ผลของโปรตีนในอาหารข้น 2 ระดับ ต่อสมดุลของพลังงาน และผลผลิตน้ำนมในโคนมหลังคลอดใหม่

Effect of Two Dietary Crude Protein Levels on Energy Balance and Milk Production in Dairy Cows during Early Postparturient Period

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ABSTRACT

The objective was to study the effect of two dietary crude protein levels in concentrates on energy balance and milk production in dairy cows during early postparturient period. Twenty two dry cows were randomly allocated into 2 groups; 11 cows (Group A) were fed a concentrate consisted of 20 % Crude protein and 11 cows (Group B) were fed a concentrate consisted of 18 % crude protein. Blood samples were collected weekly beginning at 1 week before expected calving until 12 week after calving to determine blood biochemical parameters. Milk yield was recorded daily, and milk samples were collected weekly to determine their compositions of fat, protein, and lactose. Results showed that milk production of cows in Group A tended to be higher than in Group B (17.90 ± 2.97vs16.32 ± 2.21 Kg/day). The composition of milk did not differ; except, the percentage of protein for Group A were higher than for Group B (3.17 ± 0.09vs2.95 ± 0.10 g/100g of milk). The result indicated that the energy balance after calving was negative for both groups, particularly during the first 5 weeks of lactation. The mean serum concentrations of non-esterified fatty acid (NEFA) and B-hydroxybutyrate (BHB) of Group B were higher than Group A at the second week of lactation (0.84 ± 0.27vs0.52 ± 0.26 mEq/L and 0.72 ± 0.27vs0.67 ± 0.18 mmol/L for NEFA and BHB, respectively). Our results suggested that the concentrate consisted of 20 % crude protein was more appropriate to use in high producing dairy cows at the early stage of lactation than 18 % crude protein concentrate.

Key words : crude protein, milk production, and energy balance

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บทคัดย่อ

จุดประสงค์ของงานวิจัยนี้คือ ศึกษาผลกระทบของระดับโปรตีนหยาบในอาหารข้นต่อสมดุลของพลังงานและผลผลิตน้ำนมในโคนมระยะหลังคลอดใหม่ โคแห้งนม 22 ตัว สุ่มเลือกแบ่งออกเป็น 2 กลุ่ม กลุ่ม A มี โค 11 ตัว ได้รับอาหารข้นที่มีองค์ประกอบของโปรตีนหยาบ 20 เปอร์เซ็นต์ และ กลุ่ม B มีโค 11 ตัว ได้รับอาหารข้นที่มีองค์ประกอบของโปรตีนหยาบ 18 เปอร์เซ็นต์ เก็บตัวอย่างเลือดทุกสัปดาห์ เริ่มจาก 1 สัปดาห์ก่อน กำหนดคลอดจนถึง 12 สัปดาห์หลังคลอด เพื่อวัดค่าองค์ประกอบทางชีวเคมี ทำการจดบันทึกปริมาณน้ำนมทุกวัน และ เก็บตัวอย่างน้ำนม เพื่อไปวิเคราะห์องค์ประกอบของไขมัน โปรตีน และ แลกโตส ทุกสัปดาห์ ผลการทดลองแสดงให้เห็นว่าผลผลิตน้ำนมของโคในกลุ่ม A มีแนวโน้มที่จะสูงกว่าโคในกลุ่ม B (17.90 ± 2.97 และ 16.32 ± 2.21 กิโลกรัม ต่อ วัน) เปอร์เซ็นต์องค์ประกอบน้ำนมไม่มีความแตกต่างกันระหว่างโคทั้ง 2 กลุ่ม ยกเว้น ค่าองค์ประกอบของโปรตีน ที่ กลุ่ม A มีค่าสูงกว่ากลุ่ม B (3.17 ± 0.09 และ 2.95 ± 0.10 กรัม ต่อ 100 กรัมน้ำนม) จากผลการทดลองบ่งชี้ได้ว่าระดับความสมดุลของพลังงานในโคนมหลังคลอดจะมีค่าติดลบในโคทั้งสองกลุ่ม, โดยเฉพาะ 5 สัปดาห์แรกหลังคลอด ค่าความเข้มข้นเฉลี่ยของไขมันอิสระ และ เบต้าไฮดรอกซีบิวทีเรตในซีรั่มของโคในกลุ่ม B จะมีค่าสูงกว่าโคในกลุ่ม A ในสัปดาห์ที่ 2 หลังคลอด (0.84 ± 0.27 และ 0.52 ± 0.26 มิลลิอีควิวาเลนท์ต่อ ลิตร, 0.72 ± 0.27 และ 0.67 ± 0.18 มิลลิโมล ต่อ ลิตร ในค่า ไขมันอิสระ และ เบต้าไฮดรอกซีบิวทีเรต ตามลำดับ) ดังนั้นจากผลการทดลองสามารถสรุปได้ว่า ในอาหารข้นที่มีระดับโปรตีนหยาบ 20 เปอร์เซ็นต์ มีความเหมาะสมต่อการใช้งานในโคที่ให้ผลผลิตสูง ในระยะแรกของการให้นมมากกว่า ระดับโปรตีน 18 เปอร์เซ็นต์

คำสำคัญ โปรตีนหยาบ การผลิตน้ำนม ความสมดุลของพลังงาน

INTRODUCTION

Nowadays, breed of dairy cows in Thailand is close to 100 % of Holstein-Friesian (HF), which is know as high producing breed. In early lactating period, cows need feed that could provide enough nutrients and energy to maintain their body condition and to respond for the rapid increased of milk production. Thus, dairy cows usually suffer some degree of negative energy balance (NEB) during periparturient period, which induces the cows to mobilize their body tissue, mainly fat, to compensate for their energy need. Therefore, cows with NEB increase blood non-esterified fatty acid (NEFA) concentration. The increased NEFA in the blood is known to be associated with fatty liver and ketosis. Severity of NEB after parturition depends on several factors such as parity, feed intake, body condition score (BCS) in the dry period, and protein

concentration in the feed. In Thailand, most farmers believe that an increased level of protein in concentrate at the early lactation period can increase the milk production. In addition, the requirement of high producing cow in Thailand relies on international (foreign) information since the nutritional information in Thai is limited. The objective of this study was to find the information in Northern Thailand by determine the effect of two dietary crude protein (CP) levels in concentrates on energy balance and milk production in dairy cows during early postparturient period.

MATERIALS AND METHODS

Cows and management: Twenty-two crossbred Holstein-Friesian (75 – 96.875% HF) cows, aged 2-4 years, in their last month of gestation belonging to a dairy farm at Lampang Province, Thailand were used in the study. Mean body weight of the cows was 487.28 ± 49.25 (mean ± S.D.) kg at the start of the experiment. These cows were randomly allocated in to 2 groups of 11 cows according to the levels of protein in their concentration feed; the cows in Group A were fed 20% of CP and the cows in Group B were fed 18% of CP.

Diets and Feeding: During the dry period, all cows were fed with the same diet comprising 16% of CP concentrate, whole stem fresh corn chopped, and rice straw. One week before calving, cows were gradually fed the diet with either 20% and 18% CP. The cows were fed ad libitum 4-times per day with the same forage (corn silage or whole stem fresh corn chopped and rice straw). Amount of concentrate was calculated by prediction of milk yield per day with the ratio of 2 kg of milk per 1 kg of concentrate. Eleven cows of group A were fed a commercial diet comprising 20% of CP (dry basis) and 37 - 40% of Rumen Undegradable Protein (RUP). And eleven cows of group B were fed a farm-formulated diet comprising 18% of CP (dry basis) and 40 - 43% of RUP. Both concentrates were mainly composed of favorable materials available in Thailand (fishmeal, soybean meal, and cracked corn grain). Chemical compositions of concentrates are presented in Table 1. Monthly samples of forages and concentrates were analyzed for chemical composition by proximate analysis.

Table 1. Chemical compositions of feedstuffs fed to experimental cows.

Feed stuff	CP (%)	EE (%)	NDF(%)	ADF (%)	Ash (%)	DM (%)
Concentrate A	20 – 21	8 - 9	23 – 24	15 - 17	10 - 12	90 - 91
Concentrate B	18 – 18.5	6 - 7	22 - 24	15 - 17	12 – 13	89 - 91
Corn silage	7 - 9	1 - 3	49 – 50	30 - 31	5 - 6	27 - 29
Fresh corn chopped	5 - 7	1 - 3	47 - 48	28 - 29	4 - 5	30 - 31
Rice straw	2 - 3	1 - 2	70 - 71	54 - 56	15 - 17	92 - 93

[1] CP = crude protein

[2] EE = ether extract

[3] NDF = neutral detergent fiber

[4] ADF = acid detergent fiber

[5] DM = dry matter

Sampling Procedures: Blood samples were collected weekly starting from 1 week before parturition to 12 weeks after parturition. Blood was collected from the caudal vessels in sterile tubes. At all intervals, blood sampling was performed between 2 to 4 hours after morning feeding. Blood samples were kept in icebox and, in the laboratory, were centrifuged on the collecting day. Serum samples were stored at –70°C until further analyses.

After the first week of parturition, milk samples were collected once a week in the morning milking. Milk samples were kept in icebox and analyses in the same day. The milk yield was recorded daily throughout the experiment.

Assay Procedures: Serum β-hydroxybutyrate (BHB) (RANBUT®, kit number RB 1007; Randox Laboratories Ltd., Crumlin, UK), serum non- esterified fatty acid (NEFA) (NEFAC®, kit number 990-75401; WAKO Pure Chemical Industries, Ltd., Osaka, Japan) concentrations were measured by spectrophotometry using available test kits as indicated. Milk compositions were analyzed by Milkoscan analyzer 133D®.

Statistic analysis: Data were statistically analyzed using a SAS program (SAS, 1999 - 2001). The groups of feed concentrate were a fixed effect and the serum concentrations of NEFA, BHB, the composition of milk, milk yield were a dependent variable. Data are presented as mean ±S.D. Significant differences between group A and group B were determined by t-test. The differences were considered to be significant if $P \geq 0.05$.

RESULTS

One cow in the 18% dietary crude protein group developed dystocia. The cesarean section was performed. Another cow in this group suffered from anaplasmosis. Therefore, all data from these 2 cows were excluded from the statistical analyses.

Milk production: During the experiment period, mean milk production per cow was 17.90 ± 2.97 and 16.32 ± 2.21 kg/d for group A and B, respectively (Figure 1), and did not significantly differ between the two groups (P=0.42). The percentage of milk protein was higher for group A than group B (3.17 ± 0.09 vs 2.95 ± 0.10 respectively; $P < 0.05$). The other milk composition did not differ between two groups (Table 2).

Blood variables of Energy: Mean concentrations of NEFA are presented in Figure 2. At 1 week before parturition, mean concentrations of serum NEFA were similar in the two group (0.27 ± 0.12 and 0.29 ± 0.11 mEq/L, for group A and B, respectively). After parturition, the

concentrations of serum NEFA in both groups were increased sharply. But the mean for group B at the second week after parturition was higher than the mean for group A (0.52 ± 0.26 and 0.84 ± 0.27 mEq/L, respectively).

Mean concentrations of serum BHB are shown in Figure 3. The mean concentration at 1 week before parturition was similar for the both groups (0.67 ± 0.18 and 0.72 ± 0.27 mmol/L, for group A and B, respectively). After parturition, the concentrations were increased sharply. The concentration was higher for group B than group A at the second week (0.88 ± 0.54 vs 1.44 ± 0.37 mmol/L, respectively; P<0.02).

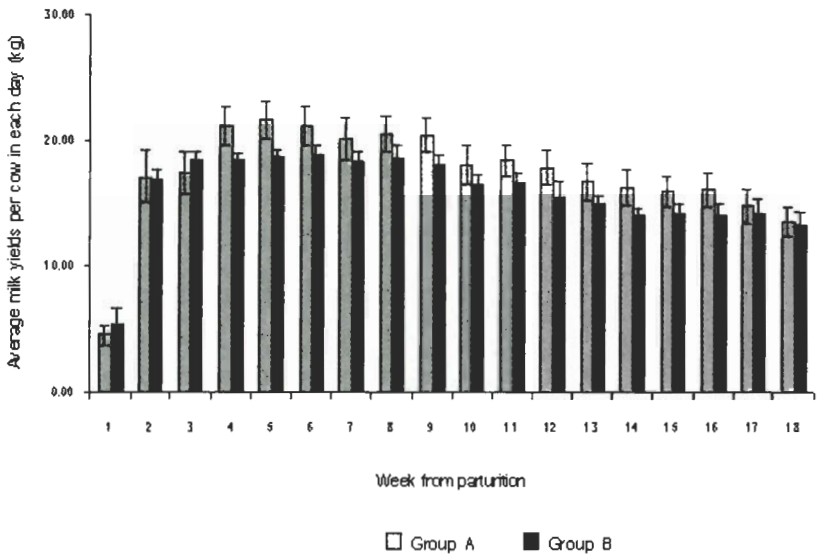

Figure 1. Comparison of mean milk yields between cows fed 20% of CP (Group A; n = 11) and cows fed 18% of CP (Group B; n = 9). Data represent mean ± S.E.M.

Table 2. Milk compositions of cows fed 20% of CP (Group A; n = 11) and cows fed 18% of CP (Group B; n = 9) during the four months of experiment. Data are means (S.D.)

Month of lactation	Percent of milk protein		Percent of milk fat		Percent of lactose		Percent of total solid	
	group A	group B	group A	group B	group A	group B	group A	group B
1	3.18 (0.13)	3.03 (0.14)	3.94 (1.02)	4.22 (0.91)	4.76 (0.11)	4.78 (0.15)	12.72 (0.92)	12.66 (0.67)
2	3.10 (0.06)	2.89 (0.07)	4.30 (0.71)	3.32 (0.09)	4.67 (0.06)	4.65 (0.12)	12.88 (0.65)	11.79 (0.08)
3	3.23 (0.06)	2.94 (0.05)	3.63 (0.21)	3.45 (0.70)	4.65 (0.03)	4.67 (0.10)	12.22 (0.24)	11.67 (0.49)
4	3.19 (0.08)	2.93 (0.04)	2.96 (0.47)	3.31 (0.32)	4.53 (0.10)	4.69 (0.07)	11.50 (0.68)	11.69 (0.27)

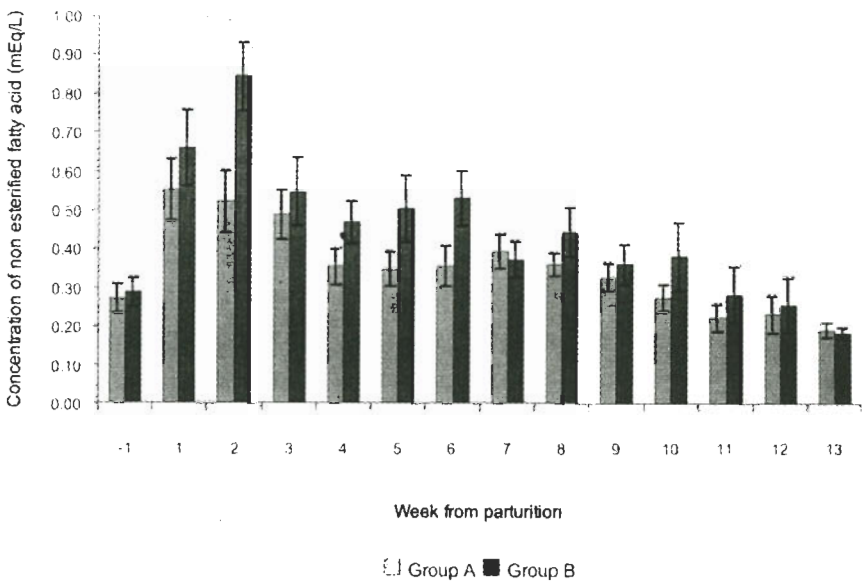

Figure 2. Comparison of serum concentrations of non esterified fatty acids (mEq/L) between cows fed 20% of CP (Group A; n = 11) and cows fed 18% of CP (Group B; n = 9) at 1 week before expected calving date until 12 week postpartum. Data represent mean ± S.E.M.

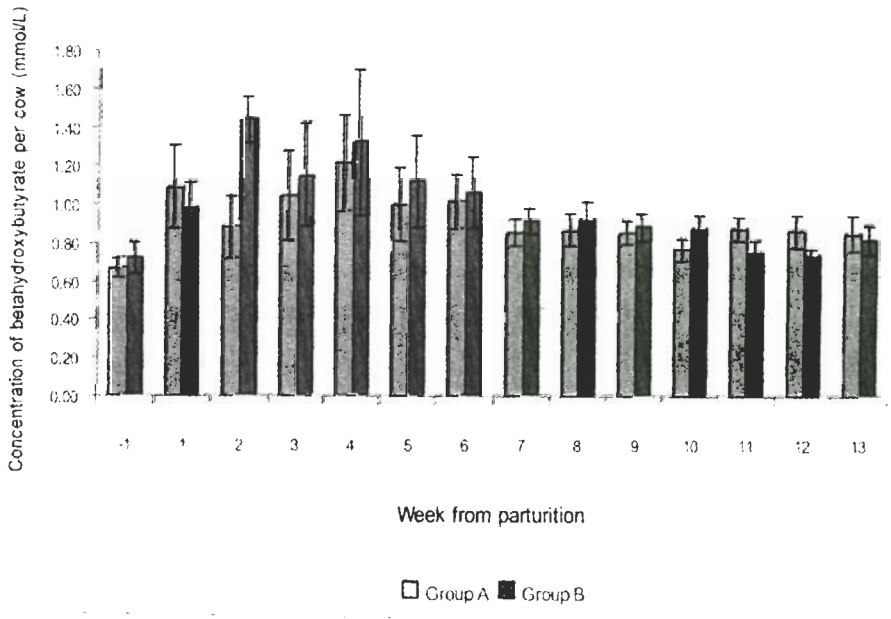

Figure 3. Comparison of serum concentrations of B-hydroxybutyrate (mmol/L) between cows fed 20% of CP (Group A; n = 11) and cows fed 18% of CP (Group B; n = 9) at 1 week before expected calving date until 12 week postpartum. Data represent mean ± S.E.M.

DISCUSSION

Our results suggested that the milk production and the energy balance in high protein concentrate (20% CP) group were better than low protein concentrate (18% CP) group, as observed that a high protein diet had better palatability, thus increasing feed intake of cows more than a low protein diet. Particularly, this effect is strong during the peak of lactation (Oldham, 1984). After parturition, cows in both groups entered some degrees of negative energy balance as indicated in this study that cows in both groups had an increase of serum NEFA after parturition. Cows responded to a negative energy balance by increasing hepatic gluconeogenesis and body fat mobilization, which resulted in an increase in serum concentration of NEFA and the serum concentration of BHB. Concentrations of serum BHB were positively correlated with serum NEFA concentration (Rukkwamsuk, 1999). Though statistically not significant, the milk productions of cows fed 20% CP tended to be higher than cows fed 18% CP. The reason may be due to the percentages of protein in the two diets in this study did not differ greatly (18% vs 20%) and the number of cow in each group was small as also observed by Kung & Huber (1983). The composition of milk in group A and B did not differ as also reported by Emery (1978), Barton et al. (1996), Komaragiri et al. (1997). We found the percentage of milk protein was higher for group A than for group B. This finding suggested that increasing amount of dietary protein could result in an increase of absorbable protein. That protein reaches the mammary tissue, which in turn could provide more amino acids needed for milk protein synthesis (Komaragiri et al., 1999).

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