา อาหารข้นต่อปริมาณน้ำนมเท่ากับ 1:2 ทำการทดลองทั้งหมด 45 วัน ผลการศึกษาพบว่า ปริมาณการกินได้ของสิ่งแห้ง ผลผลิตน้ำนมและ 3.5% fat corrected milk ในกลุ่มโคนมที่ได้รับอาหารหยาบคุณภาพสูงมีค่าสูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ ($P < 0.05$) นอกจากนี้ ในส่วนของผลตอบแทนทางเศรษฐกิจยังแสดงให้เห็นว่า กลุ่มโคนมที่ได้รับอาหารหยาบคุณภาพสูงมีรายได้และผลกำไรจากการจำหน่ายนมสูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติ ($P < 0.05$) อาหารหยาบคุณภาพสูงที่ผสมระหว่าง ถั่วมันและหญ้ารูซี่ในอัตรา 1:1 ได้แสดงถึงคุณประโยชน์ และสามารถนำไปใช้ได้จริงในระบบการเลี้ยงโคนมของเกษตรกรรายย่อยในเขตภาคตะวันออกเฉียงเหนือของประเทศไทย

คำสำคัญ: ถั่วมัน, อาหารหยาบคุณภาพสูง, ผลผลิตน้ำนม, โคนมพันธุ์ผสม, ฟาร์มเกษตรกรรายย่อย

ABSTRACT: The objective of this study was to investigate feeding of *Phaseolus calcaratus*, PC or Tua-mun mixed with ruzi grass at the ratio of 1:1 for lactating dairy crossbreds on 15 small-holder dairy farms. Randomized complete block design (RCBD) was employed using 60 lactating cows. Four cows per farm were subjected into 2 groups to receive ruzi grass (control) and PC mixed with ruzi grass (high quality roughage) and given *ad libitum*. All cows were

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offered a concentrate diet with the ratio to milk yield of 1:2. Feeding trial lasted for 45 days with cooperation with all dairy farmers. The results were shown that total dry matter intake, milk yield and 3.5% fat corrected milk were significantly higher (P<0.05) in cows fed with the mixture of roughage than those in the control group. Moreover, an economic assessment showed that milk income and the profit from milk sale were significantly greater (P<0.05) in cows fed with the mixture of roughage than those from the control group. High quality roughage as PC mixed with ruzi grass at the ratio 1:1 revealed an advantages and practical implementation for small dairy farms in the Northeastern region of Thailand.
Keywords: *Phaseolus calcaratus*, high quality roughage, milk production, dairy crossbreds, smallholder dairy farms

Introduction

Currently, most farmers in the northeastern region of Thailand have been planting only one kind of grass for dairy production and using chemical fertilizers to improve soil fertility and grass yield. The use of appropriate forage planting systems involving leguminous crop could enhance both quantity and quality of roughage especially nitrogen content (Kiyothong and Wanapat, 2004; Wanapat et al., 2007). Polthanee et al. (2001) reported that intercropping cassava with leguminous crops such as cowpea or others could improve soil fertility and provide food and feed for human and livestock, respectively.Tua-mun (*Phaseolus calcaratus*Roxb) is a sprawling leguminous shrub which grows well in sub-tropic and tropic region (Wanapat, 2009). Tua-mun has a high crude protein (CP) content with high biomass yield when intercropped with cassava in the food-feed-system (Wanapat, 2009). Wanapat et al. (2010) found that Tua-mun intercropped with ruzi grass(*Brachiaria ruziziensis*) increased biomass yield to 10.6 tonnes DM/ha and the CP was 14.1 % of DM. Moreover, supplementation of Tua-mun mixed with ruzi grass resulted in improved milk production (Wanapat et al., 2012). Furthermore, condensed tannins contained in legumes could improve protein utilization through a capacity to form reversible complexes with proteins to provide rumen by-pass protein and later was available for digestion and absorption in the lower gut (McNeill et al., 1998). Therefore, the objective of this experiment was to investigate the effect of Tua-munmixed with ruzi grass as high quality roughage for lactating dairy cowsfor small-holder dairy farms in the Northeastern region of Thailand.

Materials and Methods

The experiment was conducted on 15 small-scale dairy farms from 4 Milk Collection Centers (Ubonrat, Nampong in Khon Kaen province, and Tungfon, Nongwuasaw in Udonthani province) under the administration of Dairy Promotion Organization of Thailand (DPO) in the Northeastern region of Thailand. Randomized complete block design (RCBD) was used in this experiment. Four lactating holstein friesian crossbreds of each farm were divided into two groups (2 animals/group) (60 lactating cows in total) to receive ruzi grass (control) and *Phaseolus calcaratus* mixed with ruzi grass at the ratio 1:1 in *ad libitum* in the fresh form as a roughage sources. Each group had similar lactation characteristics, body weight and milk yield and were measured before starting the experiment. The cows were offered concentrate, at a ratio of concentrate to milk production of 1:2 after 6 am and 4 pm milking times. The

feeding experiment was a 45-day period. The ingredients and chemical composition of diets are shown in the **Table 1**. Individual intakes of roughage and concentrate were recorded for a 45-day period. Feeds were sampled for chemical composition analysis. Fecal samples were collected at the end of the 45-day of the experiment by rectal sampling. Samples were analyzed for DM, ash and CP content (AOAC, 1995), NDF and ADF (Van Soest et al., 1991) and acid insoluble ash (AIA). AIA was used to estimate digestibility of nutrients (Van Keulen and Young, 1977). The cows were milked twice daily by bucket milking machine and individual cow milk yield was recorded and milk sample collected for chemical composition analysis. Milk samples from the morning milking and the evening of each cow were pooled (70:30) and stored in a refrigerator at 4°C until they were analyzed for fat, crude protein, lactose, solids-not-fat and total solids by an infrared analyzer (MILKOSCAN). Milk production costs, income and profit were assessed. All data were analyzed using the general linear procedure in PROC GLM of SAS (1996). Treatment means were significantly compared by Duncan's New Multiple Range Test (Steel and Torrie, 1980). Differences among means with $P<0.05$ were accepted as representing statistically significant differences.

Results and Discussion

The chemical composition of crude protein content in ruzi grass and Tua-mun mixed with ruzi grass were 7.1% and 14.7% of DM while condensed tannin contents were 0.3% and 1.7% of DM, respectively (**Table 1**). These condensed tannin contents were similar with the previous value of Wanapat et al. (2012) who reported at 0.3% and 2.2% of DM, respectively while the crude protein contents of ruzi grass and Tua-mun mixed with ruzi grass were found at 6.7% and 17.4% of DM, respectively. However, Chanthakhoun et al. (2011) reported that crude protein and condensed tannin contents in Tua-mun hay were higher than under this study (18.3% and 2.8%, respectively). The fluctuation of chemical compositions of Tua-mun could be due to the differences of the season, soil quality and cultivation period. It was found that roughages intake and concentrate intake were not significantly different between treatments ($P>0.05$) while total dry matter intake was significantly improved in cows received high quality roughage ($P < 0.05$) (**Table 2**). Wanapat et al. (2006) suggested that high quality roughages can reduce the use of concentrate diet for the lactating dairy cows which did not showed in this study.High quality roughages will allow rumen microbes to increase the digestion of roughage, proving more nutrients to the host animal, and hence, decrease the concentrate supplementation (Wanapat, 1999). There were no significant effects on digestion coefficients of dry matter, organic matter, crude protein, neutral detergent fiber and acid detergent fiber ($P > 0.05$). Increasing the CP content of diets has often enhanced DMI (Abdelqader and Oba, 2012) and has been proposed that the increase in DMI is a result of more efficient cell wall digestion in the rumen. However, in the present experiment, although the CP content of roughage was higher, but there was no change in overall intakes. Changes in dry matter digestibility with dietary protein level were inconsistent, as it has been in

many literatures. Cunningham et al. (1996) reported similar organic matter digestibility when diets contained 14.5 to 18.5% CP, and were in agreement with Wattiaux and Karg (2004) who showed unchanged dry matter digestibility when dietary protein was changed from 16.5 to 17.7%. Nevertheless, decreasing dietary protein has resulted in decreased or no changes in protein digestibility (Broderick, 2003).

Table 1 Ingredients and chemical compositions of experimental diets (% DM)

Ingredients	Concentrate mixture, % DM	Ruzi grass	High quality roughage
Cassava chip	50.4		
Cassava pulp	12.1		
Rice bran	10.5		
Soybean meal	9.4		
Brewerys' grain	3.9		
Palm kernel meal	5.3		
Coconut meal	4.1		
Urea	1.3		
Molasses	1.2		
Salt	0.5		
Sulfur	0.3		
Mineral mix	1.0		
Chemical composition (mean ± SD)			
Dry matter (DM), %	91.5 ± 3.2	28.1 ± 3.3	29.1 ± 4.2
		.....% DM.....	
Organic matter(OM)	95.5 ± 1.9	88.1 ± 2.1	88.9 ± 3.6
Crude protein (CP)	17.9 ± 2.1	7.1 ± 2.2	14.7 ± 3.2
Neutral detergent fiber (NDF)	15.1 ± 3.2	75.7 ± 3.3	62.1 ± 5.2
Acid detergent fiber (ADF)	8.3 ± 2.5	55.2 ± 4.5	47.6 ± 4.1
Condensed tannins(CT)	-	0.3 ± 0.02	1.7 ± 0.17
Total digestible nutrient(TDN)	72.7 ± 4.3	54.4 ± 3.1	63.5 ± 2.4

High quality roughage = *Phaseoluscalcaratus*mixed with Ruzi grass at the ratio 1:1

Milk composition in terms of fat, protein, lactose, total solids and solids-not-fat were similar between treatments while milk yield and 3.5% fat corrected milk yield were significantly higher in cows fed with high quality roughage ($P < 0.05$). These could be due to condensed tannins contained in Tua-man could improve protein utilization by providing rumen by-pass protein and then digestion and absorption in the lower gut (McNeill et al., 1998). In addition, it seems likely that the additional N from Tua-mun increased the activity of the microbial population and thereby increased animal performances. Feed cost was not affected by roughage type ($P > 0.05$); while income and profit from milk sale were higher in cows fed with mixed roughage when compared with the control group ($P < 0.05$; **Table 3**). In the present experiment, similar in feeding costs between diet treatments was mainly justified by the use of amount of concentrate feed. These results can be implied

that high quality roughage as legume mixed with ruzi grass could enhance nutrients utilization of dairy cows particularly protein utilization. Efficiency of nitrogen utilization could be improved by increasing post-ruminal digestion and/or providing a pattern of absorbed amino acid and their requirements for milk synthesis.

Table 2 Feeding of *Phaseolus calcaratus* mixed with Ruzi grass as a high quality roughage on voluntary feed intake and nutrient digestibility in lactating dairy crossbreds

Items	Control	High quality roughage	SEM
Total dry matter intake, kg/hd/d	14.1[b]	15.8[a]	0.51
Roughages intake, kg/hd/d	6.3	6.5	0.48
Concentrate intake, kg/hd/d	7.8	9.3	0.67
Digestion coefficients, %			
Dry matter	60.7	61.9	0.49
Organic matter	65.1	67.0	0.53
Crude protein	67.3	68.8	0.27
Neutral detergent fiber	56.5	57.3	0.34
Acid detergent fiber	44.7	45.6	0.40

High quality roughage = *Phaseoluscalcaratus* mixed with Ruzi grass at the ratio 1:1

SEM = standard error of the means.

Table 3 Feeding of *Phaseolus calcaratus* mixed with Ruzi grass as a high quality roughage on milk production and economical return in lactating dairy crossbreds

Items	Control	High quality roughage	SEM
Milk yields, kg/hd/d	15.7[a]	18.9[b]	0.71
3.5% FCM, kg/hd/d	15.9[a]	20.0[b]	0.90
Milk composition, %			
Fat	3.6	3.8	0.16
Protein	3.3	3.3	0.14
Lactose	4.7	4.6	0.21
Total Solids	12.2	12.4	0.27
Solids- not- fat	8.7	8.6	0.13
Economical return, US/hd/d			
Milk income	9.28[a]	11.18[b]	0.42
Feed cost	2.03	2.07	0.18
Profit	7.25[a]	9.11[b]	0.41

[ab]Value within row with different superscripts are significantly different ($P<0.05$)

High quality roughage = *Phaseoluscalcaratus*mixed with Ruzi grass at the ratio 1:1

Conclusions

Under this on-farm trial, it could be summarized that high quality roughage (*Phaseolus* mixed with ruzi grass) could improve milk yield. Moreover, milk income and the profit from milk sale were also remarkably improved. Therefore, high quality roughage as *Phaseolus*mixed with ruzi grass could be advantages and offer practical approaches for small dairy farms in the northeastern region of Thailand and should be expanded in other tropical and sub-tropical dairy farming.

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