12-1990

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Recommended Citation

Holter, J.B.Urban, W.E.McGilliard, M.L. et al. Effect of Prepartum Dietary Energy on Condition Score, Postpartum Energy, Nitrogen Partitions, and Lactation Production Responses. Journal of Dairy Science , Volume 73 , Issue 12 , 3502 - 3511.

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Effect of Prepartum Dietary Energy on Condition Score, Postpartum Energy, Nitrogen Partitions, and Lactation Production Responses[1]

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ABSTRACT

Objectives were to examine the effects of feeding to alter body condition at calving on subsequent full lactation production performance and feed intake, on BW and periparturient blood traits, and on complete energy and N balances and ration digestibility during wk 6, 10, and 14 postpartum. Thirty pluriparous Holstein cows were assigned randomly to two energy intakes from wk 33 of previous lactation through the dry period to create either normal (7.2) or thin (5.8) mean body condition scores at calving (9 = fat, 1 = thin). The thin group was fed 0 kg hominy feed daily; the normal group was fed 2.7 kg daily to supplement forage DM available ad libitum during this period. When compared with the normal group, cows in the thin condition group exhibited less negative body fat balance (–206 vs. –507 g/d); similar milk yield, DM intake, N partitions, and nutrient digestibilities; and lower fat test (3.2 vs. 4.1%) during the balance measurements. Whole blood and serum traits were within normal physiological ranges. Full lactation measurements were similar between treatments except that milk fat percentage was lower and DM intake (as percentage of BW), was higher in the thin condition group. Although mean BW at calving was more (651 vs. 599 kg) for normal condition cows, condition scores and BW were not significantly different at 14 wk postpartum; BW curves indicated similar rates of recovery of weight thereafter. Cows considered underconditioned at parturition mobilized less body fat after calving, resulting in reduced milk fat concentration without significant effects on milk yield, protein, SNF, DM intake, or nutrient utilization.
(**Key words**: body condition, production, body tissue balance)

INTRODUCTION

The work of Soderholm et al. (17) illustrated that treatments that reduce body condition score prior to calving (2.4 vs. 3.7) also reduce body fat content (17.7 vs. 23.6% BW) with much less change in body protein (11.6 vs. 10.6% BW) and ash (2.7 vs. 2.5% BW). This finding supports the use of subjective visual appraisal of body condition to evaluate degree of fatness. Martin and Ehle (16) confirmed that body fat is mobilized in early lactation for milk production and that body fatness is related to energy density of the diet.

Bines and Morant (2), using dry, nonpregnant Holstein cows offered high energy diets for ad libitum intake, found that the animals consumed 24% more DM when thin than when fat. Garnsworthy and Jones (8) reported that dairy cows in high condition ate significantly less during the first 20 wk of lactation than did

Received March 12, 1990.
Accepted June 4, 1990.
[1]Scientific Contribution Number 1667 from the New Hampshire Agricultural Experiment Station.

thinner cows. However, others (5, 6, 13) found no difference between fat and thin cows with regard to DM intake. Increased body condition has resulted in increased milk yield and fat test in some studies (5, 14) but not in others (4, 7). Possibly some of the reported discrepancy on effects of body condition on intake and production can be attributed to protocol for designating treatment groups. For example, in one study (5), cows were assigned to condition groups (outcome groups) 4 d postpartum; significant FCM differences were found for condition groups but not for prepartum feeding intakes. Another discrepancy may be the method of evaluating body condition; for example, Fronk et al. (6) used visual body condition score and Davenport and Rakes (5) used ratio of BW to frame size.

Application of bovine somatotropin technology may lead to suboptimum body condition in late lactation and dry period and at subsequent calving. Our objective was to examine the effects of prepartum feeding level on visual body condition score at calving and on postpartum free choice feed intake; milk yield; milk composition; tissue fat and protein balances during wk 6, 10, 14 postpartum; and related nutritional traits.

MATERIALS AND METHODS

To establish normal and thin body condition groups, 30 pluriparous Holstein cows were assigned randomly without regard to BW or condition score at wk 33 postpartum to receive 2.72 or 0 kg/d hominy feed in addition to free choice forage (.63 corn silage, .37 wilted grass silage DM). These rations were fed individually through remaining lactation and following dry period, but forage intake was not recorded in the dry period. Corn silage was treated with .45% urea and .15% sodium sulfate at ensiling. Cows were fed and milked twice daily at 0500 and 1500 h in a conventional stanchion barn adapted for individual feeding and orts retrieval. Silage DM was evaluated weekly and used to adjust wet weights to ensure constant DM ratio. Ten days before expected calving, hominy feeding was discontinued and grain mixture (17% CP) was introduced to all cows and increased in .5- to .7-kg increments to a maximum daily amount equal to .8% BW at calving.

After calving, all cows were offered forage free choice plus a pelleted grain mixture (Table 1) and supplemental corn gluten meal (1.7% of concentrate) to appetite, adjusted daily from wk 1 through 8 of lactation with a ceiling of 1 kg/2 kg milk. The grain ceiling was based on previous day's milk yield to accommodate expected normal differences within and between cows in daily yield and to prevent low peak cows from overconsuming grain in relation to their needs; it served the same purpose as imposing a minimum fiber restriction. Sodium bicarbonate (57 g) was top-dressed on each cow's silage twice daily. Uneaten feeds were available 22 h/d (orts DM = 8 to 10% DM intake). After wk 8, pelleted grain was fed in a standard (10) declining fashion (adjusted weekly) to all cows based on total amount of grain each consumed during wk 1 to 8 of lactation regardless of milk yield response. Daily concentrate offered each cow

TABLE 1. Ingredient composition and theoretical analysis of pelleted grain mixture fed 10 d before through 32 wk after parturition.

Item	(% as fed)
Ingredient	
Corn meal	69.93
Soybean meal (48% CP)	8.60
Corn distillers dried grains with solubles	7.85
Corn gluten meal	5.00
Cane molasses	3.00
Dicalcium phosphate	2.25
Ground limestone	1.35
Potassium chloride (Dyna K)[1]	1.00
Salt	.90
Magnesium oxide	.06
Trace mineral premix[2]	.05
Vitamin A and D premix[3]	.015
Analysis	
CP	16.3
Fat	3.6
Ca	1.08
P	.73
K	.89
S	.18
Mg	.17
N solubility, % total N	12
NE_l, Mcal/kg	1.68

[1]International Minerals and Chemical Corp, Mundelein, IL.

[2]Provides (ppm of mixed feed): 69 Zn, 50 Fe, 12 Mn, 1.6 I, .35 Co, and .12 Se.

[3]Provides 6600 IU each of vitamins A and D/kg of mixed feed.

TABLE 2. Composition of feeds offered and orts during complete lactations.

Feeds and orts	n	DM		CP		Fat		NDF		ADF		Sol[1]	
		— (%) —		— (% DM) —								– (% CP) –	
		$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE	$\overline{X}$	SE
Corn silage	19	28.4	.3	12.6	.2	3.0	.1	50.6	1.5	30.0	1.1	74	2
Haycrop silage[2]	21	33.7	.7	13.3	.6	3.7	.1	62.1	1.5	39.6	.7	59	2
Pelleted grain	20	89.8	.2	18.8	.2	3.7	.1	18.0	.6	5.8	.2	17	1
Corn gluten meal	2	89.8	. . .	66.8	. . .	1.2	. . .	14.5	. . .	8.3	. . .	2.2	. . .
Orts	22	34.8	1.0	13.9	.5	3.1	.1	49.5	1.9	27.0	1.0	. . .	. . .
Hominy feed[3]	1	91.0	. . .	10.3	. . .	6.8	. . .	22.7	. . .	7.0	. . .	23	. . .

[1]Protein soluble in phosphate and bicarbonate buffer.

[2]Percentage of total CP insoluble in acid detergent ranged from 3.8 to 12.5%; two samples exceeded 8.6%.

[3]Fed prior to calving to cows in normal body condition group at 2.7 kg/d.

during wk 9 postpartum was 1.546% of the total concentrate she consumed during wk 1 to 8. This percentage declined weekly, as described by Holter et al. (10), so that daily concentrate offered in wk 32 postpartum and until wk 44 equaled .155% of that consumed in the first 56 d of lactation. This feeding strategy provides about 34% of lactation concentrate during wk 1 to 8 postpartum. Corn gluten meal (.15 kg/d) was substituted for equal weight of pellets from wk 9 to dryoff. Weights of milk, feeds, and orts were recorded daily, and biweekly a.m..-p.m. milk composites were analyzed for fat (Babcock) and SNF (Golding Bead Test). Milk was analyzed for protein (Orange G Dye Binding), and orts were sampled and composited by treatment every 4 wk. Composite samples of feeds and orts were analyzed for proximate nutrients, ADF, NDF, and N solubility (in phosphate and bicarbonate buffer).

All cows were evaluated subjectively for body condition at 2-wk intervals during the dry period, on d 1, and during wk 14 postpartum by three experienced dairy judges using the Oklahoma nine-point system (1). This system relates amount of fat cover to a numerical rating (9 = overconditioned to 1 = extremely thin). Relative fatness visually is evaluated first on lower rib and thigh areas: then over ribs, chine, loin and rump; and finally in brisket, neck, shoulders, thighs, and rump. Dystocia score was recorded for each cow, and BW was measured at 2-wk intervals throughout lactation. Urine ketones were estimated using reagent strips (Ames Division, Miles Laboratories, Inc., Elkhart, IN 46515) at four weekly intervals after calving. Blood was sampled from the coccygeal artery 1 wk before anticipated calving and 1 wk postpartum and processed and analyzed as in (9).

During wk 6, 10, and 14 postpartum, all cows were moved to the laboratory to measure ration digestibility and complete energy and N balances using standard large animal calorimetric procedures as outlined previously (11). Cows were adjusted to new surroundings 2 d before 6-d collection followed by 24-h heat and methane production measurements.

Lactation data first were summarized by 28-d periods after calving and then combined into complete lactations before ANOVA using SAS (18) with body condition as main effect. Balance trial and blood data were analyzed likewise with condition and weeks as main effects. Student's t test was used to evaluate difference in calving ease. A probability of 5% was used throughout unless otherwise noted.

RESULTS AND DISCUSSION

Rations used (Tables 1, 2) are typical of many Northeast dairies; corn constitutes nearly 75% of diet DM. Although solubility of forage CP was high, ration CP solubility averaged about 31%, and forages contributed about one-third of ration CP during the balance trials.

Thin and normal condition cows in prior lactation and dry period averaged 22.8 and 20.7 kg 4% FCM/d, 301 and 320 d in milk, 3.60 and 3.70% milk fat, 4 of 15 and 5 of 15 cows in first lactation, 63 and 70 d dry, 91 and 96 d in

TABLE 3. Means for BW, DM intake, and several ration characteristics for pluriparous Holstein cows during balance trials by week of lactation and body condition group at calving.

	Week postpartum			Body condition group			Probability	
Trait	6	10	14	Thin	Normal	SE	Week	Condition
Condition score[1] at calving	...	...	...	5.8	7.2	.3	...	<.05
BW at calving, kg	...	...	...	599	651	21	...	<.05
Condition score at wk 14	...	...	...	5.1	5.2	.2	...	NS[2]
BW at wk 14	...	...	...	562	586	15	...	NS
CP in ration DM, %	17.2	16.5	15.5	16.4	16.5	.1	<.01	NS
BW mean, kg	567	571	574	557	584	8	NS	<.05
DM intake, kg/d	18.0	18.9	18.4	18.2	18.6	.3	NS	NS
DM intake, % BW	3.19	3.32	3.22	3.28	3.21	.05	NS	NS
Grain in ration DM, %	65	56	40	56	51	1	<.01	<.01
NDF in ration, DM, %	28.5	31.9	38.3	32.0	33.8	.5	<.01	<.05

[1]9 = Very fat, 1 = very thin (1).

[2]$P>.05$.

milk after wk 32, and 153 and 166 d on 0 or 2.72 kg/d hominy feed, respectively. These differences were not large; they may be attributed partially to larger proportion of previous first lactations in the normal group and to possible effects of experimentation during the prior lactation. The latter point constitutes a defensible reason for assigning cows to treatments randomly, thus avoiding maximization of within-treatment variation.

Body condition scores (Table 3) at calving averaged 5.8 (range 3.7 to 7.7) for thin cows and 7.2 (range, 6.0 to 8.7) for normal cows, at which time BW also was lower (599 vs. 651 kg) for thin cows; similar results were noted by others (3). However, at wk 14 postpartum, both treatment groups had lost condition and were not significantly different in condition score or BW. Thus, cows in the normal body condition group apparently lost more body fat (–65 vs. –37 kg BW) than thin cows during the first trimester of lactation as in (5, 8).

Ration CP (Table 3) decreased from wk 6 to 14 postpartum as intended and was not different for condition groups. During balance trials, BW was higher for normal than for thin cows but was not significantly different for wk 6, 10, and 14. Apparently, BW had minimized by wk

TABLE 4. Means for milk and SCM yields, milk composition, and apparent body tissue changes of pluriparous Holstein cows during balance trials by week of lactation and body condition group at calving; urine ketones wk 1 to 4 postpartum by body condition group.

	Week postpartum			Body condition group			Probability	
Trait	6	10	14	Thin	Normal	SE	Week	Condition
Milk yield, kg/d	39.3	37.0	31.1	36.1	35.6	.8	<.01	NS[1]
Fat, %	3.56	3.48	3.95	3.23	4.10	.12	NS	<.01
Protein, %	2.66	2.80	2.81	2.75	2.76	.04	NS	NS
SNF, %	8.17	8.29	8.39	8.20	8.37	.06	NS	NS
Total solids, %	11.7	11.8	12.4	11.4	12.5	.2	<.05	<.01
SCM Yield, kg/d	35.3	33.2	29.9	31.0	34.8	.6	<.05	<.05
Body balance, g/d								
Protein	316	266	240	284	264	26	NS	NS
Fat	–579	–262	–229	–206	–507	77	<.05	<.01
Urine ketones, % cows over 5 mg/dl	...	...	...	6.7	26.6	...	...	...

[1]$P>.05$.

TABLE 5. Means for gross energy (GE) and N partitions and water intake of pluriparous Holstein cows during balance trials by week of lactation and body condition group.

Trait	Week postpartum			Body condition group			Probability	
	6	10	14	Thin	Normal	SE	Week	Condition
GE Intake, Mcal/d	74.6	78.5	77.0	75.8	77.6	1.2	NS[1]	NS
Feces, % GE	30.4	31.3	33.1	31.3	31.9	.4	<.01	NS
Urine, % GE	2.6	2.4	2.3	2.5	2.4	.1	NS	NS
Methane, % GE	3.4	4.1	5.1	3.9	4.5	.1	<.01	<.01
Heat, % GE	34.2	32.7	32.8	33.3	33.2	.5	NS	NS
Milk, % GE	34.5	30.9	27.9	29.9	32.4	.6	<.01	<.01
Tissue, % GE	–5.1	–1.3	–1.3	–.8	–4.3	1.0	NS	<.05
ME,[1] % GE	63.2	61.8	59.1	61.9	60.8	.4	<.01	NS
Energy balance, kcal/d	–3687	–975	–807	–346	–3300	789	NS	<.01
N Intake (NI), g/d	496	501	457	482	487	9	<.01	NS
Feces, % NI	29.8	31.1	33.6	31.1	31.9	.6	<.01	NS
Urine, % NI	27.2	28.3	28.2	27.4	28.4	.7	NS	NS
Milk, % NI	33.0	32.4	29.9	32.3	31.3	.6	<.01	NS
Tissue, % NI	10.0	8.2	8.2	9.2	8.4	.8	NS	NS
N balance, g/d	51	42	38	45	42	4	NS	NS
Water intake, kg/d	75	73	68	70	74	2	NS	NS

[1]ME = Metabolizable energy.

[2]P>.05.

6 of lactation. Intake of DM was not significantly different among weeks or between body condition groups during balance trials, an observation in agreement with results of other studies (3, 5, 6, 13). Percentage of grain in ration DM was lower for normal than for thin group because they consumed 1.1 kg/d more forage DM (fed free choice) and .7 kg/d less grain. As a result, their ration contained somewhat higher NDF percentage. We consider this an early lactation treatment effect.

Milk yield (Table 4) during balance trials was high, peaked about wk 6, and, like DM intake, was not significantly different between

TABLE 6. Means for nutrient digestibility and TDN and for digestible (DE), metabolizable (ME), and net energy for pluriparous Holstein cows during balance trials by week of lactation and body condition group.

Trait	Week postpartum			Body condition group			Probability	
	6	10	14	Thin	Normal	SE	Week	Condition
Apparent digestibility, %								
Energy	69.6	68.7	66.9	68.7	68.1	.4	<.01	NS[3]
DM	71.1	70.4	68.7	70.5	69.7	.3	<.01	NS
CP	70.2	68.9	66.4	68.9	68.1	.6	<.01	NS
Ether extract	82.0	81.5	78.4	80.5	80.8	.8	<.05	NS
NDF	44.5	48.5	51.4	47.4	48.9	.7	<.01	NS
ADF	43.2	48.2	51.2	46.9	48.2	.7	<.01	NS
Corrected NDS[2]	84.9	84.1	82.7	84.4	83.4	.4	<.01	NS
TDN, %	70.2	69.7	68.1	69.8	69.0	.3	<.01	NS
DE, Mcal/kg DM	2.89	2.85	2.80	2.86	2.84	.03	NS	NS
ME, Mcal/kg DM	2.62	2.57	2.48	2.58	2.53	.03	<.05	NS
$NE_{mt + p}$,[1] Mcal/kg DM	1.85	1.83	1.74	1.82	1.79	.03	NS	NS
$NE_l/BW^{.75}$, kcal/kg	186	197	175	191	181	5	NS	NS

[1]$NE_{mt + p}$ = NE for maintenance plus production.

[2]NDS = 100 – NDF, corrected for ether extract and soluble ash.

[3]P>.05.

TABLE 7. Periparturient blood traits of thin and normal pluriparous Holstein cows.

	Body condition		Time postpartum	
Trait[1]	Thin	Normal	–1 wk	+1 wk
Whole blood				
White cells, $10^3/\mu l$	7.4	8.1	7.9	7.5
Red cells, $10^6/\mu l$	5.8**	6.2	6.0	6.0
Hemoglobin, g/dl	10.1**	11.0	10.6	10.5
Hematocrit, %	28.1**	30.7	29.1	29.7
MCV	48.8	49.9	48.9	49.9
MCH, μμg	17.5	17.8	17.7	17.6
MCHC	35.8	35.8	36.3*	35.3
Serum				
Total protein, g/dl	7.0**	7.5	7.1	7.3
Albumin (A), g/dl	3.6	3.6	3.6	3.6
Globulin (G), g/dl	3.4*	3.8	3.5	3.7
A/G ratio, wt/wt	1.11	.96	1.06	1.02
Urea N (BUN), mg/dl	11.4	12.2	10.2	11.4
Creatinine (C), mg/dl	1.43	1.38	1.54**	1.26
BUN:C ratio, wt/wt	8.3	7.7	6.7**	9.3
Calcium, mg/dl	9.4	9.6	9.6	9.3
Phosphorus, mg/dl	7.1	6.8	6.6*	7.3
Sodium, meq/L	145	145	146	144
Potassium, meq/L	4.5	4.4	4.5	4.4
Chloride, meq/L	103	102	104**	101
Glucose, mg/dl	61	63	68**	57
Cholesterol, mg/dl	88	92	93	87
Triglyceride, mg/dl	15.7	18.3	25.1**	8.9
Alkaline phosphatase, IU/L	51*	63	63*	51
Total bilirubin, μg/dl	.15	.17	.16	.16
LDH, IU/L	709*	779	672**	816
SGPT, IU/L	17.0	19.5	20.4	16.1
SGOT, IU/L	64	74	53**	84
GGTP, IU/L	19.9	21.7	19.5	22.1

[1]MCV = Mean corpuscular volume, MCH = mean corpuscular hemoglobin, MCHC = mean corpuscular hemoglobin concentration, LDH = lactic dehydrogenase, SGPT = serum glutamic-pyruvic transaminase, SGOT = serum glutamic-oxaloacetic transaminase, and GGTP = gamma glutamyl transpeptidase.

*$P<.05$.

**$P<.01$.

body condition groups as noted also by Boisclair et al. (3). However, cows in the thin group exhibited strikingly lower fat test, and because of this, lower total milk solids percentage and yield of SCM. Otherwise, milk composition was similar between groups. Body protein balance was not significantly affected by interval postpartum or body condition, being substantially positive in all instances. However, body fat balance was strongly negative in all cases, especially at wk 6 postpartum and for normal condition cows. Apparently the group with more depot fat reserves (normal group) mobilized more of that fat for milk fat synthesis. This conclusion is supported by their higher urine ketone levels (no clinical ketosis) and by the greater losses of condition and BW during the course of the balance trial as noted. Difference in fat test confirms, but was more pronounced than, that reported by Davenport and Rakes (5); however, it disagrees with Gardner (7), who found no effect of prepartum energy intake on early lactation fat test.

Parenthetically, we note that ration CP concentrations (Table 3), which generally would be regarded as normal for high-producing cows in the first trimester of lactation, exceeded the CP needs of these cows as evidenced by their unnecessarily high (Table 4) body protein balances. Increased N storage as protein, at any given energy balance, decreases body fat balance to the extent of the energy contained in

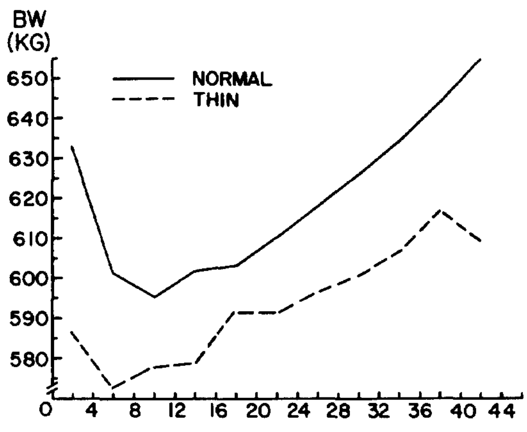

Figure 1. Postpartum BW of pluriparous Holstein cows fed prepartum to create normal or thin body conditions.

such stored protein. Because CP of concentrates generally is more digestible than CP of forages (15), selection of ration CP concentration ought to be conservative when most of the ration CP is provided by grain. It appears that 33, 61, and 63% of the negative body fat balances during wk 6, 10, 14, respectively (Table 4), can be attributed to body protein balances in excess of zero. Corresponding percentages for thin and normal condition groups would be 82 and 31.

Effects of interval (weeks) postpartum on partitions of dietary gross energy (GE) and N can be related generally to declining ratio of concentrate to forage (see Table 3) in the diet. Intakes of GE and N by cows in thin and normal body condition groups were not significantly different as indicated also by DM intake and ration CP percentages (Table 5). Cows in the thin group lost less GE as methane because of the lower proportion of forage in their diet as discussed above. Less energy was secreted as milk by thin cows because of milk fat depression experienced by this treatment group. The markedly less negative tissue energy balance of cows in the thin condition group resulted in their less negative body fat balance (Table 4) and agrees with differences in BW change and urine ketones previously noted. Neither partition of N nor water intake were different for thin and normal condition groups.

Efficiency of digestion, as indicated by apparent digestibility of nutrients (Table 6), was not significantly different for thin and normal body condition groups, and differences due to stage of lactation (weeks) are an expected reflection of increasing proportion of forage in diets. Measures of energy density of rations were similar for condition groups despite the somewhat higher proportion for forage (see Table 3) consumed by cows in the normal condition group.

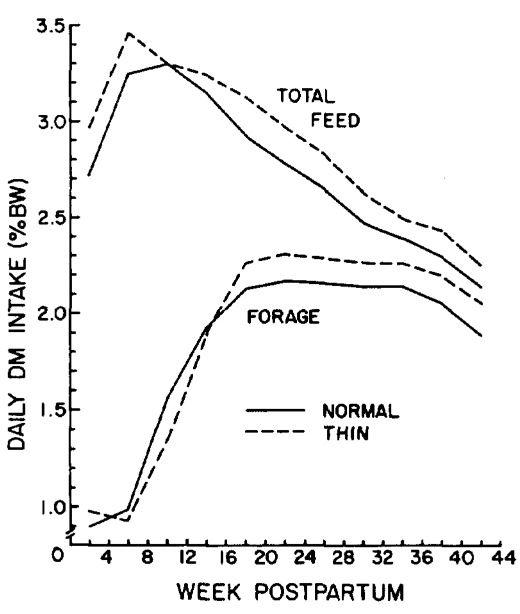

Figure 2. Effects of prepartum feeding to create normal or thin body conditions on postpartum daily intakes of total feed and forage DM per unit BW by pluriparous Holstein cows.

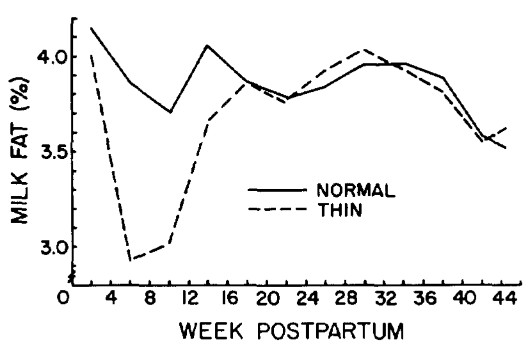

Figure 3. Effect of prepartum feeding to create normal or thin body conditions on postpartum milk fat percentages of pluriparous Holstein cows.

TABLE 8. Intake, BW, and production traits of normal and thin pluriparous Holstein cows during complete lactations.

Trait	Calving condition score[1] Thin, 5.8	Normal, 7.2	SE	P^2
n	15	15	. . .	. . .
Days in milk	298	295	8	NS
BW, kg	595	618	14	NS
Corn silage, % forage DM	63.0	63.0	. . .	. . .
DM Intake (DMI), kg/d	17.1	17.0	.4	NS
Forage DM, kg/d	11.2	11.2	.4	NS
Grain DM, kg/d	5.95	5.76	.20	NS
Diet DMI, % BW	2.89	2.74	.06	<.12
Forage DMI, % BW	1.89	1.82	.05	NS
Orts DM, % DMI	8.5	8.5	.1	NS
Milk yield, kg/d	24.9	24.3	.9	NS
Fat, %	3.62	3.93	.13	<.10
SNF, %	8.21	8.24	.10	NS
Protein, %	2.97	2.98	.07	NS
4% FCM Yield, kg/d	23.4	24.0	.9	NS
SCM[3] Yield, kg/d	22.6	22.9	.8	NS
SCM:DMI, kg/d	3.42	3.62	.12	NS

[1]Aalseth et al. (1); 9 = fat, 1 = thin.

[2]NS = (P>.20).

[3]Solids-corrected milk (19).

In order to examine which treatment effects noted for the balance trial would change if cows had been assigned to condition groups based on body condition score at calving, we compared the 15 highest (normal) with the 15 lowest scoring (thin) cows. Mean condition scores at calving with this treatment assignment were somewhat wider (5.5 and 7.4, respectively, data not tabulated) for thin and normal groups compared with that using prepartum feeding assignment. Using outcome groups, thin cows exhibited higher (P<.01) DM intake per unit BW (3.40 vs. 3.12% BW) than normal condition cows because of their lower BW (541 vs. 593 kg), not because they ate more DM (18.36 vs. 18.45 kg/d). Other significant differences in conclusions between assignment methods were as follows. Normal condition cows produced 2.7 kg more milk but not with significantly higher fat test (3.8 vs. 3.4%). Body tissue energy and fat balances were not different (P>.05) for condition outcome groups. Proportion of dietary N secreted in milk was higher (32.86 vs. 30.53%) for normal than for thin cows only because of their higher milk yield. Digestibilities of fat and NDF were higher (2.6 and 2.3 percentage units, respectively) for normal than for thin cows. Otherwise, treatment effects were similar to those noted for the balance trial when cows were grouped according to precalving feeding treatment.

Whole blood (Table 7) of thin versus normal condition cows contained significantly lower red cell count, hemoglobin concentration, and hematocrit percentage; serum was lower in globulin (and thus protein), alkaline phosphatase, and lactic dehydrogenase. However, these differences were not large, all means were within physiologically normal range for periparturient cows, and treatment effects may

TABLE 9. Calving ease of pluriparous Holstein cows by body condition group at calving.

Dystocia score	Explanation	Body condition group Thin	Normal
		(no. calvings)	
2	Unobserved	7(0)[1]	4(0)
2	Unassisted	4(2)	5(1)
3	Easy pull	3(0)	3(0)
4	Hard pull	1(0)	3(0)
Mean dystocia score		2.33	2.60[2]

[1]Number in parenthesis is incidence of twin births.

[2]No significant difference (P>.05).

TABLE 10. Effect of body condition at calving on reproductive traits of pluriparous Holstein cows.

	Body condition	
Trait	Thin	Normal
Total number cows	15	15
Not bred	3[1]	1[2]
Bred–not conceived/no. services	2/3.5	3/2.0
Bred–conceived/services per conception	10/1.8	11/1.6
Days to first service/no. cows	72/13	69/14
Days open	94	90

[1]Culled dry and open for poor udder conformation, low production, and chronic high somatic cell count and poor udder support.

[2]Culled dry and open for high somatic cell count and poor udder support.

or may not represent biologically important differences. No evidence was found for these traits that would be useful as a diagnostic tool in regard to body condition.

Complete lactation traits (Table 8) indicate generally minor effects of prepartum energy intake and body condition at calving on subsequent lactation. Body weights, which were different at calving (Table 3), were not significantly different, on average, during the complete lactation. Generally, BW changes of normal and thin cows were parallel during later lactation (Figure 1), except at wk 42, when unequal cow numbers caused some divergence. Intakes of total DM, forage, and grain did not differ. When expressed per unit BW, DM intake was somewhat higher for the thin condition group due to their nonsignificantly lower BW and higher grain intake. As illustrated in Figure 2, thin cows tended to consume more concentrate DM per unit BW in the first trimester and more forage DM per unit BW in the second and third trimesters of lactation. Milk and FCM yields were similar between treatments, but, contrary to the observations of Jaquette et al. (12), milk fat test was depressed in the thin condition group, particularly from wk 4 to 16 of lactation (Figure 3). Milk per day of lactation ranged from 18.0 to 30.7 and from 20.8 to 31.7 kg for individual cows in normal and thin condition groups, respectively.

Body condition score at calving, across treatments, was not closely correlated with the full lactation traits measured. As expected, correlation with mean BW was positive ($r = .50$); correlations of body condition with yields of milk, 4% FCM, milk fat, percentages of milk fat, SNF, and protein were .26, .30, .30, .05, −.32, and −.27, respectively. There was no correlation between body condition score at calving and DM intake per day ($r = -.05$), but due to its relationship with BW, correlations with total DM and forage DM intakes per unit BW were −.70 and −.56. The r for condition score vs. milk yield during d 1 to 28 of lactation was .33, somewhat higher than for total lactation milk yield. These observations support those discussed and provide no basis for predicting production responses from body condition score at calving.

As noted in Table 9, mean dystocia score was not significantly different between treatments, although hard-pull assistance was required for 3 normal vs. 1 thin condition cow. There were no large effects of treatments on measures of reproductive efficiency in this experiment (Table 10), which was not designed to measure calving ease or reproductive traits.

CONCLUSIONS

Our study provides no evidence to refute general recommendations which caution against excessive body condition at calving. However, we have determined that reducing mean body condition score to 80% of normal (normal = 7.2 out of 9 or 4.0 out of 5) by means of prepartum feeding causes underconditioned cows to mobilize less body fat for production in the first trimester after calving. This, in turn, results in milk fat depression without affecting milk yield, DM intake, or efficiency of ration utilization.

ACKNOWLEDGMENTS

The authors gratefully acknowledge professional and technical help of J. Whitehouse, D. Fimlaid, R. Murray, and L. V. Emmons. Special thanks is given to Susan Ramsey for her computer expertise.

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