

# Performance of Periparturient Dairy Cows Fed Alfalfa Hay in Total Mixed Ration : A Field Trial in Thailand

Theera Rukkwamsuk<sup>1,\*</sup>, Sunthorn Rungruang<sup>2</sup>,  
Apassara Choothesa<sup>1</sup> and Theo Wensing<sup>3</sup>

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## ABSTRACT

Performance of 20 periparturient Holstein Friesian dairy cows fed alfalfa hay-base total mixed rations during transition and lactation periods was studied in a commercial dairy farm. From 7 d prior to anticipated calving date until 7 d after calving, all cows were also drenched with 400 ml of propylene glycol once daily. Blood samples were collected at -2, 1, 2, 3 and 4 wk from parturition. Milk yields were recorded daily, and milk samples were collected twice a week to determine milk compositions. Compared with the concentrations at -2 wk, serum glucose and urea nitrogen concentrations decreased whereas serum non-esterified fatty acid and  $\beta$ -hydroxybutyrate concentrations increased after calving. These results indicated that these cows entered some degrees of negative energy balance. Average milk production during 30 d postpartum was  $34.8 \pm 8.7$  kg/d. Average days from calving to first service was  $86 \pm 24$  d, and 55% of 20 cows were conceived at first service. In conclusion, cows fed alfalfa hay-base diet and drenched with propylene glycol during periparturient period could improve negative energy balance, milk yield and conception rate. However, replacing roughages from agro-industry by product with alfalfa hay in Thai dairy farms would depend on the economical analysis because most alfalfa hay was imported from foreign country.

**Key words:** alfalfa, dairy cow, negative energy balance

## INTRODUCTION

Thai dairy farmers use traditional by-products from agricultures to feed their cows. Pineapple peels, peanut by-products, corn by-products, and rice straw are widely used to feed dairy cows throughout the country. Peanut by-products including peanut skins, peanut hulls, peanut hay and silages are economically priced, and they can be incorporated into a variety of diets for dairy cattle (Hill, 2002). It is accepted that

quality of roughages influences to a greater extent on milk yield and milk quality, and to lesser extent on reproductive performance and health status of the cows.

Alfalfa is rarely grown in Thailand because of unsuitable climate, therefore a large part of alfalfa hay used in Thailand is imported from foreign countries. Because of relatively high cost, this alfalfa hay is restrictedly used by some farmers. Data concerning the beneficial use of alfalfa in dairy cattle are considerably reported in

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<sup>1</sup> Faculty of Veterinary Medicine, Kasetsart University, Kamphaengsaen, Nakhon Pathom 73140, Thailand.

<sup>2</sup> Pakthongchai Dairy Farm, Pakthongchai, Nakhonratchasima 30150, Thailand.

<sup>3</sup> Faculty of Veterinary Medicine, Utrecht University, 3508TD Utrecht, The Netherlands.

\* Corresponding author, e-mail: theera.r@ku.ac.th

western countries (Broderick, 1995; Leonardi and Armentano, 2003) but are limited in Thailand. Before any assumptions in using alfalfa in the diet of dairy cows in Thailand could be made, a study was required. The objective of this study was therefore to evaluate the use of alfalfa hay in total mixed ration on performance of periparturient dairy cows in a commercial dairy herd.

## MATERIALS AND METHODS

### Animals and diets

The study was conducted in a commercial dairy farm in Nakhonrachasima Province, northeastern part of Thailand. The farm consisted of 503 lactating cows, 171 dry cows, and 414 replacement calves and heifers. The average milk yield was 20.5 kg/cow daily. Close-

up and lactating cows were kept in a free-stall housing with an evaporative cooling system, which controls the inside temperature between 25-28°C.

Twenty healthy pregnant Holstein Friesian dairy cows in the dry period were randomly selected from this farm, and were fed with alfalfa hay-base diet during the transition and lactation periods. At the start of the experiment, average ages of these cows were 3.44 ( $\pm$  0.36) years; average 305-d milk yields were 7320 ( $\pm$  1512) kg; and average dry periods were 59.6 ( $\pm$  16.8).

During the early dry period, cows were fed the dry period total mixed ration. Thereafter, they were assigned to alfalfa hay-base total mixed rations in their transition and lactation periods as indicated in Table 1. The chemical compositions of the rations are shown in Table 2. All cows were

**Table 1** Composition of total mixed rations as fed basis.

Ingredient	Dry period	Transition period	Lactation period
	----- kg as fed-----		
Concentrate <sup>1</sup>	1.3	...	...
Concentrate <sup>2</sup>	...	2.11	...
Concentrate <sup>3</sup>	...	...	4.61
Wet brewer grain	8.0	3.0	6.0
Corn silage	8.0	12.1	10.65
Alfalfa hay	...	3.0	4.0
Peanut hay <sup>4</sup>	2.0	...	...
Rice straw <sup>5</sup>	3.5	...	...
Cassava chips <sup>6</sup>	...	0.9	1.8
Whole cotton seed	...	0.5	1.5
Fish meal	...	0.05	0.1
Blood meal	...	0.05	0.1
Molasses	1.0	0.75	1.0
Premixes <sup>7</sup>	0.5	0.5	1.0

<sup>1</sup> Consisting of 33.0 % soybean meal, 27 % canola meal, 22.5 % wheat bran, 11 % dried brewer grain, 4.1 % limestone, and 2.4 % salts.

<sup>2</sup> Consisting of 64 % extruded corn, 31.3 % soybean meal, and 4.7 % energizer-RP10.

<sup>3</sup> Consisting of 58.6 % extruded corn, 25.1 % soybean meal, 10.9 % corn gluten meal, and 5.4 % energizer-RP10.

<sup>4</sup> Consisted of 90.4 % of DM, 11.1 % of CP, 1.3 % of crude fat, 24.7 % of crude fiber, 34.3 % of ADF, and 37.6 % of NDF.

<sup>5</sup> Consisted of 93.9 % of DM, 4.4 % of CP, 2.3 % of crude fat, 35.6 % of crude fiber, 52.2 % of ADF, and 26.4 % of NDF.

<sup>6</sup> Consisted of 89.8 % of DM, 2.5 % of CP, 0.4 % of crude fat, 3.4 % of crude fiber, 5.5 % of ADF, and 10.7 % of NDF, and 73.96 % of starch.

<sup>7</sup> Commercial premixes containing trace minerals and vitamins.

drenched once daily with 400 ml of propylene glycol from 7 days (d) before anticipated calving date to 7 d after calving. Dry matter intake of cows was estimated every day and milk yields were recorded daily. The cows were received their first artificial insemination in the second estrus postpartum and conception rate at first service was determined.

### Sampling procedures

Blood samples were collected from all cows at -2, 1, 2, 3, and 4 weeks from parturition. At sampling, 20 ml of blood were collected from the jugular vein in evacuated tubes with no preservative. The tubes were kept on ice and were centrifuged at  $1,200 \times g$  for 15 min within 2 to 3 hours after collection, and serum samples were harvested and stored at  $-20^{\circ}\text{C}$  until analysis for glucose, non-esterified fatty acids (NEFA),  $\beta$ -hydroxybutyrate, and urea nitrogen concentrations.

Composite milk samples were collected at morning milking from all cows twice weekly for 4 wk after parturition. For determination of milk composition, 30 ml of composite milk was kept in a plastic bottle with potassium dichromate at 0.1% (wt/vol) as a preservative. All milk samples were stored at  $4^{\circ}\text{C}$  and were analyzed within 7 d.

### Assay procedures

Concentrations of serum glucose

(Glucose GOD-PAP, Class-1 Laboratories Co., Ltd., Bangkok, Thailand), NEFA (NEFA C, Wako Pure Chemical Industries Ltd., Osaka, Japan),  $\beta$ -hydroxybutyrate (RB 1007, Randox Laboratories, San Diego, CA, USA), and urea nitrogen (Urea Nitrogen Reagent, Class-1 Laboratories Co., Ltd.) were measured enzymatically with commercially available kits as indicated.

Milk compositions (protein, fat, lactose, and solid non fat) were measured automatically using Fourier Transform Infrared Spectrophotometer (MilkoScan FT6000 Spectrophotometer).

### Statistical analysis

Data were explored for normal distribution using Kolmogorov-Smirnov test. Normal distributed data were subjected to analysis of variance using dietary treatments as a fixed main effect and sampling day as a repeated measure (Patrie and Watson, 1999). Within group, comparison of data between sampling days was performed using the pairwise comparisons of repeated measure analysis of variance. The two-sided level of statistical significance was preset at  $P \leq 0.05$ .

## RESULTS AND DISCUSSION

### Feed intake, milk yield and milk composition

During the first 30 d postpartum, average dry matter intake in cows fed alfalfa hay-base diet

**Table 2** Chemical compositions of the total mixed ration.

Item	Dry period	Transition period	Lactation period
Dry matter (%)	49.51	51.15	55.91
Ash (%)	7.29	7.41	9.18
Crude protein (%)	11.44	12.90	16.48
Crude fat (%)	2.56	3.96	4.83
NDF <sup>1</sup> (%)	61.36	39.13	42.21
ADF <sup>2</sup> (%)	31.75	27.66	23.38

<sup>1</sup> Neutral detergent fiber

<sup>2</sup> Acid detergent fiber

was  $17.6 \pm 1.2$  (mean  $\pm$  SD) kg/d, which could be estimated approximately 3% of body weight. Propylene glycol did not influence the dry matter intake of the cows, which was consistent with previous study by Miyoshi *et al.* (2001).

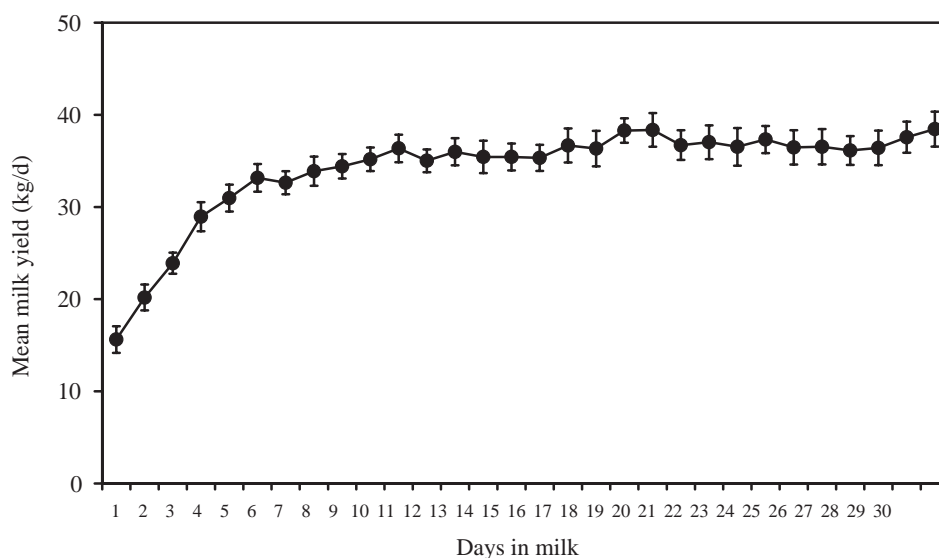
Milk yield during the 30 d of lactation of cows is presented in Figure 1. Cows fed alfalfa hay-base diet produced a satisfactory yield which was above average milk yield per day of their herd mates. Average milk yields during the first 30 days of lactation were  $34.8 \pm 8.7$  kg/d.

Milk compositions of cows during the 30 d of lactation are presented in Table 3. At the first week of lactation, percentages of fat and protein in the milk were high and the percentages declined in the second week and became almost at a constant levels at wk 4 of lactation. The increased fat percentages in the milk might be related to increased lipolysis in adipose tissue as corresponding to negative energy balance (Rukkwamsuk *et al.*, 2001). Unlike fat and protein percentages, milk lactose percentages did not change much during the 4 wk of lactation. As explained by increased fat and protein percentages

in the first week of lactation, percentages of solid non fat were high at the first week and declined as the protein percentages declined. These results demonstrated that cows could also produce satisfactory compositions of milk at any time of lactation.

### Serum glucose, NEFA, b-hydroxybutyrate, and urea nitrogen

Serum glucose, NEFA,  $\beta$ -hydroxybutyrate, urea nitrogen concentrations were demonstrated in Figure 2, 3, 4, and 5. At 2 wk before parturition, serum glucose concentrations were  $59.5 \pm 1.1$  mg/dL. After parturition, serum glucose concentrations decreased sharply, indicating that cows suffered some degree of negative energy balance. Serum glucose concentrations remained at lower levels until wk 4 after parturition (Figure 2). This finding corresponded well with other previous studies (Van den Top, 1995; Rukkwamsuk *et al.*, 2005). However, postpartum concentrations of serum glucose in this study were higher than the previous observation by Rukkwamsuk *et al.* (2005),



**Figure 1** Milk yield during the first 30 days of lactation in cows fed alfalfa-base diet (n = 20). Data are means ( $\pm$  SEM).

indicating that propylene glycol did improve energy balance of the postparturient dairy cows.

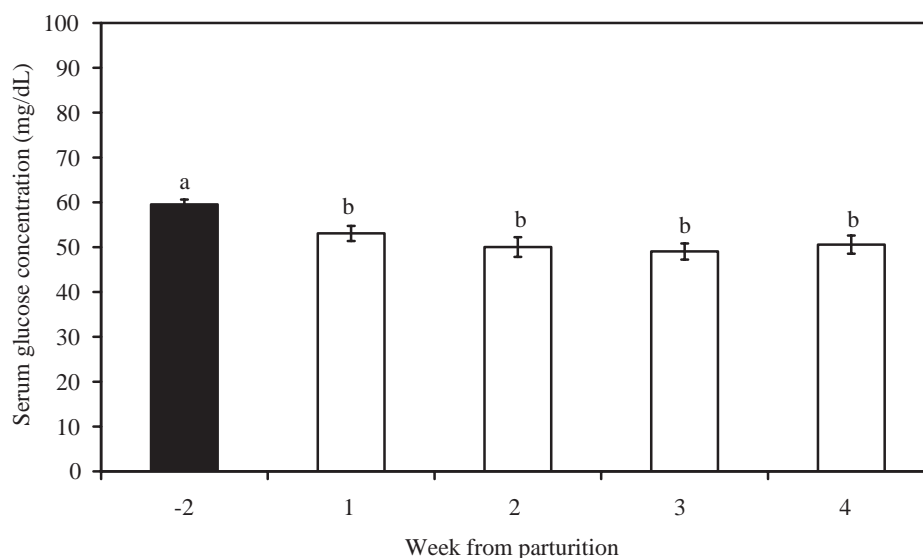
Serum NEFA concentrations increased after parturition as cows entering a period of high energy requirement. The concentrations increased sharply immediately after calving and remained at high levels and slightly reduced to the concentrations close to the prepartum levels at wk 4 postpartum (Figure 3). Drenching propylene glycol to cows reduced degree of lipolysis as also

reported earlier (Studer *et al.*, 1993). During the first week of lactation in which serum NEFA concentrations were at the highest levels, the milk fat percentages were also at the highest levels (Table 3). Therefore, milk fat percentages could be used as a practical parameter for explaining negative energy balance in postparturient dairy cows, which is also suggested elsewhere (Rukkamsuk *et al.*, 2001).

**Table 3** Compositions of milk of cows fed alfalfa-base diet (n = 20). Data represent means (SEM).

Item	Weeks after parturition							
	0.5	1	1.5	2	2.5	3	3.5	4
Milk fat (%)	4.73 (0.33)	4.85 (0.35)	4.47 (0.27)	4.18 (0.39)	4.62 (0.61)	3.28 (0.19)	4.31 (0.74)	3.04 (0.27)
Milk protein (%)	3.72 (0.09)	3.43 (0.06)	3.14 (0.05)	3.02 (0.03)	2.89 (0.04)	2.81 (0.05)	2.57 (0.05)	2.60 (0.05)
Milk lactose (%)	4.74 (0.05)	4.87 (0.04)	4.92 (0.02)	5.02 (0.03)	4.95 (0.05)	4.99 (0.05)	4.93 (0.05)	4.99 (0.04)
SNF* (%)	9.14 (0.07)	9.00 (0.07)	8.78 (0.07)	8.75 (0.04)	8.55 (0.07)	8.59 (0.07)	8.45 (0.08)	8.53 (0.06)

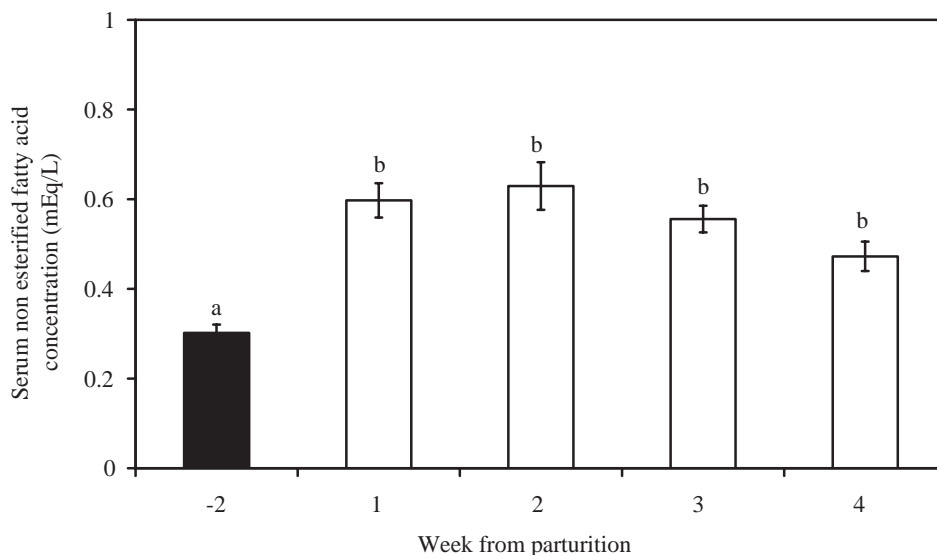
\* Solid non fat



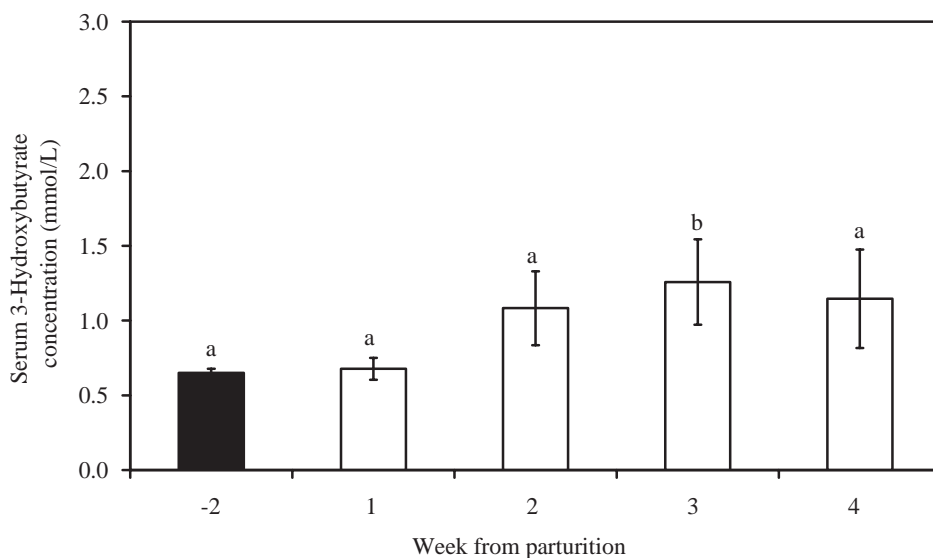
**Figure 2** Serum glucose concentrations measured before (■) and after parturition (□) in cows fed alfalfa-base diet (n = 20). Data are means ( $\pm$  SEM). Different letters indicate concentrations measured after parturition significantly differed from concentrations measured before parturition.

Serum  $\beta$ -hydroxybutyrate concentrations changed in the same manner as serum NEFA concentrations. The prepartum concentrations were at the lowest concentrations, whereas the

concentrations during 2 to 4 wk postpartum were slightly high, though not significant at 2 and 4 wk (Figure 4). Increased serum NEFA concentrations were usually followed by increased ketone bodies



**Figure 3** Serum NEFA concentrations measured before (■) and after parturition (□) in cows fed alfalfa-base diet (n = 20). Data are means ( $\pm$  SEM). Different letters indicate concentrations measured after parturition significantly differed from concentrations measured before parturition.



**Figure 4** Serum  $\beta$ -hydroxybutyrate concentrations measured before (■) and after parturition (□) in cows fed alfalfa-base diet (n = 20). Data are means ( $\pm$  SEM). Different letters indicate concentrations measured after parturition significantly differed from concentrations measured before parturition.

levels in the blood. This is in agreement with other previous studies (Van den Top, 1995; Hoedemaker, *et al.*, 2004).

Serum urea nitrogen concentrations remained in a narrow range between 12 and 15 mg/dL, although the concentrations were lower at 1 wk postpartum (Figure 5). Apart from being glucogenic precursor, propylene glycol might improve protein utilization and metabolism in the rumen.

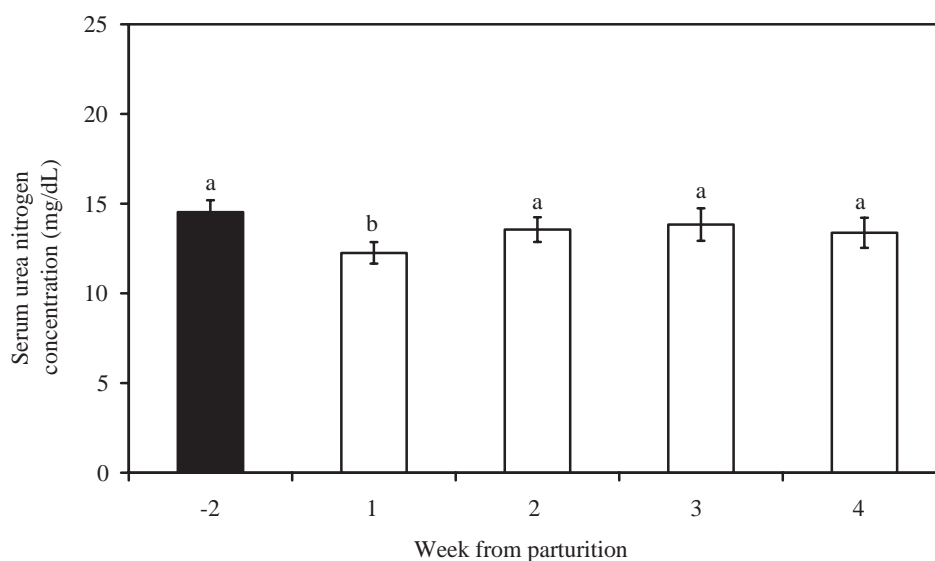
### Conception at first service

Average days from calving to first service of cows fed alfalfa hay-base diet were  $86 \pm 24$  d, which was in an acceptable range (Sakaguchi *et al.*, 2004). Eleven cows (55%) were conceived at first insemination. Therefore, cows fed alfalfa hay-base diet had also a satisfactory postpartum fertility.

In conclusion, alfalfa hay-base diet in combination with propylene glycol administration during periparturient period improved energy balance in dairy cows. Cows fed alfalfa hay-base diet produced satisfactory milk yields and compositions. They also showed a good conception rate at first insemination after calving. However, alfalfa hay was still costly. Hence, economical use of alfalfa hay in dairy cattle diet in Thailand needed to be evaluated.

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**Figure 5** Serum urea nitrogen concentrations measured before (■) and after parturition (□) in cows fed alfalfa-base diet (n = 20). Data are means ( $\pm$  SEM). Different letters indicate concentrations measured after parturition significantly differed from concentrations measured before parturition.

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