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Calf Note 172 – Effects of rumen acidosis on digestion in calves

Introduction

In a previous Calf Note (#170), I introduced the concept of subacute rumen acidosis (**SARA**) in young calves. Data from a couple of studies showed that calves often experience rumen pH less than 5.8 (a typical definition for SARA in lactating dairy cows). Numerous factors typical of the developing ruminant may predispose calves to SARA, including small dietary particle size, high carbohydrate concentration of the diet and limited salivary buffer production. If it is true that many calves experience SARA, what are the effects on digestion and efficiency of production? This Calf Note will summarize some of the recent research regarding SARA and its effects on digestion and health. Since most of the work on SARA has been done with adult cattle, most of the research summarized here will be in adults.

Effects on intake and digestion

Low ruminal pH (less than 6) impairs fiber digestion, probably by reducing growth of cellulolytic bacteria which are sensitive to ruminal pH (Hoover, 1986). Krajcarski-Hunt et al. (2002) reported that switching lactating dairy cows to a high starch diet (barley + wheat replacing 25% of the total TMR to reduce overall forage content from 40% to 30%) reduced in situ NDF digestion in most forages (Fig. 1).

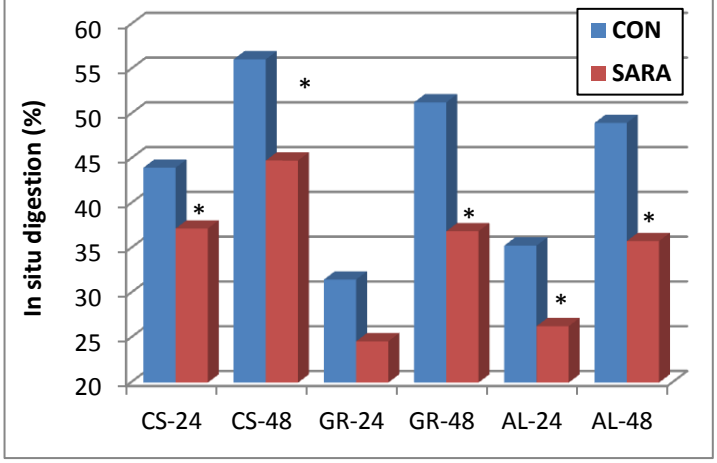

Figure 1. In situ digestion of corn silage (CS), grass hay (GR), and alfalfa hay (AL) after 24 and 48 h of incubation in lactating dairy cows. From: Krajcarski et al. (2002).

*P < 0.05.

Some studies reported a cyclic effect of acidosis on intake of cattle. That is, cows will eat normally on one day, but then eat less the next day (Gozho et al., 2005). Occasionally, calves may show a similar cyclicity in intake of calves fed high starch pelleted starters without added forage. It appears that high rates of fermentation induce low ruminal pH, which inhibits intake the following day. Subsequently, the calf goes into negative energy balance and eats more aggressively. This pattern continues as the calf goes from high intake to low intake due to low rumen pH (acidosis).

Studies evaluating the effect of SARA on digestion in calves are limited. There are many confounding factors – physical form of the diet (pellets vs. textured vs. meal), inclusion of forage,

type of ingredients used (rapidly fermented ingredients such as wheat and barley vs. corn), etc. We do know that digestibility of nutrients increases as the calf ages and the digestive tract matures. For example, Leibholz (1975) reported that digestion of acid detergent fiber (ADF) increased somewhat with week after weaning (calves were weaned at 5 wk of age and fed a diet of barley, soybean meal and wheat chaff). However, the site of fiber digestion changed dramatically. For the first four weeks after weaning, much of the ADF was digested in the hindgut, whereas rumen digestion increased later. By 8 weeks after weaning (13 weeks of age), nearly all fiber digestion occurred in the rumen. Overall, about 50% of the ADF ingested was ultimately digested by the calf.

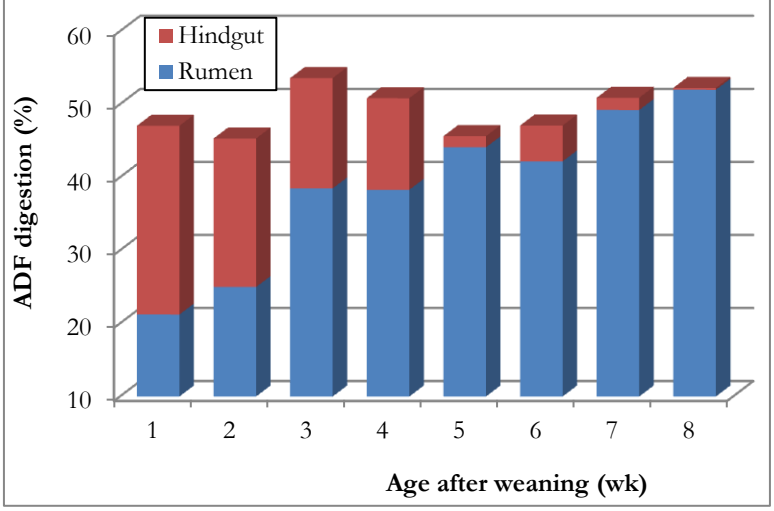

Figure 2. Digestion of fiber in calves fed a diet of soybean meal, barley and wheat chaff. From Leibholz, 1975.

A study by Stobo et al. (1966) weaned calves at 5 weeks of age and then fed them a diet containing 90% concentrate or 33% concentrate. They monitored digestibility at 13 and 17 weeks of age. Digestibility of crude fiber at 13 weeks was 18.4% and 57.3% for calves fed 90% and 33% concentrate, respectively. At 17 weeks, crude fiber digestion was 14.5 and 54.0%, respectively. These authors also measured rumen pH after feeding at 13 and 17 weeks; mean pH measures, particularly after feeding, were lower in calves fed the higher concentrate diets. Overall rumen pH were generally at or above 6.0; however, rumen fluid was collected by stomach tube, which can lead to artificially high pH measurements due to salivary contamination of the samples. These data suggest (but only indirectly) that calves with SARA may have reduce fiber digestion compared to calves fed to avoid SARA.

Causes of SARA

Calsamiglia et al. (2012) recently suggested that SARA is due to a combination of low ruminal pH and the type of ration fed. Though this distinction might seem academic, it's actually important. If the problem causing SARA is simply one of low ruminal pH (which may due to the type of ration or other factors), then it would be possible to control or eliminate SARA by feeding the right combinations of rumen buffers and other "stabilizers" to increase pH of the rumen. If SARA is primarily a function of ration form, then the solution would be to increase particle size of the diet to allow the animal to chew its cud to produce saliva and provide buffering. Larger particle size also removes keratin from the surface of the ruminal papillae. A build-up of keratin on the outside of

the papillae (called hyperkeratosis or parakeratosis) inhibits absorption of VFA across the papillae wall, thereby causing increased VFA concentration in the rumen, lowering pH.

One interesting observation is that consumption of water helps the animal maintain rumen pH. When calves consume water, it enters the reticulorumen and then leaves through the reticulo-omasal orifice. Water leaving the rumen will carry with it small particles, which will be digested in the intestine. Calves with limited access to water may not consume sufficient amounts, which could exacerbate SARA even further. It's in the animal's best interest to have water available at all times and to encourage calves to drink water frequently throughout the day.

Khan et al. (2008) formulated diets containing 25% starch but based on ground corn, ground barley, ground wheat or crimped oats. All diets were pelleted and offered for ad libitum consumption (along with mixed grass hay). Rumen pH was measured at 35, 50 and 70 days of age and was higher when calves were fed diets containing corn (and barley in some cases) than wheat or barley. However, digestion of DM or NDF (measured from d 77 to 84) were unaffected by treatment. It's noteworthy that NDF digestion only averaged about 41%, which is lower than many reports in the literature. However, these data do not support the idea that differences in ruminal pH affect digestions. It's possible that differences in rumen pH decreased from d 70 to 77 when digestibility measurements began. Also, there were differences in hay intake – calculation of the % of the diet as hay suggested that calves consumed between 49% and 69% of their DM as mixed grass hay, which would affect digestibility measurements. Thus, the comparison of digestion at 77-84 days in calves fed such a high forage diet may not be applicable to calves fed higher grain diets.

Item	Barley	Corn	Oat	Wheat	SE
Rumen pH					
d 35	5.23[b]	5.49[a]	5.41[a]	5.19[b]	0.12
d 50	5.46[c]	5.79[a]	5.68[b]	5.62[b]	0.10
d 70	5.66[c]	6.16[a]	5.96[b]	5.95[b]	0.14
Digestibility, %[1]					
DM	0.71	0.72	0.72	0.71	0.01
NDF	0.43	0.41	0.42	0.40	0.01

Table 1. Rumen pH in calves fed starters containing various cereal grains at 35, 50 and 70 d of age. From: Khan et al., 2008.

[1]Digestibility measured from d 77-84.

[a,b,c]$P < 0.05$.

Summary

Low ruminal pH resulting in SARA may inhibit growth of fiber digesting bacteria in the rumen of the growing calf and impair fiber digestion. Diet physical form and composition, immaturity of the rumen, limited saliva production, lack of access to free water and other factors affect the calf's

predisposition to SARA. Careful attention should be paid to the amount of carbohydrate calves consume, as differences in digestibility may affect growth. However, the number of confounding factors makes predicting effects of SARA difficult in young calves. In a future Calf Note, we'll look at the effects of including some forage in the diet on rumen pH and incidence of SARA.

References

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Written by Dr. Jim Quigley (31 December 2012)

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