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Calf Note #226 – Volume of milk fed

Introduction

As the days of feeding calves very limited amounts of milk replacer (e.g., 400-500 g of solids/d to weaning at 30 days) fade in the past, researchers, veterinarians, and producers are searching for the “best” program for feeding liquid and dry feeds, and the weaning strategy to optimize growth, health, and efficiency. A number of strategies have been evaluated in practice as well as the scientific literature. Most studies have found that calves fed milk solids from milk replacer (**MR**) or milk are heavier at weaning, though the subsequent growth, particularly from 2 to 4 months of age has not often been reported.

The July issue of the Journal of Dairy Science had an article from our research group at Provimi / Cargill wherein the researchers reported the results of a study that fed calves three levels of MR, including one group that was fed MR for ad libitum consumption. The goal of the research was to compare feeding programs and evaluate growth and efficiency of growth to 4 months of age.

The Research

The trial was conducted in 2016 and used 48 Holstein bull calves in the study. All calves received colostrum and were from a single dairy farm. They were transported to the research facility (Nurture Research Center in New Paris, Ohio, USA) to begin the study at 2-3 days of age. Calves were housed individually in pens until day 56, then were grouped by treatment into groups of 4 calves per hutch in super hutches until the end of the trial at 112 d.

Calves were fed one of three MR feeding programs: a moderate program (**MOD**; 0.66 kg/d for 39 d, then 0.33 kg/d for 3 d), an ad libitum rate of MR (**ADLIB**; offered twice daily between 0630 and 0830 h and between 1430 and 1630 h for 35 d, 0.66 kg/d for 4 d, and 0.33 kg/d for 3 d), or a step-up rate of MR (**STEPUP**; increased daily from 0.32 to 0.62 kg/d in first 12 d, 0.66 kg/d for 27 d, and 0.33 kg/d for 3 d). The MR contained 25% CP (DM basis), 18% fat, and all milk protein. The fat source was lard. Amino acid supplementation was included.

Calves were also offered a calf starter (**CS**) beginning at the start of the trial. The CS (21% CP, 40% starch, 4% fat) was offered for ad libitum consumption until 56 d of age. When the calves moved into the super hutches, the CS was blended into a dry TMR with grass hay (11% CP, 63% NDF) in the ratio of 95:5 CS:hay. Water was always available.

The researchers monitored intake, growth (body weight and hip width), health, and calculated efficiency. More information is available in the article, [here](#).

Key Takeaways

There were several results of particular interest. Let's begin with the first 56-days of the trial (see Table 1).

Milk replacer intake. Calves fed AD LIB drank more MR than other calves. There was no difference between MOD and STEPUP. Calves fed AD LIB consumed a total of 50.8 kg of MR solids during the 42-day MR liquid feeding period, which calculates to 1.2 kg of solids per day. This is reasonably similar to other published research wherein calves were fed for ad lib intake. It's important to remember that these calves were offered MR ad lib for only 35 days, and then the amount offered was reduced to weaning on day 42.

Item	MOD	AD LIB	STEPUP	M vs. A ¹	M vs. S ¹
BW, kg					
0 d	42.8	46.2	43.0	NS	NS
56 d	79.6	86.9	75.4	0.04	NS
ADG, kg/d	0.66	0.73	0.58	0.06	0.03
Hip width, cm					
0 d	17.3	17.8	17.2	NS	NS
56 d	21.6	22.1	21.2	NS	NS
Change	4.3	4.3	4.0	NS	NS
MR intake, kg	26.7	50.8	24.5	0.01	NS
Starter intake, kg	0.79	0.62	0.73	0.01	NS
Gain : feed	0.52	0.47	0.50	0.02	0.02
Abnormal fecal days ²	0.8	2.1	0.8	0.01	NS

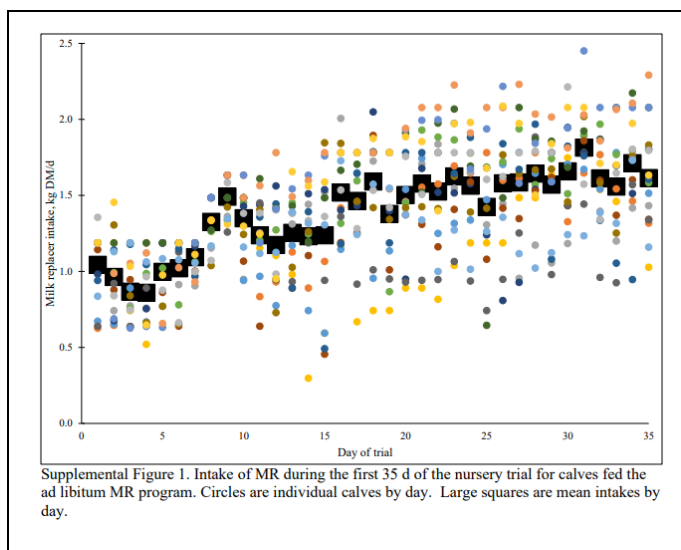
Table 1. Performance of calves fed milk replacer at moderate (MOD), ad libitum (AD LIB) or step-up program (STEPUP) in the first 56 d of the study.

¹Probability of a statistical difference; NS = non-significant, $P > 0.05$. M vs. A = MOD vs. AD LIB; M vs. S = MOD vs. STEPUP.

²Fecal scores were assigned daily based on a 1 to 5 system (1 = normal consistency to 5 = watery with abnormal coloring). Fecal scores >2 were considered abnormal.

Another important observation was the variation around daily intake. Each colored dot in Figure 1 shows the daily DM intake of MR from each calf. The black squares are average intakes from d 1 to 35 when calves were fed ad libitum. The amount of variation is remarkable. On a given day, some calves ate >2 kg of solids and others <600 g. However, anecdotal reports from farms using ad lib programs confirm this observation. Calves may consume a large amount of MR on one day and not much on the following day.

Growth. Calves fed AD LIB were heavier than other calves at 56-days; calves fed AD LIB weighed 7.3 kg more at the end of the study. Increased BW at weaning in calves fed large amounts of milk or MR has consistently been shown in research and field trials and is an argument for



implementing accelerated feeding programs. However, there was no effect of feeding program on structural growth (hip width) – treatments hip width increased an average of 4.0 to 4.3 cm during the first 2 months of life.

Fecal scores. Consistent with many other studies, this study reported that calves fed ad libitum amounts of MR produced more fluid feces than calves fed limited MR. Several published trials have reported similar findings, which may be related to consumption of more water (a calf consuming 1 kg of milk solids will consume about 7 liters of water from MR reconstituted to 125 g/L), high osmolality, and possibly, limited digestibility of nutrients, particularly during the first 3 to 4 weeks of life could also contribute to increased fecal fluidity.

Feed efficiency. We normally think that calves fed more milk will grow more efficiently than calves less milk. Calves fed less MR will begin eating dry feed sooner, and dry feed is less digestible compared to milk or MR. However, in this study, calves fed AD LIB were *less efficient* over the entire 56-d phase. Indeed, calves fed AD LIB were less efficient than calves fed MOD in utilizing nutrients even prior to weaning (0.49 vs. 0.55, respectively, from d 0-42), which suggests that calves fed MOD utilized both MR and CS relatively efficiently, and calves fed AD LIB may have wasted nutrients by limited digestibility that occurs early in life.

Now let's take a look at the second phase of the trial, from d 57 to 112 days – the data are in Table 2. Here are some key points.

Growth. From 2 to 4 months of age, calves fed AD LIB in this study gained <1 kg/d and gained less than calves fed MOD. As a result, they lost the growth advantage gained in the first 2 months. At 4 months of age, BW was similar among all groups. Similarly, ending hip widths and changes in hip width were not different among treatments, suggesting that the added investment in MR feeding with AD LIB treatment did not result in any difference in calf size at 4 months of age.

Intake and efficiency. Calves fed AD LIB tended to eat more CS than calves fed MOD during the second two months of the study, but they used that intake less efficiently. This further supports the idea that these calves didn't consume enough starter to promote rumen development, and as a result, they struggled after weaning to digest the feed they were consuming.

Item	MOD	AD LIB	STEPUP	M vs. A ¹	M vs. S ¹
BW, kg					
57 d	79.0	87.4	75.6	0.05	NS
112 d	136.5	139.3	131.8	NS	NS
ADG, kg/d	1.03	0.93	1.00	0.05	NS
Hip width, cm					
57 d	21.5	22.1	21.2	NS	NS
112 d	26.6	26.3	26.1	NS	NS
Change	5.1	4.2	4.8	NS	NS
DM intake, kg	3.04	3.36	3.00	0.10	NS
Gain : feed	0.35	0.28	0.37	0.01	NS

Table 2. Performance of calves fed milk replacer at moderate (MOD), ad libitum (AD LIB) or step-up program (STEPUP) in the second 56 d of the study (d 57-112).

¹Probability of a statistical difference; NS = non-significant, $P > 0.05$. M vs. A = MOD vs. AD LIB; M vs. S = MOD vs. STEPUP.

Numerous studies in the literature have found that starter intake is required **prior to weaning**, and we recently estimated that consumption of a total of about 15 kg of non-fiber carbohydrate is a reasonable target for mature rumen function and weaning (Quigley et al., 2019). We estimate that calves fed AD LIB didn't reach this level of NFC intake until well into the 9th week of life, and therefore suffered from "post-weaning slump" due to poor digestion of nutrients from dry feed.

So, calves fed MOD or STEPUP programs ate about the same amount of dry feed and grew similarly. Calves fed AD LIB were less efficient. It is possible that delaying weaning for 2-4 weeks would allow AD LIB calves to reach intake of starter to promote sufficient rumen development. That's why it is SO important to consider not only age at weaning, but also the degree of rumen development, driven by starter (and more importantly, non-fiber carbohydrate) intake.

Summary

Feeding calves for ad libitum intake for the first 35 days with weaning at 42 days resulted in heavier calves at 56 days but weighed about the same by 112 days. Feed efficiency was lower in calves fed AD LIB during the first 6 weeks of the trial, suggesting that the high amount of milk consumed was not being utilized as efficiently as the MOD program, which included MR and greater CS intake. This suggests that – for the first 3 to 4 weeks of life – moderate feeding programs be the most efficient management strategy.

Calves fed AD LIB grew slower during the second phase of the trial and were much less efficient. It's likely that a lack of CS intake early in life of AD LIB fed calves did not promote the rumen development needed to effectively utilize nutrients in the starter.

References

- Quigley, J. D., W. Hu, J. R. Knapp, T. S. Dennis, F. X. Suarez-Mena, and T. M. Hill. 2019. Estimates of calf starter energy affected by consumption of nutrients. 2. Effect of changing digestion on energy content in calf starters. *J. Dairy Sci.* 102:2242-2253. <https://doi.org/10.3168/jds.2018-15354>.
- Suarez-Mena, F. X., T. S. Dennis, K. M. Aragona, T. M. Hill, J. D. Quigley, and R. L. Schlotterbeck. 2021. Effects of feeding milk replacer at a moderate rate, ad libitum, or with a step-up program on Holstein calf growth performance to 4 months of age. *J. Dairy Sci.* <https://doi.org/10.3168/jds.2020-19951>.

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