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The Effect of Dietary Energy Concentration on Calf Performance[1]

C. S. KUEHN, D. E. OTTERBY, and J. G. LINN
Department of Animal Science

W. G. OLSON
Department of Clinical and Population Sciences
University of Minnesota
St. Paul 55108

H. CHESTER-JONES
Southern Experiment Station
Waseca, MN 56093

G. D. MARX
Northwest Experiment Station
Crookston, MN 56716

J. A. BARMORE
Vita Plus Corporation
Madison, WI 53715

ABSTRACT

At three locations, 120 calves were fed a high fat milk replacer at 10% of birth weight from d 5 through 13. On d 14, calves were assigned randomly within sex and date of birth to a 2 × 2 factorial arrangement of treatments. Treatments were (on a DM basis) high fat milk replacer (21.6%) and high fat starter (7.3%), high fat milk replacer (21.6%) and low fat starter (3.7%), low fat milk replacer (15.6%) and high fat starter (7.3%), and low fat milk replacer (15.6%) and low fat starter (3.7%). Milk replacer was fed at 8% of birth weight/d from d 14 to 35 and at 4% of birth weight/d from d 36 to 42. High fat replacer depressed DMI before and after weaning. High fat starter depressed DMI after weaning. Before weaning, calves gained more BW when fed low fat replacer. Calves fed low fat starter gained more BW after weaning. On d 56, BW were highest for calves fed low fat replacer and starter and lowest for those fed high fat replacer and starter. Growth or health of calves was not improved by fat addition to the diet.
(**Key words**: diet, calf, energy, fat)

Abbreviation key: **ADG** = average daily gain, **DE** = digestible energy, **HH** = high fat milk replacer and high fat starter, **HL** = high fat milk replacer and low fat starter, **LH** = low fat milk replacer and high fat starter, **LL** = low fat milk replacer and low fat starter, **MR** = milk replacer, **NWES** = Northwest Experiment Station, **SES** = Southern Experiment Station, **SP** = St. Paul Campus.

INTRODUCTION

Increased energy intake by calves often is desired for increased growth or maintenance of normal growth in cold weather. This increase is accomplished by additional milk or by added fat to milk or starter to increase energy density. Huber et al. (4) found that calves fed more milk consumed less starter than did calves fed less milk. Addition of tallow at 0, 2.5, 5, and 10% to limit-fed starters did not affect DMI, but improved feed efficiency (8). When starter was fed for ad libitum intake,

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either 10 or 20% fat added to starter reduced intake and BW gains (13). Calves fed starters containing 10% fat consumed 38% less DM and gained 28% less BW than calves fed starter without fat. Starters containing 20% fat reduced starter consumption and BW gains even further.

In cold climatic conditions, added fat to milk replacer (**MR**) has increased BW gains in calves (6, 7, 19). Scibilia et al. (19) fed MR containing 10, 17.5, or 25% fat to calves housed at –4 or 10°C. Calves housed at –4°C gained more BW with higher fat in the MR. Amount of fat in MR did not affect BW gains of calves housed at 10°C. Whole milk or MR supplemented with fat did not support starter consumption in winter higher than that of unsupplemented whole milk or MR (5), but BW gains were greater for calves fed the fat supplement. Schingoethe et al. (18) observed that BW gains in winter were higher for calves fed additional milk than for calves fed the same amount of solids in a fat supplement. Calves receiving a starter with high percentage of fat (6%) did not differ in feed intakes, BW gains, or ratios of feed to gain compared with those calves fed low fat (2%) and raised in mild winter conditions (20).

The objective of this study was to evaluate the performance of calves fed diets differing in energy concentration by the addition of fat through d 56 of life.

MATERIALS AND METHODS

One hundred twenty Holstein calves were used in the study and were located (40 per location) at Northwest Experiment Station (**NWES**), Crookston; Southern Experiment Station (**SES**), Waseca; and the St. Paul Campus (**SP**), University of Minnesota.

Dietary Treatments

From birth through d 4 of life, calves received daily feedings of colostrum and transitional milk at 10% of birth weight; half was given in the morning, and half in the afternoon. Starting on d 5 and continuing through d 13, all calves were fed MR containing 21.6% fat, DM basis (Milk Specialties Co., Dundee, IL), at 10% of birth weight. On d 14, healthy calves at each location were blocked by sex and date of birth and assigned randomly to a 2 × 2 factorial arrangement of treatments. Feeds consisted of high or low fat MR and a high or low fat calf starter (Vita Plus Corp., Madison, WI). Treatment designations are **HH**, high fat MR and high fat starter; **HL**, high fat MR and low fat starter; **LH**, low fat MR and high fat starter; and **LL**, low fat MR and low fat starter. Beginning on d 14, calves were fed their assigned MR at 8% of birth weight daily. Orts were weighed and recorded daily. From d 36 through 42, the amount of MR fed was 4% of birth weight/d. Half the MR was fed in the morning, and half was fed in the afternoon. All calves were weaned on d 43. The MR comprised whey protein concentrate, dried whey, and edible animal fat. A coccidiostat (Deccox®; Rhône-Poulenc, Atlanta, GA) was added to the MR at 24.7 mg/kg. Milk replacers were formulated to contain either 21.6% fat (high) or 15.6% fat (low) and 20.8% CP, DM basis. Samples were taken from each lot received and analyzed. Means and standard deviations were 20.1 ± .44% ether extract and 21.4 ± .28% CP for the high fat MR and 13 ± .06% ether extract and 21.2 ± .09% CP for the low fat MR. Lactose contents of the high and low fat MR were 44.5 and 49.0%, respectively. Vitamin and mineral contents of the MR were similar. Starters were fed for ad libitum intake from d 14 to 56. Because of minimal consumption of starter during the first 2 wk of life (10), starter was not offered until d 14. Starters were offered daily, and orts were measured weekly or more frequently if feed contamination occurred. Starters were formulated to contain 7.3% fat (high) or 3.7% fat (low) and 20.0% CP, DM basis. The fat source of the high fat starter was ground, roasted soybeans. Soybeans were processed in a drum roaster (Roast-A-Matic®; Lebanon, PA) to an exit temperature of 150°C and steeped for 30 min. Ingredient contents of starters are in Table 1, and nutrients contents are in Table 2. Molasses, soybean meal or soybeans, calcium carbonate, vitamin and mineral premix, and coccidiostat were pelleted before addition to the grains. Water was available free choice to calves at all locations.

Management Practices

NWES. Twenty-four females and 16 males were raised in individual pens bedded with

TABLE 1. Ingredient composition of high and low fat starters.[1]

Ingredient[1]	High fat	Low fat
	(% of DM)	
Corn, roasted and rolled	46.0	50.0
Whole oats	16.0	16.0
Liquid molasses	7.5	7.5
Soybean meal	10.8	23.9
Soybeans, roasted and ground	17.1	. . .
$CaCO_3$	.4	.4
Vitamin and mineral premix[2]	2.2	2.2

[1]Starter contained 24.7 mg/kg of Deccox® (Rhône-Poulenc, Atlanta, GA).

[2]Guaranteed to contain 17.0% Ca, 5.5% P, 20.0% NaCl, .8% Mg, 1.0% K, 1.4% S, 13 ppm of I, 12 ppm of Se, 551,000 IU/kg of vitamin A, 137,000 IU/kg of vitamin D_3, 2380 IU/kg of vitamin E, 992 μg/kg of vitamin B_{12}, 66 ppm of niacin, 130 ppm of d-pantothenic acid, 2200 ppm of choline, and 44 ppm of thiamine.

sunflower hulls in an indoor ventilated calf nursery that was heated in cold months. Temperature of the nursery was recorded daily at the a.m. feeding.

The experiment was initiated on March 26, 1992 and continued through October 26, 1992. Calves were fed between 0800 and 0900 h and between 1330 and 1430 h. On designated weigh days, calves were weighed prior to the a.m. feeding. When scours occurred, an electrolyte solution (Life-Guard®; Norden Laboratories, Inc., Lincoln, NE) was fed as needed, and MR was withheld. In addition, 4 ml of gentamicin sulfate (Fermenta Animal Health Co., Kansas City, MO) or penicillin G (Pfizer Animal Health, New York, NY) were given by intramuscular injection to calves with temperatures over 39°C or with respiratory problems. Cows were vaccinated for rota-corona viruses with ScourGuard®-3(K)/C (SmithKline Beecham, West Chester, PA) at 3 and 2 wk prior to calving. Calves were given an oral vaccine (Calf-Guard®; Norden Laboratories, Inc.) if they were born prior to the second injection of the dam.

One calf died on d 31 from pneumonia and an infarction of the small intestine. Data were not used, and the calf was replaced for the trial.

SES. Seventeen females and 23 males were raised in individual outdoor hutches bedded with straw. The experiment began March 9, 1992 and continued through September 21, 1992. Calves were fed at approximately 0800 and 1600 h. Calves were weighed prior to morning milk feeding on designated weigh days. Outdoor ambient temperatures were collected from the weather station located near the calf hutch area.

Calves were given an oral rota-corona vaccine, Calf-Guard®, immediately after birth. Scouring calves were treated with electrolyte solution (Sav-A-Caf™; Tri-Mutual Inc., Minneapolis, MN) for a minimum of two feedings. In addition, these calves were orally given 160 mg of trimethoprin and 800 mg of sulfamethoxazole (Rugby Labs, Inc., Rockville Centre, NY) twice daily for 3 to 5 d. Milk continued to be offered during the scouring period. Calves with temperatures of ≥39°C were treated intramuscularly with 5 ml of penicillin (Aquacillin; Vedco, Inc., Overland Park, KS).

SP. Twenty-seven females and 13 males were raised in individual outdoor hutches bedded with straw. The experiment began on February 1, 1992 and was completed September 3, 1992. At birth, each calf received an oral rota-corona vaccine (Calf-Guard®) and intramuscular injections of 3 ml of vitamin B complex (Vedco, Inc., St. Joseph, MO), 3 ml of vitamins A and D_3 (500,000 IU/ml of vitamin A and 75,000 IU/ml of vitamin D_3; Hoffmann-LaRoche, Inc., Nutley, NJ), and 5 ml of MuSe (5 mg of Se and 50 mg/ml of vitamin E;

TABLE 2. Nutrient composition of high and low fat starters.[1]

Item	High fat		Low fat	
	$\bar{X}$	SD	$\bar{X}$	SD
DM, %	92.01	1.24	91.87	.95
	(% of DM)			
CP	19.91	.79	20.16	.77
NDF	16.00	.81	15.02	1.30
ADF	4.66	.40	4.22	.36
Ether extract	7.26	.71	3.65	.50
Ash	5.62	.00	5.45	.13
Ca	.91	.06	.94	.08
P	.77	.05	.76	.04
K	1.43	.10	1.48	.06
Mg	.28	.02	.29	.01
Na	.28	.02	.30	.02

[1]Estimated DE from NRC (14): high fat, 3.78 Mcal/kg; low fat, 3.69 Mcal/kg.

Schering Corp., Kenilworth, NJ). The following day, 5 ml of iron-hydrogenated dextran (100 mg/ml; Vedco, Inc.) were administered intramuscularly. Calves were fed at 0630 and 1630 h. On weigh days, calves were weighed prior to the a.m. feeding. Scours were treated by feeding an electrolyte product (Deliver™; Diamond Scientific, Des Moines, IA or Resorb®; SmithKline Beecham) for four feedings and half the treatment on the fifth and sixth feedings. Approximately 1 h after electrolyte was fed, calves were offered MR. Calves with temperatures of over 39°C were given 4 ml of penicillin G (Pfizer Animal Health) for 3 d. Penicillin was given longer if high temperatures persisted. For respiratory problems, Naxcel® (UpJohn, Kalamazoo, MI) was prescribed for treatment. Daily ambient temperatures were recorded at the campus weather station.

Data Collection and Analyses

Calves were weighed at birth and on d 14, 21, 28, 35, 42, 49, and 56 of trial. Fecal consistency was scored daily on a four-point scale [1 = normal to 4 = watery (9)] by one person within location. Fecal samples were collected on d 14 and 56 and at any occurrence of scours throughout the experiment. Samples were analyzed for bacteria, parasites, and viruses at the University of Minnesota Veterinary Diagnostic Laboratory (St. Paul).

Starters were sampled weekly, composited monthly by location, dried in a forced-air oven at 55°C for 24 h, and ground through a 1-mm screen in a Wiley Mill (Thomas Scientific, Swedesboro, NJ). Analyses of samples included DM, CP, ether extract, and minerals (1), NDF, and ADF (3).

Jugular blood samples were drawn via vacuum tubes on d 28, 42, and 56. All samples were taken at similar times corresponding to 3 to 5 h after a.m. milk feeding. Samples were placed on ice during transport to the laboratory. After centrifugation (1100 × *g* for 20 min), serum was decanted and frozen for subsequent analysis of glucose (Glucose Kit Number 510; Sigma Chemical Co., St. Louis, MO) and NEFA (Wako Chemicals USA, Inc., Richmond, VA).

Statistical Analyses

Data were analyzed using the general linear models procedures of SAS (17). The model used was

$$\begin{aligned} Y = {} & \mu + B_i + X + L_j + S_k + M_l + Str_m \\ & + (L_j \times S_k) + (L_j \times M_l) + (L_j \times Str_m) \\ & + (S_k \times M_l) + (S_k \times Str_m) \\ & + (M_l \times Str_m) + (L_m \times S_k \times M_l) \\ & + (L_m \times S_k \times Str_m) \\ & + (L_m \times M_l \times Str_m) \\ & + (S_k \times M_l \times Str_m) \\ & + (L_j \times S_k \times M_l \times Str_m) + E_{jklm} \end{aligned}$$

where

μ = overall mean,
B_i = block effect within sex and location (i = block number),
X = d-14 BW covariant,
L_j = location effect (j = 1, 2, or 3),
S_k = sex effect (k = 1 or 2),
M_l = milk effect (l = 1 or 2),
Str_m = starter effect (m = 1 or 2), and
E_{jklm} = residual error.

The BW on d 14 was used as a covariant in the model for all analyses except MR intake. Significance was declared at $P \leq .01$ unless otherwise indicated. Location effects were separated by least significant difference of least squares means.

RESULTS AND DISCUSSION

The average monthly temperature for the NWES nursery ranged from 8.4°C in April to 19.6°C in August. At the SES, the lowest average monthly temperature was in March at –2.2°C, and the highest average monthly temperature was in June at 19°C. The lowest average monthly temperature of –2.4°C occurred in February at SP, and the highest average monthly temperature was in August with 19°C.

On d 14, average BW at NWES were 43.1, 45.0, 42.4, and 40.1 kg for the HH, HL, LH, and LL treatments, respectively. At the SES, d-14 BW were 42.1, 44.5, 41.5, and 42.0 kg for treatments HH, HL, LH, and LL, respectively. Average d-14 BW for SP were 40.7 kg for the HH group, 40.0 kg for the HL group, 40.2 kg for the LH group, and 43.8 kg for the LL group. Because of differences in BW of calves, all analyses were adjusted for d-14 BW.

Males consumed significantly more DM from MR than did females because of higher average birth weights than those of female calves (43.8 vs. 40.0 kg). Amounts of MR

consumed did not differ among treatments or locations (Table 3). Milk refusals for each treatment and location were minimal.

Low fat MR promoted higher starter DMI than did high fat MR through weaning. Other studies have reported similar decreases in starter DMI with additional milk or milk solids in the diet (4, 6, 7, 15). In addition, increased milk solids decreased intake of milk when fed for ad libitum intake (11). The MR treatment continued to affect starter DMI after weaning.

Prior to weaning, type of starter did not affect DMI; but, after weaning, calves fed low fat starter consumed more DM than calves fed high fat starter. Calves fed high fat MR consumed less starter until weaning than calves fed low fat MR. After weaning, consumption of starter by all calves increased, but those fed low fat starter consumed more starter DM than calves fed high fat starter. Miller et al. (13) found that calves receiving 10 or 20% fat (DM basis) in starter had lower DMI than calves fed a control starter with no added fat. A sex × MR × starter interaction occurred for starter DMI from d 43 to 56 ($P < .02$). Both males and females consumed the most starter on the LL diet, and females consumed the least on the HH diet; however, males on the HL treatment consumed less than males on the HH diet.

Prior to weaning, females consumed .55 kg/d of starter DM compared with .50 kg/d by males. After weaning, females consumed 1.74 kg/d, and males consumed 1.68 kg/d. Location affected starter DMI before and after weaning: calves at SES and SP consumed more starter DM before and after weaning than did NWES calves; after weaning, SP calves also consumed more than SES calves. Lower intakes by calves at NWES likely were the result of differences in housing facilities, because SES and SP calves were raised in outdoor hutches, but NWES calves were housed indoors. McKnight (12) found that calves housed in hutches consumed more starter than calves in indoor facilities.

The amount of fat in MR affected average daily gain (**ADG**) from d 14 to 42 (Table 3). Calves fed LL and LH gained more ($P < .02$) than calves fed HL and HH (.50 vs .43 kg/d). After weaning, the amount of fat in the starter affected ADG, and calves fed LL and HL gained more than calves fed LH and HH (.99 vs .89 kg/d). These data agree with those of Miller et al. (13), who found that calves fed starter supplemented with fat gained less than calves fed unsupplemented starter. The ADG from d 14 to 42 were .46 kg/d for both males and females. After weaning, males averaged .97 kg/d of gain, and females averaged .91 kg/d. Adjusted BW for treatments on d 56 were HH, 66.7 kg; HL, 67.5 kg; LH, 68.2 kg; and LL, 70.8 kg. Calves located at SP and SES gained more than calves at NWES prior to weaning, and calves at SP gained more than SES calves. From d 43 to 56, calves located at SES and NWES gained similarly, but SP calves had higher ADG (1.18 kg/d) than either SES (.83 kg/d) and NWES (.82 kg/d) calves.

Digestible energy (**DE**) intakes were calculated according to NRC (14) recommendations with high fat MR = 4.58 Mcal of DE/kg of DM, low fat MR = 4.28 Mcal of DE/kg of DM, high fat starter = 3.78 Mcal of DE/kg of DM, and low fat starter = 3.69 Mcal of DE/kg of DM (Table 4). Calves fed high fat MR (HL and HH) consumed more DE than calves fed low fat MR (LL and LH) (48.47 vs. 44.82 Mcal).

From d 14 to 42, DE intakes from starter were higher for calves fed LL and LH (60.90 Mcal) than for calves fed HL and HH (48.36 Mcal). After weaning, calves that had been fed low fat MR tended to consume more DE than those fed high fat MR ($P = .04$). Total DE during the experimental period was highest for calves fed low fat MR. Energy efficiency (megacalories of DE per kilogram of BW gain) was not affected by dietary treatment, but did differ by location before and after weaning and from d 14 to 56.

In our experiment, fat added in either the MR or the starter did not improve ADG at any of the three locations. Calves for our experiment were 2 wk old at the start of the dietary treatments, which likely allowed them to tolerate cold stress better than a younger calf would. Scibilia et al. (19) reported that 6-d-old calves, raised in a −4°C environment for 3 wk and receiving additional fat in the liquid diet (25% of DM), had higher ADG than calves receiving a low fat diet (10% of DM). However, calves in the same study (19) raised at 10°C did not benefit from added fat. Gebremedhin et al. (2) found that the thermoneutral zone of calves housed in chambers was between 15 and 29°C and observed that

TABLE 3. Average daily DMI of milk replacer (MR), average daily DMI of starter, and average daily gain by treatment.[1]

Item	HH	HL	LH	LL	SE	Main effects of diet	
						MR	Starter
Average MR DMI, kg/d							
d 14 to 35	.41	.42	.40	.41	.01	.19	.33
d 36 to 42	.21	.22	.21	.21	.004	.90	.20
Average starter DMI, kg/d							
d 14 to 42	.47	.46	.58	.58	.03	<.01	.98
d 43 to 56	1.61	1.70	1.68	1.85	.05	.04	.02
Average daily gain, kg/d							
d 14 to 42	.43	.42	.48	.52	.03	.02	.65
d 43 to 56	.89	.97	.90	1.01	.04	.55	.01

[1]Treatments include high fat MR and high fat starter (HH), high fat MR and low fat starter (HL), low fat MR and high fat starter (LH), and low fat MR and low fat starter (LL).

heat production of calves markedly increased at temperatures <8°C. In the present study, temperatures in February, March, and April were below the thermoneutral range, but calves probably were not in a state of severe enough cold stress to benefit from the fat. Similarly, Stewart and Schingoethe (20) did not find an effect of a starter containing supplemental fat on intake or gain in mild winter conditions.

Health

Dietary treatment did not affect fecal score (Table 5) or general health. Diarrhea was the principal health problem of the calves at SES and SP. From d 14 to 28, SP calves averaged higher fecal scores than did NWES or SES calves. From d 28 to 42, SES calves had the highest mean fecal scores, which differed from NWES calves but not from SP calves. After weaning, calves at SES and SP had higher mean fecal scores than NWES calves, and scores from SP calves were higher ($P < .03$) than those from SES calves. Overall, calves at SES and SP had higher mean fecal scores than NWES calves. Differences among locations were associated with higher incidences of cryptosporidia infection (Table 6). The location × sex interaction from d 43 to 56 was caused by 4 males at SP that exhibited diarrhea after weaning. One of these cases was diagnosed as a cryptosporidia infection, but specific organ-

TABLE 4. Estimated digestible energy (DE) intake by treatment.[1]

Estimated DE	HH	HL	LH	LL	SE	Main effects of diet	
						MR	Starter
	(Mcal)[2]						
d 14 to 42							
MR	48.41	48.53	44.42	45.22	.49	<.01	.34
Starter	49.33	47.45	61.37	60.42	3.32	<.01	.66
Total DE	97.74	95.97	105.80	105.64	3.34	<.01	.77
d 43 to 56							
Starter DE	78.98	81.69	82.70	88.61	2.62	.04	.10
d 14 to 56							
Total DE	176.72	177.66	188.50	194.25	5.52	.01	.54
DE:Gain, Mcal/kg							
d 14 to 42	8.99	8.78	8.77	8.42	.71	.68	.69
d 43 to 56	6.46	6.28	7.13	6.67	.36	.14	.37
d 14 to 56	7.38	7.10	7.77	6.97	.31	.66	.08

[1]Treatments include high fat milk replacer (MR) and high fat starter (HH), high fat MR and low fat starter (HL), low fat MR and high fat starter (LH), and low fat MR and low fat starter (LL).

[2]Estimated DE computed from NRC recommendations (14): high fat MR, 4.58 Mcal of DE/kg of DM; low fat MR, 4.28 Mcal of DE/kg of DM; high fat starter, 3.78 Mcal of DE/kg of DM; and low fat starter, 3.69 Mcal of DE/kg of DM.

TABLE 5. Fecal score[1] by location for Northwest Experiment Station (NWES), Southern Experiment Station (SES), and St. Paul (SP).

					Main effects		
Fecal score	NWES	SES	SP	SE	Location	MR[2]	Starter
d 14 to 28	1.37[b]	1.41[b]	1.58[a]	.05	.01	.83	.48
d 28 to 42	1.08[b]	1.20[a]	1.11[ab]	.03	.02	.17	.69
d 43 to 56[3]	1.00[c]	1.15[b]	1.26[a]	.03	<.01	.68	.54
d 14 to 56	1.15[b]	1.25[a]	1.32[a]	.03	<.01	.47	.44

[a,b,c]Means within rows with different superscripts differ ($P < .05$).

[1]Scoring system, 1 = normal to 4 = watery (9).

[2]Milk replacer.

[3]Location × sex interaction ($P < .01$).

isms were not diagnosed for the other 3 cases. All other calves were negative on fecal cultures for cryptosporidia on d 56.

Blood Metabolites

Concentrations of NEFA decreased from d 28 in calves throughout the study for all dietary treatments (Table 7). Quigley et al. (16) similarly found that NEFA concentrations declined from birth to weaning. No effect of starter was evident before weaning. Concentrations of NEFA in calves fed high fat MR were higher than concentrations of calves fed low fat at d 28 (208 vs. 143 μeq/L) and d 42 (139 vs. 106 μeq/L). By d 56, effect of MR had diminished, and starter diet affected NEFA concentration ($P = .03$). Calves fed high fat starter averaged 118 μeq/L, and calves fed low fat starter averaged concentrations of 72 μeq/L. A location effect was evident on d 28. Calves at NWES had higher NEFA concentrations than did SP or SES calves. The reason for this may be the difference in housing. Calves at NWES were housed in a heated nursery.

A location × MR interaction ($P < .05$) occurred on d 56 for NEFA concentrations because calves on the LL and LH treatments at SES had higher NEFA concentrations than calves on HL and HH treatments at SES, but, at NWES and SP, MR treatment did not affect NEFA concentrations. A location × sex × MR interaction ($P = .05$) affected NEFA concentrations on d 42. Concentrations of NEFA for calves fed HL and HH tended to be higher than those fed LL and LH for SP males and females, NWES males, and SES females. The interaction possibly resulted because this trend did not occur in NWES females and SES males.

Dietary treatment did not affect glucose concentrations. Glucose concentrations on d 56 were higher for females than for males (99 vs. 90 mg/100 ml). Some location effects were evident, but no diet × location interactions occurred. Two interactions, MR × starter ($P < .05$) and sex × MR ($P < .05$), for glucose concentrations were observed on d 28. Reasons for the interactions are not clear.

CONCLUSIONS

No benefit in calf growth or performance was observed from additional fat in either the MR or starter. Fat in the MR depressed DMI and DE intake of starter through weaning.

TABLE 6. Fecal sample diagnosis for Northwest Experiment Station (NWES), Southern Experiment Station (SES), and St. Paul (SP) and by treatment[1] from birth through d 28.

Organism	NWES	SES	SP	HH	HL	LH	LL
	(no. of cases)						
Cryptosporidia	1	33	28	17	15	16	14
Salmonella	0	0	3	1	0	1	1
Rotavirus	3	3	4	2	4	1	3

[1]Treatments include high fat milk replacer (MR) and high fat starter (HH), high fat MR and low fat starter (HL), low fat MR and high fat starter (LH), and low fat MR and low fat starter (LL).

TABLE 7. Concentrations of NEFA and glucose in blood serum by treatment.[1]

Day	HH	HL	LH	LL	SE	Main effects of diet: MR	Main effects of diet: Starter
	NEFA (μeq/L)					P	
28	210.9	205.4	140.9	145.2	18.4	<.01	.97
42	133.4	143.8	115.9	95.9	14.1	.02	.73
56	113.3	71.4	123.5	71.6	21.1	.80	.03
	Glucose (mg/dl)						
28	103.4	97.8	100.4	108.9	3.4	.21	.66
42	91.4	96.4	90.7	97.2	3.2	.98	.07
56	93.8	93.2	93.6	95.6	2.7	.69	.79

[1]Treatments include high fat milk replacer (MR) and high fat starter (HH), high fat MR and low fat starter (HL), low fat MR and high fat starter (LH), and low fat MR and low fat starter (LL).

Prior to weaning, calves receiving low fat MR gained more than did calves on high fat MR. After weaning, fat in the starter depressed DMI but not DE intake. Calves that gained the most were fed the low fat starter. High fat concentrations in MR or starter may benefit calves in cold environments or under continuous stress, but not those in relatively mild conditions or under low stress situations. Under conditions of this experiment, MR with 15.6% fat and a starter without added fat fed after calves were 14 d of age resulted in similar or better calf performance than did MR with 21.6% fat or starter with added fat.

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