Milk replacer feeding levels and starter protein and fat levels on growth and rumen fermentation

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Feeding dairy calves more milk or milk replacer (MR) has become more prevalent following studies in the early 2000s which showed benefits versus the more traditional early weaning program which minimized milk feeding (Kertz et al. 2017; Kertz 2019). But there is an inverse relationship between amount of milk/MR fed and calf starter intake (Kertz et al., 1979; Gelsinger et al.. 2016). Further complexing the situation is beneficial effects of a well-texturized starter versus all pelleted or ground starters (Porter et al., 2004; Gelsinger et al., 2020; Ghaffari and Kertz 2021). Add to this picture arguments about what % CP and fat levels should be in calf starters. This is some background on a calf study with a 2,600 cow Iranian dairy farm (Yazdanyar et al., 2025)

Seventy-three female Holstein dairy calves (mean BW = 89.4 ± 4.2 lb) were assigned to a completely randomized design with a 2 × 3 factorial arrangement. The study investigated the effects of 2 main factors: the level of milk feeding (moderate vs. high) and the composition of the starter diet on growth performance, rumen fermentation, and blood parameters. The starter diets differed in CP (20% vs. 24%, DM basis) and total CF (ether extract [EE]; 3.0% vs. 5.5%, DM basis). The 6 treatment groups were as follows:

- moderate milk with 20% CP and 3% CF **(MM-CON**)
- moderate milk with 24% CP and 3% CF (**MM-HCP**)
- moderate milk with 20% CP and 5.5% CF (**MM-HCF)**
- high milk with 20% CP and 3% CF (**HMCON**)
- high milk with 24% CP and 3% CF (**HM-HCP)**
- high milk with 20% CP and 5.5% CF (**HM-HCF**)

The additional fat was palm fat consisting of C12:0 (2.3%), C14:0 (4.2%), C16:0 (86.0%), C18:0 (2.0%), C18:1 (4.1%), and other fatty acids (1.4%). Immediately after birth, calves were separated from their dams, weighed, and housed individually in pens (1.2 × 2.4 m from birth to 3 d of age, then 1.8 × 2.8 m) in a naturally ventilated barn. Sand bedding was used, which was changed daily. Within the first hour after birth, each calf received 2.5 L of colostrum, followed by another 2.5 L 6 h later. Colostrum was provided by the dams.

Calves were fed pasteurized whole milk in steel buckets twice daily at 0730 and 1630 hours beginning on day 3.

- Moderately fed calves received 4.5 L/day from 3 to 10 days, 5 L/day from11 to 40 days, 2.5 L/day from 41 to 50 days, and 1 L/day from 51 to 52 days.
- High-fed calves received 6 L/day from 3 to 10 days, 8.5 L/day from 11 to 40 days, 3 L/day from 41 to 50 days, and 1.5 L/day from 51 to 52 days.

Average composition of the milk was monitored weekly and was 3.13 ± 0.12% fat, 3.06 ± 0.07% CP, 4.86 ± 0.05% lactose, and 12.16 ± 0.24% DM. Weaning was on day 53, and calves were monitored until day 73.

Starter refusals were collected daily at 0800 hours with fresh feed provided at 0830 hours. Calves had free access to water throughout the trial. The starter contained 7.5% chopped wheat straw (particle size = 2.4 ± 0.13 mm), which was thoroughly mixed with the starter before feeding. Ingredients and chemical compositions of the starter are listed in **Table 1.**

Table 1. Ingredient and nutrient composition of calf starters.

	Control	**High CP %**	**High crude fat %**
Ingredients, %			
Wheat straw chopped	7.5	7.5	7.5
Steam rolled barley	4.0	4.0	4.0
Steam rolled corn	51.0	46.0	44.0
Soybean meal	25.0	36.0	25.5
Wheat bran	7.5	1.5	11.5
Palm fatty acids	---	---	2.5
Major minerals	3.0	3.0	3.0
Vit trace mineral mix	2.0	2.0	2.0
Nutrients, % of DM			
CP	20.0	24.0	20.0
Ether extract	3.0	3.0	5.5
NDF	18.1	16.9	19.4
ME, Mcal/kg	2.98	2.99	3.02
Starch	43.8	39.4	38.6
Sugar	5.9	8.1	7.4

- With 48 to 55 % steam rolled grains, it was unnecessary to have chopped wheat straw added—nor need to have barley and probably corn not steam rolled as rolling itself should be adequate (Ghaffari and Kertz 2021).
- Calculated ME (metabolizable energy differed litter among calf starters—less than 1.5%.
- Starch levels differed little among starters, were least when fatty acids were added, and are less critical when well-texturized starters are fed.

Table 2. Daily starter intake and weight gain by milk feeding level and kind of starter,

	Medium Milk Fed			**High Milk Fed**		
	Control	**High CP%**	**High fat%**	**Control**	**High CP%**	**High fat %**
Initial BW, lb	89.2	90.1	90.3	89.9	89.2	91.2
Starter intake, lb						
Preweaning	1.31	1.54	1.29	1.41	1.45	0.81
Postweaning	4.66	4.68	4.59	4.83	4.48	4.45
Overall	2.28	2.44	2.21	2.31	2.42	1.85
Daily gain, lb						
Preweaning	1.43	1.52	1.42	1.78	1.80	1.31

Postweaning	2.00	2.05	1.96	2.12	2.19	1.85
Overall	1.42	1.52	1.42	1.73	1.80	1.31

- Initial body weight (BW) did not differ.
- High fat starter intake was lowest, especially when fed with the highest milk feeding level. This was especially true for the preweaning period and reflected in overall daily gains.

Table 3. Body height measurements by milk feeding level and kind of starter.

	Medium Milk Fed			**High Milk Fed**		
	Control	**High CP%**	**High fat%**	**Control**	**High CP%**	**High fat %**
Withers height, in						
Initial	31.2	31.0	31.3	31.5	31.3	31.3
Preweaning	37.9	38.8	38.0	38.5	39.0	37.1
Postweaning	40.6	40.9	40.2	40.2	41.3	39.8
Hip height, inch						
Initial	30.0	30.7	30.8	31.1	30.9	31.0
Preweaning	36.2	36.8	36.1	37.4	36.7	36.0
Postweaning	3.81	35.6	37.9	38.9	39.2	37.9

- Not shown are body lengths which had no differences, and heart girth. The latter showed some differences, but I do not find this measurement is very meaningful.
- Withers heights were greatest for the high milk feeding level with high % CP starter, and lowest for high milk feeding level with high % fat starter at weaning and final measurements.
- Hip heights were puzzling as they are about 2 inches greater than withers heights. But in this study they were ***lowe***r than withers heights. I cannot conceive why this would be the case except for some mismeasurement technique.

Ruminal pH did not differ among treatments. There were some differences among treatments in the High Milk High % Fat starter treatment being lower in total VFA, and molar concentrations of acetate and propionate reflecting lower starter intake. Likewise, there were few differences in microbial nitrogen and urinary nitrogen compounds, The few differences were related primarily to the low High % Fat starter intake.

Comments:

- Greater milk feeding did increase daily gain prior to and after weaning.
- The 24 versus 20% CP in starters made little difference, not supporting the marketing driven fetish for greater % CP in starters.
- The greatest differences among starters was the addition of a fat supplement causing decreased intake and daily gain. I addressed why this occurs more fully in my book pages 77-82 (Kertz 2019).

Once again, I must address the poor state of making starters—and not just in this study. Unless very hard and flinty, corn does not need to be processed—or minimally by cracking or rolling. Barley likewise needs minimal processing by rolling. In this study, corn and barley summed to 48 to 55%, meeting the minimum of 45% recommended (Ghaffari and Kertz 2021). But both were steamrolled, which was not necessary. Let the calves do the processing! On top of that, 7.5% chopped wheat straw was added. Only if a starter is all meal or pelleted is it necessary to add chopped roughage and then only about 5% is needed.

Now we are back to the cost factor. When I recommend a well-texturized starter because of greater intake and gain, the rejoinder is that it costs more. Not really. Yes, the upfront cost may be more per bag or ton, but when a meal starter is ground or pelleted, there is that processing cost. And now to make those meal or pelleted starters more functional for calves, you must purchase roughage, store, buy and use a chopper, handle and use more labor adding considerable costs. Why is that not considered in calf starter costs?

The Bottom Line

Feeding more milk does increase daily gain prior to weaning, and possibly after weaning too. But that also reduces starter intake which may lead to a postweaning slump due to inadequate intake and rumen development. In this study, starter intake and daily gain were reduced by addition of a fat supplement to a starter. Avoid adding fat sources to calf starters and increasing CP to over 20%. Also, consider all added costs and labor when making meal or all pelleted starters with added chopped roughage.

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