In an attempt to promote both starter consumption and rumen development, traditional dairy calf management programs have restricted the amount of liquid feed pre-weaning to about 10% of birth weight. However, current research is focusing more on the effects of elevating the plane of nutrition for pre-weaned dairy calves. By increasing the volume of liquid fed pre-weaning to about 20% of birth body weight, the results have been higher average daily gains (ADG), earlier pubertal onset and higher milk production over multiple lactations, and decreased signs of hunger. However, it is thought that this higher plane of nutrition, which is offered on most commercial dairy farms in two meals per day, may pose some unwanted long-term effects for calf metabolism and digestion, particularly in terms of insulin sensitivity. In “Effect of plane of milk replacer intake and age on glucose and insulin kinetics and abomasal emptying in female Holstein Friesian dairy calves fed twice daily,” MacPherson, et al. examine any potential unwanted effects on insulin sensitivity that feeding higher planes of nutrition twice-a-day could have, and if any effects would persist once calves are weaned. They also examine the effect of higher planes of nutrition on the speed of abomasal emptying and what this could mean for blood glucose levels.

The seventy-day study followed twelve female Holstein Friesian calves that received 4 litres of colostrum in two feedings of 2 litres each at one and six hours after birth. They were then randomly allocated to one of two treatments, either 8 litres of Milk Replacer per day (MR/d) or 4 litres of MR/d. Both treatments were split into two equal feedings daily. The low calves (fed 4 L MR/d) began their treatment immediately after colostrum feeding, while the high calves (8 L MR/d) gradually stepped-up the amount of milk replacer fed during the first week of life. All calves had ad libitum access to water, calf starter and wheat straw. Individual intakes were recorded and weaning was done via a step-down method which was completed by the end of week 8. Body weights were recorded at least once a week and a series of blood samples was taken at weeks 4, 7 and 10 to determine post meal glucose levels, insulin levels and abomasal, or gastric, emptying speed. Glucose tolerance tests were also performed.

**Higher ADG and body weight for the calves fed a higher plane of nutrition**

The high calves had higher pre-weaning ADGs than the low calves at 0.77 kg/d vs. 0.61 kg/d, respectively. This lead to a marked difference in body weight at weaning, with 81.2 kg for the high calves and 71.9 kg for the low calves. ADG for the high calves over the entire experiment was also higher compared to the low calves, at 0.78 kg/d vs. 0.68 kg/d. Thus, body weight at the end of the experiment was higher for the high calves, with an average of 92.0 kg vs. 85.3 kg for the low calves.

**Effects on insulin and glucose levels**

While the researchers found no differences in glucose tolerance test kinetics between the high and low dairy calves at 4, 7 or 10 weeks of age, basal glucose was indeed higher for the calves fed an elevated plane of nutrition. While the prolonged feeding of a primarily milk diet past the age of two months has been associated with impaired insulin sensitivity, this study, calves were fully weaned prior to that, by 56 days of age. Additionally,
post-meal blood glucose and insulin concentrations always returned to baseline within six hours of eating. This suggests that calves fed large meals can, in fact, regulate blood glucose concentration.

Additionally, no differences were detected between treatments via glucose tolerance tests (GTT) either before or after weaning. Thus, it seems that feeding plane has little effect on insulin sensitivity. These findings may, at first glance, seem contradictory to other recent studies which found that insulin sensitivity is affected by a higher plane of nutrition fed in large meals twice daily. However, when the entirety of the research parameters are taken into account, the current study has controlled for many more factors which could alter the results than previous studies have. These controls included implementing strict protocols for colostrum management, including higher feeding volume; calves were fed high planes of nutrition from birth; which none of the previous studies had done; and, quite importantly, the GTT’s were conducted after 12 hours of fasting. All of these qualitative differences point to the improved reliability of the present study.

**Importance of the rate of gastric emptying**

MacPherson et al. postulate that perhaps the rate of gastric motility and emptying plays a role in the glycaemic response of the highly fed calves. In the study, the highly fed calves had a slower abomasal emptying rate than the calves fed lower amounts of milk replacer. They point out that this could be a way that the calves’ systems attempt to stabilize blood metabolite levels. It is well understood that for many species, larger meals are, in fact, emptied more slowly. The current study seems to be the first to show that this is also the case for calves.

**Higher future productivity without negative effects on metabolism**

Feeding a higher plane of nutrition in two meals per day offers significant pre-weaning growth advantages. This increased pre-weaning growth leads to better health and higher overall lifetime performance by many measures, including earlier calving and increased lactational performance at the first and subsequent lactations. And, as shown in the present study, offering higher amounts of milk does not affect insulin sensitivity and glucose metabolism. The ability calves have to stabilize blood metabolite levels may at least in part be due to their ability to slow the transit of larger meals from the abomasum to the lower gut. Indeed, this study points to positive results for upping the level of pre-weaning calf nutrition.

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**Key takeaways from the research:**

- Higher pre-weaning ADGs are achieved when calves are fed 8 L MR/d in two meals as opposed to 4 L MR/d.
- Higher body weights are achieved pre- and post-weaning when feeding 8 L MR/d compared with 4 L MR/d.
- Feeding 8 L MR/d has minimal effects on insulin sensitivity and glucose metabolism.
- Pre-weaned calves fed 8 L MR/d have slower rates of abomasal, or gastric, emptying. Weaning is a critical time for calves.
- Starting the weaning process later helps prevent health issues.
- Improving nutrition pre-weaning yields greater growth outcomes.

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**References**


