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Calf Note 175 – Insulin sensitivity in milk fed calves

Introduction

Calf raisers have many options when it comes to feeding liquid – whole / waste milk or milk replacer; feeding less milk to foster early rumen development; feeding one, two or more times per day; and weaning at various ages. While we generally assume that the calf can respond appropriately to the many ways that we feed liquid. In other words, the calf is able to digest, absorb and utilize nearly all the nutrients in the liquid no matter the feeding method. In fact, there are many times when our feeding programs affect the ways that calves utilize their nutrients. A recent study from the Journal of Dairy Sciences shows that calves fed high amounts of liquid twice per day become more insulin resistant in response to the level of feeding. The implications of this interesting research will be discussed below.

The research

The research conducted by Bach et al. (2013) used eight young (8 d of age) Holstein calves. Four of the calves were fed a conventional diet – i.e., 2 L per feeding or an accelerated diet – 4 L per feeding. The milk replacer (25% CP and 19% fat) was fed twice daily at a 12% solids concentration. Calves were also offered a commercial starter and water for ad libitum consumption.

On days 7, 30, and 60 of the experiment, calves were exposed to a glucose tolerance test (GTT). This test is an infusion of a fixed amount of glucose (180 mg/kg BW) into the jugular vein of the animal. Then, the amount of glucose and insulin in the blood is monitored for a period of time after the infusion

to evaluate how the calves respond to the infused glucose. In this experiment, blood glucose and insulin were monitored at -15, -5, 0 (time of infusion), 4, 8, 12, 18, 25, 35, 45, and 60 minutes after infusion. The -15, -5 and 0 minute samples were used to establish a baseline.

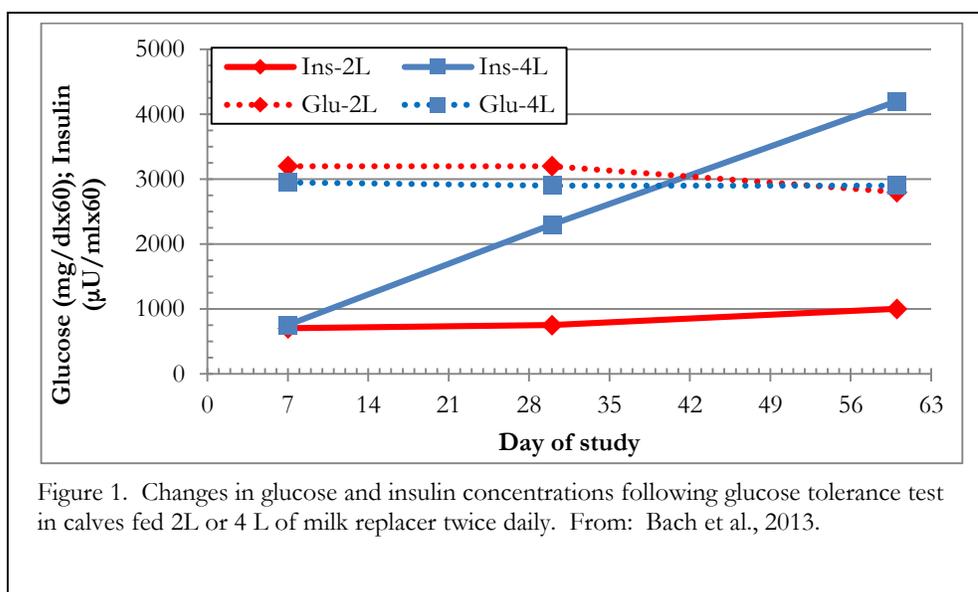


Figure 1. Changes in glucose and insulin concentrations following glucose tolerance test in calves fed 2L or 4 L of milk replacer twice daily. From: Bach et al., 2013.

Blood glucose concentrations are tightly regulated by the body. When glucose increases, the pancreas secretes the hormone insulin, that promotes the uptake of glucose by cells in various tissues (including muscle and adipose), thereby reducing the circulating glucose concentrations. Thus, infusing glucose into the blood stream (as in this GTT) should cause an increase in insulin concentration and re-establishment of glucose homeostasis in the blood.

Results of the study showed that glucose concentrations were maintained adequately – i.e., both groups of calves were able to maintain their glucose concentrations appropriately. However, in both groups of calves, it required more insulin to do the same job of regulating blood glucose concentration as the calves aged. As can be seen in Figure 1, both solid lines increase from d 7 to 30 and 60.

The striking change occurred in calves fed 4 L of milk replacer twice daily. The amount of insulin required to maintain glucose concentrations increased dramatically from d 7 to 30 and from 30 to 60 days (Figure 1). At 7 days of the study, calves fed 4 L per feeding required $1,000 \mu\text{U}/\text{ml} \times 60 \text{ min}$ to maintain their glucose concentrations; by 60 days, this had increased to over $4,000 \mu\text{U}/\text{ml} \times 60 \text{ min}$.

The implications of this dramatic increase are as yet unclear. Decreased insulin sensitivity is associated with increasing fat deposition (Bach et al., 2013) and reduced efficiency of protein utilization (Van den Borne et al., 2006). Thus, it's possible that calves fed larger volumes of milk replacer (in this case twice daily) could become fatter than calves fed less milk replacer. It's not clear at this point whether more frequent feedings could ameliorate this issue; more research is needed to document this possibility.

This interesting research points out the importance of understanding the implications of our management and feeding strategies on the farm. This study suggests that large amounts of milk might change how our calves use their nutrients; whether this change might be permanent remains to be determined.

References

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- Van den Borne J.J.G.C., J.M.A.J. Verdonk, J. W. Schrama, and W.J.J. Gerrits. 2006. Reviewing the low efficiency of protein utilization in heavy preruminant calves: a reductionist approach. *Reprod. Nutr. Dev.* 46:121–137.

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