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Negative Energy Balance in Periparturient Dairy Cows Raised in Small-Holder Farms in Kamphaengsaen District, Nakhon Pathom Province

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ABSTRACT

Negative energy balance was studied in 45 periparturient dairy cows from 15 small-holder farms in Kamphaengsaen District, Nakhon Pathom Province. Blood samples were collected at 1 week prepartum and 2 and 4 weeks postpartum for evaluation of negative energy balance and to study the relationship between concentrations of serum non-esterified fatty acid, serum glucose and body condition score. The results revealed that there were no significant differences in concentrations of non-esterified fatty acid at 1 week prepartum and 2 and 4 weeks postpartum. The concentrations of serum glucose and body condition score were significantly decreased after parturition. The changes of body condition score between 1 week prepartum and 2 weeks postpartum (r = 0.475) or between 1 week prepartum and 4 weeks postpartum (r = 0.364) were positively correlated with serum concentrations of non-esterified fatty acid at 2 weeks postpartum. In conclusion, periparturient dairy cows of small-holder farms in Kamphaengsaen District, Nakhon Pathom Province had some degrees of negative energy balance as observed by decreased serum glucose concentration and decreased body condition score. The results of this study would be useful for small-scale herd management to prevent periparturient negative energy balance problems and its consequences.

Key words: dairy cow, glucose, negative energy balance, non-esterified fatty acid

INTRODUCTION

Increased energy requirements and physical-endocrinological changes during periparturient period cause dairy cows to enter a negative energy balance (NEB) period (Harrison *et al.*, 1990). Cows respond to NEB, which is associated with lowered blood glucose and insulin concentrations, by increasing mobilization of body energy stores, mainly glycogen, fat, and protein to compensate for their energy requirements (Rukkwamsuk *et al.*, 1999a). Increased fat mobilization (lipolysis) causes an elevation of non-esterified fatty acids (NEFA) in the blood (Rukkwamsuk *et al.*, 1998). In the liver, these NEFAs are re-esterified to triacylglycerols (TAG) or are oxidized to form energy or ketone bodies (Bruss, 1993). Intensive lipolysis due to severe

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NEB may induce fatty liver (Rukkwamsuk *et al*., 1999b). It is documented that intensive lipolysis, NEB and fatty liver are associated with suboptimal milk production, poor health condition and reproductive disorders in postparturient dairy cows (Gerloff *et al*., 1986; Wentink *et al*., 1997; Jorritsma *et al*., 2005).

In Thailand, major health problems of dairy cows raised in small-holder farms included clinical and subclinical mastitis, blood parasites, reproductive disorders, respiratory problems, lameness and hoof problems (Poolket *et al*., 2000). In addition, suboptimal reproductive performances were reported in crossbred Holstein Friesian cows kept in small-holder farms in Kamphaengsaen District, Nakhon Pathom Province (Yawongsa *et al*., 2003). These problems may partly link to NEB and its consequences during periparturient period. Recently, fatty liver in high producing dairy cows is reported in a commercial dairy herd in Thailand (Rukkwamsuk *et al*., 2004). This study provides evidence that cows raised in Thailand would suffer some degrees of NEB. However, data concerning NEB in periparturient dairy cows raised in small-scale farms are limited.

Therefore, this study investigated NEB in periparturient dairy cows raised in small-holder farms. Relationship between serum glucose, NEFA, and body condition score (BCS) during periparturient period was also determined.

MATERIALS AND METHODS

Cows and samplings

Forty-five dry crossbred Holstein Friesian cows from 15 small-holder farms in Kamphaengsaen District, Nakhon Pathom Province were used. Expected calving dates of these cows were between January and April 2004. All farms had similar managements, having commercial concentrates fed to their cows. During the dry period, cows were fed with roughage-based diet and were offered concentrates approximately 1 to 2 kg per cow/day. During postparturient period, the concentrates were offered to the cows at the rate of 1 kg of concentrates per 2 kg of milk produced, and were subdivided into two meals per day. Cows were fed *ad libitum* with corn-stem, corn-leaf, corn-cob, rice straw and grasses as roughages.

Blood samples were collected from all cows at 1 week before expected calving and at 2 and 4 weeks after calving. Blood samples were centrifuged at 1200 g for 15 min, and serum samples were harvested and stored at -20°C until analyses. Body condition score, which is determined on a 5-point scale (1 = emaciated to 5 = obese) (Edmonson *et al*., 1989) was also recorded at all sampling periods.

Sample analyses

Concentrations of serum glucose (Glucose GOD-PAP, CLASS-1 Laboratories Co., Ltd., Bangkok, Thailand), serum NEFA (NEFA C, Wako Pure Chemical Industries Ltd., Osaka, Japan) were measured enzymatically with commercially available kits as indicated.

Statistical analyses

Data were tested for normal distribution using the Shapiro-Wilk W test (Patrie and Watson, 1999). Comparison of data between prepartum and postpartum sampling days were performed using the paired Student *t* test. Relationships between BCS and serum parameters were examined using the simple correlation (Patrie and Watson, 1999). The two-sided level of statistical significance was preset at $P \leq 0.05$.

RESULTS AND DISCUSSION

Serum glucose concentrations of periparturient dairy cows are presented in Figure 1. Before parturition, serum glucose concentrations (mean ± SEM) were 97.2 ± 4.9 mg/dL, the concentrations decreased to 80.6 ± 3.7 mg/dL at 2

weeks postpartum, and at 4 weeks postpartum the concentrations were 90 ± 4.4 mg/dL. This result indicated that these dairy cows suffer some degrees of NEB after calving. Although dairy cows had an increase of serum NEFA concentrations during NEB (Rukkwamsuk *et al*., 1998), serum NEFA concentrations did not differ between before and after parturition (Figure 2). Average serum concentrations of NEFA were 0.56 ± 0.04 mEq/L, 0.58 ± 0.05 mEq/L and 0.48 ± 0.04 mEq/L at 1 week prepartum and 2 and 4 weeks postpartum. This result was not in agreement with previous

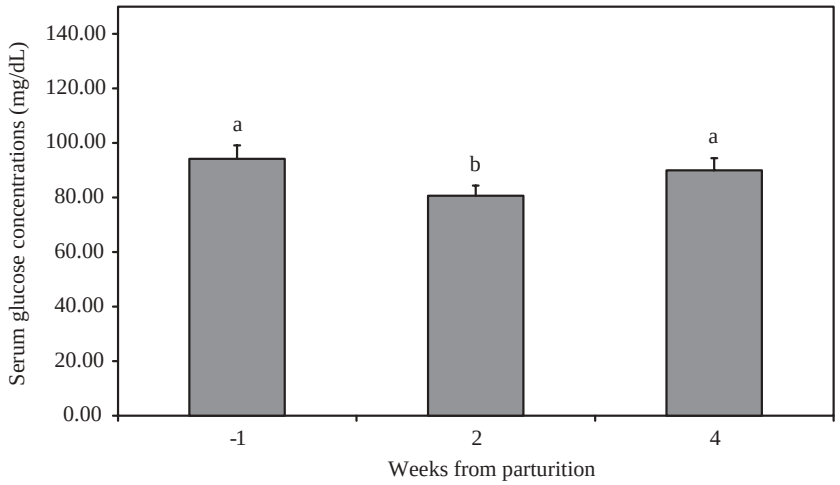

Figure 1 Serum glucose concentrations (mg/dL) of periparturient dairy cows (n = 45) measured at -1, 2 and 4 weeks from parturition. Data represented mean and SEM. Different letters indicate mean concentrations between prepartum and postpartum sampling periods were different at $P < 0.05$.

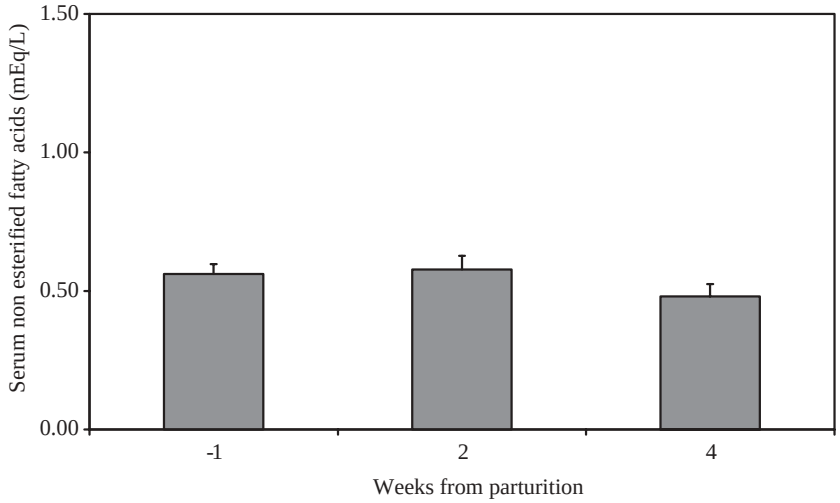

Figure 2 Serum non-esterified fatty acid concentrations (mEq/L) of periparturient dairy cows (n = 45) measured at -1, 2 and 4 weeks from parturition. Data represented mean and SEM.

study (Rukkwamsuk *et al*., 1998). However, serum concentrations of NEFA at 1 week prepartum seemed to be higher than normal value (0.24 ± 0.07 mEq/L) that was reported earlier in Thailand (Rukkwamsuk *et al*., 2005). Increased serum concentrations of NEFA observed in this study suggested that, 1 week before calving, dairy cows raised in small-holder dairy farms have already gone into a period of NEB.

Body condition scores of periparturient dairy cows are demonstrated in Figure 3. At 1 week prepartum, BCS was 3.08 ± 0.08, which was lower than the expected BCS of 3.5 for close-up dry cows (Ferguson *et al.*, 1994). After parturition, all dairy cows went into a period of NEB and lost their BCS. At 2 and 4 weeks postpartum, BCS were 2.48 ± 0.05 and 2.48 ± 0.04, respectively. The changes of BCS were 0.59 (BCS at 1 week prepartum – BCS at 2 weeks postpartum) and 0.60 (BCS at 1 week prepartum – BCS at 4 weeks postpartum). The changes of body condition score between 1 week prepartum and 2 weeks postpartum (r = 0.475) or between 1 week prepartum and 4 weeks postpartum (r = 0.364) were positively correlated with serum concentrations of NEFA at 2 weeks postpartum. This result indicates that dairy cows with NEB during periparturient period lose body weight mainly by fat mobilization to compensate for their energy requirement.

In conclusion, NEB in dairy cows raised in small-holder farms could be observed at 1 week prepartum. Cows in this study that calved between January and April 2004 seemed to have lower BCS at calving. Decreased BCS during the first month of lactation indicated that these cows went into some degrees of NEB. Low serum glucose and high serum NEFA concentrations may be used for predicting NEB. However, BCS is a quick and inexpensive, yet somewhat subjective method of estimating fat stores in dairy cows. It can be used by farmers as a management tool for monitoring negative energy status in their herds.

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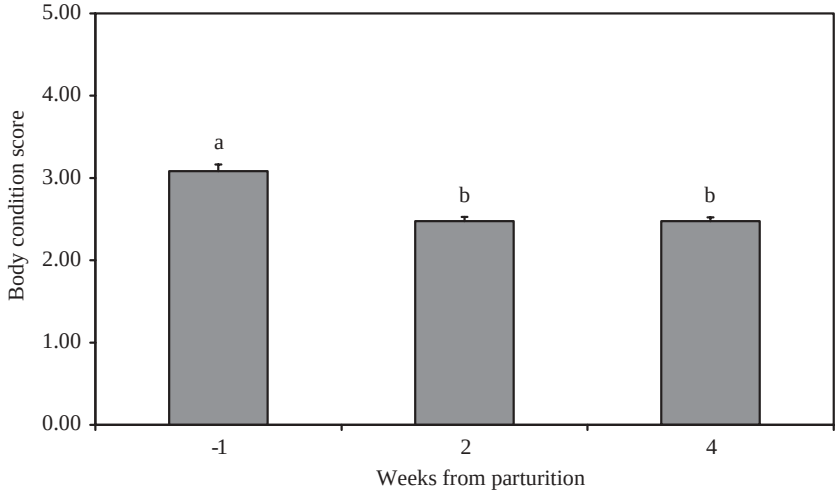

Figure 3 Body condition score of periparturient dairy cows (n = 45) measured at -1, 2 and 4 weeks from parturition. Data represented mean and SEM. Different letters indicate mean concentrations between prepartum and postpartum sampling periods were different at P < 0.05.

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