Growth and body composition of calves fed only a milk replacer or whole milk

Al Kertz, PhD, PAS, DIPL ACAN
ANDHIL LLC
St. Louis, MO 63122
andhil@swbell.net
www.andhil.com
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Previously, I reported (Kertz 2025) on a study of growth and body composition with calves fed 3 levels of a milk replacer (Bartlett et al, 2024). In a sister study (Bartlett et al., 2025), male Holstein calves were fed either whole milk or milk replacers (MR). In some ways, a milk replacer is not a "milk replacer." That is because a milk replacer does not have bioactive compounds found in milk (and even more in colostrum), nor the same fatty acids, nor the same sources and levels of protein, fat, and lactose. So, a milk replacer is more a substitute ***for*** milk while it is not a substitute ***of*** whole milk. I have included verbatim sections of the protocol for this calf study (Bartlett et al, 2025) so readers do not have to read the published paper instead for this information.

"Male Holstein calves were purchased from an Illinois dealer at less than 1 week of age. Groups of calves were delivered on May 27, July 22, and September 17, 1999. Calves were housed individually in hutches which were placed on 15 to 20 cm of crushed rock so no bedding was used to avoid consumption of organic material that could confound results. The next day, calves were fed whole nonsalable milk at 10% of body weight. They remained on this diet for 14 days to allow for adjustment. Water was available at all times, but no dry feed was offered,"

"Following the 14-day adjustment period, calves were stratified from highest to lowest BW and then were randomly assigned to either an initial harvest (baseline) group or to 1 of 12 experimental treatments. Eleven calves were slaughtered for baseline measurements (2, 5, and 4 from groups 1 to 3, respectively), and 74 remained on their respective diets for 5 weeks before slaughter. A total of 29 calves were used to address the objectives of this experiment. Data from all 11 baseline calves were pooled and used to calculate the starting body composition in treatment calves. Calves (n = 18) from 3 of the 12 treatments were used to address the current objectives, and only data for those treatments are reported here."

"Calves (n = 6 per treatment) were assigned to (1) conventional milk replacer (CMR; 22.3% CP, 21.4% fat, 49.1% lactose); (2) high-fat milk replacer (HFMR; 25.4% CP, 27.4% fat, 40.1% lactose); or (3) saleable whole milk (25.4% CP, 27.1% fat, 41.9% lactose)—see **Table 1.** Milk replacers were reconstituted to 12.5% solids with warm tap water. Reconstituted CMR was fed at 14% of BW; reconstituted HFMR and whole milk were fed at 11.65% of BW so that initial intakes of ME and CP were similar among treatments. Amounts fed were increased weekly as calves grew to maintain intakes at the same percentage of BW."

"Milk replacers were reconstituted to 12.5% solids with warm tap water. ***Reconstituted CMR was fed at 14% of BW; reconstituted HFMR and whole milk were fed at 11.65% of BW so that initial intakes of ME and CP were similar among treatments.*** Amounts fed were increased weekly as calves grew to maintain intakes at the same percentage of BW. To determine the effects of increased nutrient intake on growth and body composition, calves were fed a milk replacer at 3 different rates: 1.25%,

1.75%, or 2.25% of body weight (DM basis), adjusted weekly (n = 6 per treatment for the 1.25% and 1.75% groups, n = 8 for the 2.25% of BW group)."

"Calves were fed a whey-protein-based milk replacer (MR 24.8% CP, 18.9% fat, 49.2% lactose, 7.2% ash, 5.1 Mcal/kg gross energy [GE]), reconstituted to 12.5% solids with warm tap water. ***Calves fed at 1.25% and 1.75% of BW were fed twice daily, whereas calves fed at 2.25% of BW were fed 3 times daily. Corresponding liquid feeding rates (as fed) were 10%, 14%, and 18% of body weight.*** Calves were weighed once weekly and the amount of DM offered was adjusted weekly to maintain the desired feeding rates."

"Milk replacer and milk intakes were measured daily. Average daily intake was calculated by summing total CMR intake and dividing by 35 days. ***All calves consistently consumed all of their daily CMR offered without refusals.*** Water was offered for ad libitum consumption, and intake was recorded daily. Calves were weighed once weekly. Calf withers height, body length, and heart girth were measured once weekly. Calves were monitored several times daily for signs of illness. Fecal scores were assigned and recorded once daily using the following system: 1 = dry, hard; 2 = soft, formed; 3 = pudding-like; 4 = mix of liquid and some solids; and 5 = liquid. Blood samples were collected once weekly via jugular venipuncture at ~0700 hours, which was before the morning feeding,"

Slaughter and measurements are described in detail in the manuscript.

Table 1. Nutrient levels in calf milk replace (MR), high fat milk replace (HRMR), and whole milk treatments with CP = crude protein, GE = gross energy, and ME = metabolizable energy.

Treatments	MR	HFMR	Whole milk
CP %	25.30	25.35	25.42
Fat %	21.40	27.38	27.11
Lactose %	49.10	40.14	41.7
Ash %	7.20	7.13	5.60
GE, Mcal/kg	5.1	5.6	5.6
CP/ME, g/Mcal	48.1	49.7	49.9

Table 2. Dry Matter (DM) and nutrient intakes in first week of calf milk replacer (MR), high fat milk replacer (HFMR), and whole milk treatments with CP = crude protein, GE = gross energy, and ME = metabolizable energy.

Treatment	MR	1HFMR	Whole milk
DM intake, lb	1.74	1.57	1.51
CP, lb	0.39	0.40	0.35
Lactose, lb	0.86	0.63	0.67
Total fatty acids, %	0.33	0.39	0.36
Gross energy, Mcal/day	28.7	29.6	30.8
Metabolizable energy, Mcal/day	33.3	34.0	33.7

Data in **Table 2** show:

- Marginally greater DM intake from MR most likely due to its lower fat content. Since weekly feeding adjustments were based on the previous week's intake, this inadvertently resulted in greater subsequent DM intake with the MR treatment.

- This also resulted in greater lactose, but lower fatty acid intakes.

Table 3. Initial and final body weight (BW), average daily gain (ADG), body measurements, and gain to feed ratio for calf milk replacer (MR), high fat milk replacer (HFMR), and whole milk treatments

Treatments	MR	HFMR	Whole milk
Initial BW, lb	98.6	104.6	100.9
Final BW, lb	156.7	145.6	144.9
ADG, lb	1.52	1.22	1.26
Final heart girth, inch	38.0	35.4	38.3
Final body length, inch	28.7	29.0	25.3
Final withers height, inch	32.9	33.8	33.5
Gain to feed ratio	1.29	1.40	1.53
Average fecal score	3.3	3.2	2.9
Days with fecal score ≥ 24	9.7	12.0	3.8

Data in **Table 3:**

- No differences among BW, but greatest ADG with MR treatments.
- There were no other significant differences among treatments.

Table 4. Body composition for calves fed calf milk replace (MR), high fat milk replace (HFMR), and whole milk treatments.

Treatments	MR	HFMR	Whole milk
Final composition, %			
Water	71.10	70.70	71.23
Protein	18.26	19.16	18.48
Fat	6.97	6.62	6.66
Ash	3.66	3.49	3.63
Energy, Mcal/kg EBW	1.59	1.55	1.56

- There were no differences among treatments in body composition except for greater ($P < 0.04$) % protein in treatment HFMR versus MR and whole milk treatments.

Data not shown found that:

- Blood values were similar among treatments except for urea-N ($P < 0.01$) of 7.4, 8.2, and 10.7 for MR, HFMR, and whole milk treatments, respectively.
- Retained body energy Mcal/day were different ($P < 0.05$) at 1.429, 1.117, and 1.160 for MR, HFMR, and whole milk treatments, respectively.
- There were no differences among treatments in efficiencies of utilization of protein, energy, and fat.

Conclusions by authors:

- 'Despite similar intakes of ME and protein at the start of the experiment, calves fed the higher lactose diet had greater ADG, which by protocol led to more MR being fed. As a result, DMI, ME

available for growth, and CP intakes were greater by the end of the study. In turn, greater intakes led to greater EBW gain and gains of lean tissue components than calves fed higher fat diets.

- Because of the early stimulation of greater growth, which resulted in greater amounts of milk replacer being fed, ***our results are consistent with the hypothesis that dietary lactose promotes greater growth of lean tissue than dietary fat in young dairy calves.***
- Although differences were slight, our data indicate that calves fed milk may be more efficient at using dietary CP for lean tissue deposition and have shorter occurrences of abnormal feces than calves fed milk replacer of similar nutrient composition.'

The Bottom Line

This study indicated that higher lactose in a milk replacer may be more beneficial than higher fat for lean growth. But remember that this study only evaluated liquid feeding; and on-farm, there is the integrative factor of the starter being fed and its contribution to pre- and post-weaning calf performance (Kertz 2019)

References

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