EFFECT OF PROTECTED FAT ON ENERGY BALANCE, PLASMA CONCENTRATIONS OF INSULIN-LIKE GROWTH FACTOR-I AND REPRODUCTION IN LACTATING DAIRY COWS

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Story in Brief

Concentrations of insulin-like growth factor-I were measured in early lactating dairy cows fed either a control diet or a diet containing a protected fat (2% on a DM basis) between weeks 4 and 12 post partum. All cows were fed the control diet from parturition to week 4 post partum . Energy balance and body weights were determined weekly. Diet had no effect on interval to first, second or third estrus in cows with negative or positive energy balance. Moreover, diet had no effect on plasma IGF-I. However, cows in positive energy balance had greater plasma IGF-I than those in negative energy balance.

(Key Words: Insulin-like Growth Factor-I, Energy Balance, Protected Fat)

Introduction

Reproductive performance of lactating dairy cows tends to decrease as milk production increases. During early lactation, many high producing cows are unable to consume enough feed to meet their energy demands, resulting in a state of negative energy balance. Energy balance (EB), quantified using measures of milk production (quantity and composition), dietary intake (quantity and composition) and body weight, may be associated with reproductive efficiency. Energy balance has an inverse relationship with days to first postpartum ovulation (Butler and Smith, 1989) and cows that express estrus before their first postpartum ovulation have a greater EB than cows that do not express estrus (Berghorn et al., 1988; Spicer et al., 1990).

Although studies implicate EB as a regulator of ovarian function, the hormone(s) or metabolite(s) mediating the effects of EB on ovarian function

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Results and Discussion

The various components that were used to calculate EB and their average values for PEB and NEB cows during weeks 1 to 4 and 5 to 12 post partum are in Table 1.

Diet and EB had no effect ($P>.10$) on intervals to first, second or third estrus (Table 2). Similarly, Spicer et al. (1990) reported that interval to first and second estrus did not differ between cows in positive and negative energy balance.

Diet had no effect ($P>.10$) on plasma IGF-I concentrations during week 5 to 12 post partum. However, NEB cows had lower ($P<.05$) plasma IGF-I concentrations during weeks 1 to 12 than did PEB cows (Figure 1). Previous studies (Spicer et al., 1990) have shown a positive association between EB and blood IGF-I levels. Week post partum affected ($P<.01$) plasma IGF-I concentrations (Figure 1); in PEB and NEB cows, plasma IGF-I increased

Table 1. Mean components (± SE) used to calculate energy balance in positive energy balance (PEB) and negative energy balance (NEB) cows during weeks 1 to 4 and 5 to 12 post partum (PP).

Component	Weeks PP	PEB	NEB
Body Weight, lb.	1-4	1403 ± 24	1436 ± 33
	5-12	1423 ± 25	1433 ± 36
DM Intake, lb./day	1-4	47.0 ± 2.5	34.0 ± 3.8
	5-12	54.4 ± 2.2	50.7 ± 3.2
Daily Milk, lb.	1-4	63.7 ± 4.9	60.8 ± 4.5
	5-12	76.8 ± 4.2	77.9 ± 4.5
Milk fat, %	1-4	3.86 ± 0.19	4.38 ± 0.26
	5-12	3.54 ± .19	3.58 ± 0.17
SNF, %	1-4	8.92 ± 0.12	8.73 ± 0.10
	5-12	8.64 ± .09	8.67 ± .09
Energy balance,	1-4	5.17 ± 1.29	-7.50 ± 2.46
Mcal/day	5-12	8.32 ± 1.42	4.74 ± 1.90
NE maintanence,	1-4	10.1 ± 0.1	10.3 ± 0.2
Mcal/day	5-12	10.2 ± 0.1	10.3 ± 0.2
NE intake,	1-4	37.2 ± 2.0	26.9 ± 3.2
Mcal/day	5-12	43.8 ± 1.9	40.5 ± 2.6
Milk energy,	1-4	21.0 ± 1.4	21.5 ± 1.5
Mcal/day	5-12	24.0 ± 1.3	24.7 ± 1.4

Table 2. Mean days to first, second and third estrus for negative energy balance (NEB) and positive energy balance (PEB) cows fed either control (C) diet or protected-fat (PF) diet.

	Postpartum Estrus (days)		
Group-diet	First	Second	Third
NEB - C	37.5(6)[a]	82.8(5)	104.0(5)
NEB - PF	58.5(4)	92.0(3)	82.5(2)
PEB - C	26.4(5)	62.0(5)	84.3(4)
PEB - PF	34.3(6)	72.2(6)	105.4(5)
Pooled SE	7.4	16.0	13.6

[a]Number in parentheses denotes number of cows.

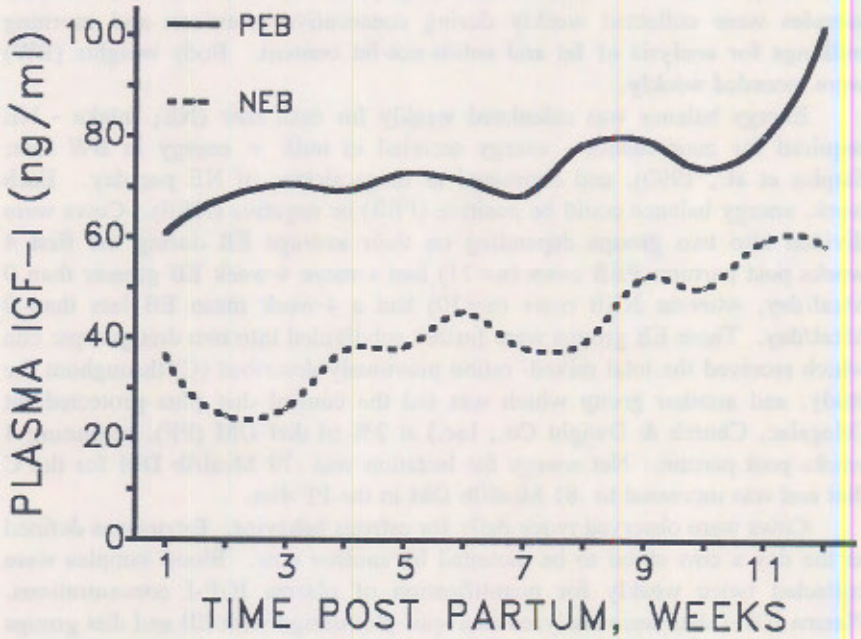

Figure 1. Concentrations of IGF-I in plasma of cows with positive (PEB) or negative (NEB) energy balance during early lactation. Within energy balance group, data from cows on the two dietary treatments were pooled. Pooled SE for PEB and NEB cows are 5.5 and 5.8 ng/ml, respectively.

is(are) unknown. Insulin-like growth factor-I (IGF-I) is a potential mediator of the positive effects of increased EB on reproduction in dairy cattle (Spicer et al., 1990). Specifically, IGF-I in blood of cattle, predominantly of liver origin, is modified by variations in energy intake (Houseknecht et al., 1988) and increases as EB increases (Spicer et al., 1990). Thus, increasing the energy content of the diet with fat that bypasses the rumen may increase blood levels of IGF-I, resulting in positive effects on reproductive function. The objective of this study was to determine if addition of protected fat to diets of lactating dairy cows in negative EB alters plasma IGF-I concentrations and(or) reproductive functions.

Materials and Methods

From parturition to week 12 post partum, 21 pluriparous Holstein cows were individually fed a total mixed ration of sorghum silage, alfalfa hay, whole cottonseed and concentrate (20.3, 19, 8.5 and 52.2%, respectively on DM basis). Cows were milked twice daily (3:00 AM and 3:00 PM) and milk samples were collected weekly during consecutive afternoon and morning milkings for analysis of fat and solids-not-fat content. Body weights (BW) were recorded weekly.

Energy balance was calculated weekly for each cow (NE_l intake - NE required for maintenance - energy secreted in milk + energy in BW loss; Staples et al., 1990), and expressed as megacalories of NE per day. Each week, energy balance could be positive (PEB) or negative (NEB). Cows were divided into two groups depending on their average EB during the first 4 weeks post partum: PEB cows (n=11) had a mean 4-week EB greater than 0 Mcal/day, whereas NEB cows (n=10) had a 4-week mean EB less than 0 Mcal/day. These EB groups were further subdivided into two diet groups: one which received the total mixed ration previously described (C) throughout the study, and another group which was fed the control diet plus protected fat (Megalac, Church & Dwight Co., Inc.) at 2% of diet DM (PF), beginning 4 weeks post partum. Net energy for lactation was .79 Mcal/lb DM for the C diet and was increased to .81 Mcal/lb DM in the PF diet.

Cows were observed twice daily for estrous behavior. Estrus was defined as the day a cow stood to be mounted by another cow. Blood samples were collected twice weekly for quantification of plasma IGF-I concentrations. Plasma IGF-I data were analyzed as a split-plot design with EB and diet groups as main plots and week post partum as a subplot.

approximately two-fold between week 1 and 12 post partum. Similarly, Spicer et al. (1990) observed that serum IGF-I increased with week post partum in lactating dairy cows.

In summary, feeding protected fat between weeks 4 and 12 post partum had no effect on days to first, second or third estrus or on plasma IGF-I concentrations.

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