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Calf Note 194 – Does more "growth" equal more milk?

Introduction

The adage that "more milk equals more milk" has gained significant traction in the industry. That is, feeding more milk to calves prior to weaning results in greater first-lactation and lifetime milk production, likely as a result of epigenetic programming during the important pre-weaning period. Several studies have proposed that additional milk (or milk replacer) feeding results in greater future milk production (e.g., Soberon et al. 2012; Soberon and Van Amburgh, 2013) and others. Subsequently, others have reported no effect of additional milk feeding (Morrison et al., 2009; Kiezebrink et al., 2015). A recent meta-analysis (Gelsinger et al. 2016) suggested that preweaning average daily gain (**ADG**) and not milk intake *per se* was important to future milk production. Of course, preweaning ADG increases with increasing milk intake (milk is highly digestible and has an excellent nutrient profile). However, preweaning ADG may be influenced by things other than milk intake – grain intake, disease, management, stress, environment, etc. The observation that ADG is key to future milk production does not support the idea that intake of some specific nutrient, hormone or growth factor in whole milk contributes to an epigenetic modification of the calf to improve milk production.

So, does more milk equal more milk? Or, does more growth (especially preweaning) equal more milk? While there is still much more to learn, two recent studies contribute to our understanding of preweaning nutrition and future milk production. Let's take a look.

The Research – Study 1

Study #1 was published by Chester-Jones et al. (2017) in the Journal of Dairy Science. In this study, data from 2,880 calves were evaluated. Each calf was part of one of 37 different research studies conducted from 2004-2012 at the University of Minnesota Southern Research and Outreach Center in Waseca, MN. Calves arrived at the Station at about 3 d of age and were assigned to an experimental treatment until they were returned to one of three commercial dairies at 195 d of age. This study differs from many others wherein different amounts of milk were tested – i.e., most calves in these studies were fed 0.57 kg/day of a milk replacer containing 20% CP, 20% fat and were weaned at 6 wk. About 10% of the calves were fed an accelerated (or enhanced) milk replacer feeding program. Most studies evaluated different calf starter feeding programs, including types and amounts of nutrients and physical form of the starter. After about 2 months of age, all calves were treated similarly and then sent to a separate grower farm at about 6-7 month of age. Heifers were returned to their home dairy farms prior to calving. Age at calving and first-lactation milk production was recorded by the dairy.

The researchers performed a mixed model regression analysis to evaluate the effects of BW and ADG at 6 or 8 weeks of age on first lactation milk production (amounts of milk, protein and fat). They also separately evaluated the effects of intake and season of birth on production in first lactation.

The researchers initially compared (regressed) the effects of ADG from 0-6 wk of age (approximately the time of weaning for most calves) on first-lactation milk production. The relationship was highly significant ($P < 0.05$) and for every 1 kg of ADG at 6 wk, 305-d milk yield improved by 456 kg (1,005 lbs.). This finding is consistent with other data that report that preweaning growth influences future milk production. Excellent! However, when we look at Figure 1, the situation seems somewhat less clear. There seems to be a lot of variation around this regression line, and while the regression is statistically significant, the biological implications seems less clear. As the authors wrote "*However, despite the high level of significance we found, it is difficult to be confident in this prediction equation because of the high variation around the estimate (SE = 229 kg…).*"

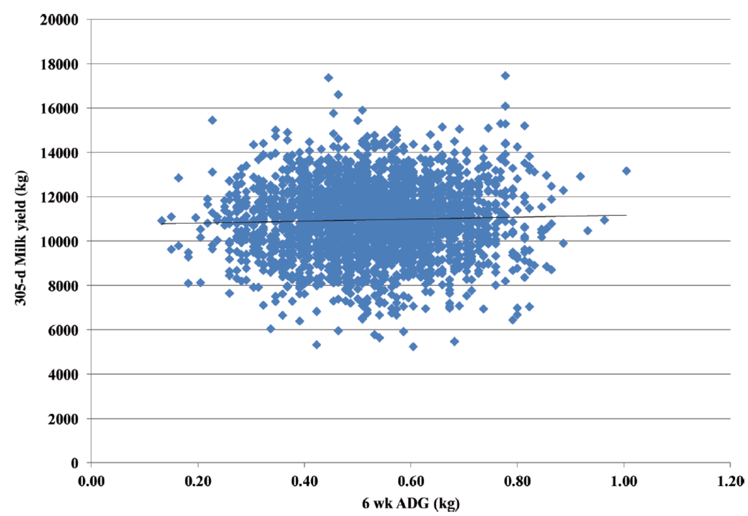

Figure 1. Relationship between ADG from 0-6 weeks and first-lactation milk production. From Chester-Jones et al., 2017.

A few interesting observations made by the researchers were:

Body weight was a better predictor of production than ADG. As we can see in Table 1, BW appears to be a better predictor milk production than ADG. For example, the probability that ADG from 0-6 wk of age would increase milk production was 0.03. That is, there is a 97% probability that the increase in milk production with each kg of ADG (543.7 kg) is not due to random chance. However, each kg of BW at 6 wk of age will increase milk production in the first lactation by 20.1 kg and the probability that this is due to random chance is <0.0001%. As the authors pointed out, there are several studies that indicate that bigger calves produce more milk as cows, which may be due to both growth and birth BW (e.g., Ghoraishy and Rokouei, 2013.; Hoseyni et al., 2016). Hoseyni et al. (2016) also reported that calves born to multiparous cows produced more milk in their first lactation compared to calves born to primiparous cows.

Production in 305 d, kg	Estimate of ADG	*P*	Estimate of BW	*P*
Milk				
6-wk	543.7	0.03	20.1	<0.0001
8-wk	579.0	0.02	14.8	<0.0001
Fat				
6-wk	21.0	0.03	0.84	<0.0001
8-wk	27.4	0.01	0.66	<0.0001
Protein				
6-wk	23.0	0.001	0.70	<0.0001
8-wk	26.1	<0.0001	0.55	<0.0001

Table 1. Effect of ADG from 0-6 wk or 0-8 wk (ADG) or BW at 6 or 8 wk (BW) on first lactation milk production. Adapted from Chester-Jones et al., 2017.

There was a lot of farm to farm variation. When the researchers compared their results for all farms together with similar test for each farm they found major differences. The effect of ADG on first lactation milk, fat and protein production was generally less significant when each farm was tested individually. However, in nearly all cases calf BW at 6 or 8 wk of age was a more reasonable predictor of future milk production than calf ADG at 6 or 8 wk for each dairy. As the authors wrote: "*This high variation suggests that additional factors not accounted for in these analyses affected first-lactation performance.*"

When the authors compared the effect of starter DM intake on first lactation milk production, they found a statistically significant effect. For each additional kg of starter intake at 8 wk of age, calves produced 8.1 kg more milk in the first lactation. The average calf (across all farms) consumed 44.4 kg of starter to 8 wk of age in these studies and produced an average of 10,959 kg of milk in first lactation. Thus, if a calf consumed 45.5 kg of starter from birth to 8 wk of age (+1 kg than average), we would expect that calf would produce 10,967 kg of milk (+8 kg). Again, however, variation was high and there were clearly many other factors affecting first lactation milk production other than DM intake.

The authors concluded their study by writing "*Although we found high levels of significance, it was difficult to be confident in the prediction equations generated for calf growth parameters versus first-lactation performance. Improvements were modest and variation was high, suggesting that additional factors not accounted for in these analyses affected first-lactation performance.*"

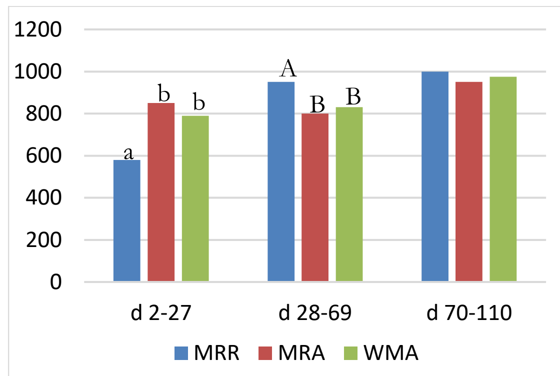

Figure 3. Average daily gain (g/d) in calves fed restricted milk replacer (**MRR**), ad libitum milk replacer (**MRA**) or ad libitum whole milk (**WMA**). Adapted from: Korst et al., 2017.
[a,b]$P < 0.05$
[A,B]$P < 0.05$.

The Research – Study 2

The second recent study that evaluated the effects of preweaning milk intake on future milk production (Korst et al., 2017) fed 57 Holstein calves (29 females, 28 males) from birth to d 110 of life, Thereafter, the 28 females stayed in the herd through their first lactation.

Calves were assigned to 1 of 3 groups at birth – milk replacer restricted (**MRR,** n = 20, 6.78 kg MR (11.5% solids)/calf per day), milk replacer ad libitum (**MRA,** n = 17, 13.8% solids), or whole milk ad libitum (**WMA,** n = 20). For the first 3 days, calves consumed colostrum from their dam. From d 4 to 27, calves were fed according to treatment and from d 28 to 55, all calves received MRR feeding until weaning at d 69.

Item	MRR	MRA	WMA	*P*
No of calves	20	17	20	…
BW, kg				
Birth	41.9	41.8	42.3	…
27 d	56.4[a]	65.4[b]	63.9[b]	0.05
70 d	95.8	98.4	99.0	NS
110 d	131.6	131.3	133.7	NS

Table 2. Body weight of calves at various ages when calves were fed restricted milk replacer (**MRR**), ad libitum milk replacer (**MRA**) or ad libitum whole milk (**WMA**). Adapted from: Korst et al., 2017.

The total intake of milk replacer or milk solids to weaning was 48, 69 and 62 kg for MRR, MRA and WMA treatments, respectively to 69 d. Intake of starter was 51, 41, and 48 kg, respectively, for the first 69 d.

Table 2 shows the growth of calves during the first trial. Calves began the trial at about 42 kg and grew faster to 27 d when fed MRA or WMA. By 27 d, calves fed ad libitum weighed an average of 8.3 kg more than calves fed MRR. However, by 70 d, calves fed the restricted MR weighed the same. Figure 3 shows a similar story for ADG – calves fed ad libitum MR or WM had greater ADG during the first period, but lower ADG during the second period, so that by the end of 70 d, all calves weighed the same. The final BW at 110 d were all similar among the groups.

Item	MRR	MRA	WMA	*P*
No. of heifers	10	9	9	…
Age 1st calving, d	775	773	745	0.97
305-d milk produced, kg	8,452	9,064	9,217	0.92
305-d fat produced, kg	329	358	347	0.93
305-d protein, kg	279	300	300	0.65

Table 3. Production of heifers in 1st lactation when calves were fed restricted milk replacer (**MRR**), ad libitum milk replacer (**MRA**) or ad libitum whole milk (**WMA**). Adapted from: Korst et al., 2017.

Results of the production of calves in their first lactation is in Table 3. Although the amount of milk was NUMERICALLY greater, the probability that the differences among treatments was essentially zero. The probability that milk production differed among treatments was 0.92 – that is, there is only a 3% probability that the difference in milk production (9,217 vs. 9,064 vs. 8,452) is real. The probability that the numbers are not different is 92%. The authors wrote that "*In trial 2, we followed the performance of the heifer calves from trial 1 until the end of their first lactation, although the sample size was too small to allow for sufficient power.*" Based on this statement, some of the conclusions and calculations within their paper (i.e., the differences observed in the study were "real" and similar to others in the literature) are difficult to justify.

It is possible that if we repeated this study with a greater number of animals, we might be able to say with certainty that the differences are "real" (that is, not due to random chance). However, we have no way of knowing for sure. Thus, we have to conclude that there were no differences among the treatments in milk, protein or fat produced.

Summary

The adage that "more milk = more milk" could possibly be better defined as "more growth = more milk". Nutrition to optimize lifetime milk production may be best provided by feeding more liquid prior to weaning; however, more research in the literature suggests that pre-weaning nutrition provided by either liquid or dry feed can optimize milk production. The finding by Gelsinger et al. (2016) that pre-weaning nutrition only accounts for about 3% of variation in first-lactation milk production suggests that time, effort and energy spent to manage calf health, weaning transition, and post-weaning growth are good investments. Others have also shown that many factors other than milk intake (or ADG) prior to weaning influence future milk production. It is essential that we focus on the entirety of the calf's life pre-calving so we can allow her to produce to her genetic potential. Increasing evidence suggests that preweaning growth – whether influenced by milk intake, grain intake, environment or health – can influence future production. However, bigger calves also seem to produce more milk, so size at birth may be important, also.

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