Interpreting Urine pH of Pre-Fresh Cows Differing in Metabolic Acid-Base Status

August 30, 2018 Webinar Q&A

The following questions were submitted by webinar attendees. The following responses are written by Tim Brown, Director of Technical Support for SoyChlor.

Q: So, it's not only the concentration (of DCAD level) that matters, but also the amount (net anion surplus)? But as they eat more they also eat more cations?

A. Both correct. But remember that it is the net difference in the number of equivalents of consumed anions relative to consumed cations that determines the degree of metabolic acidification of the cow over any given period of time. Look at slide #15 in our webinar, with the example of a cow consuming 10 kg of a -100 meq/kg diet one day, and then consuming 12 kg of that same -100 meq/kg diet another day. Sure, on that second day, she will consume more total equivalents of cations than she did the first day. But since the diet has a net excess of anions relative to cations (that's what makes it a negative DCAD diet!), her intake of anions relative to cations will be greater on that second day, and thus she will have a greater metabolic acid load to deal with.

Q: Is there any research demonstrating the effects of DMI/anion intake on urine pH?

A. I am not familiar with any research that either intentionally delivered different amounts of DM each day and looked at the effect on urine pH, or where actual DMI was monitored and correlated with urine pH over some subsequent period of time. I think that my response to the question above will shed some light on this question. If the DCAD level of the diet is negative and constant, feeding different amounts would deliver a different load of anions relative to cations, and subsequently result in greater acidification of the cow. The same would happen if a cow consumed a certain mass of -100 meq/kg diet one day (let's say 10 kg DM), and the next day she also consumed 10 kg of DM, but the diet instead had a DCAD of -150 meq/kg. She consumed the same amount of DM each day, but the net excess of anions relative to cations was greater on the second day, so she would have a greater metabolic acid load to eliminate from her body.

Q: Has the extreme low DCAD also affected the potassium excretion and sodium sparing ability of the kidney?

A. Sorry, I can't find any information to form an answer to this one. None of the recent papers that compared extreme and moderate acidification of cows reported potassium and sodium content of blood, or urinary excretion of potassium and sodium during the acidified, pre-partum phase. And I am not enough of a renal physiologist to speculate on this one.

Q: What is the hypothesis of the issue of when cows go down when we use an extreme DCAD approach?

A. Without more information, I don't want to venture too far into diagnosing the reasons why transition cows may "go down" under certain circumstances. If this down cow responds to I.V. calcium, suggesting that it was hypocalcemia that caused her to go down in the first place, we have to remember that metabolic acidification by itself is only a part of what initiates the mobilization of bone calcium and the increase in calcium flux. Magnesium adequacy plays a big role, particularly in the metabolic signaling between parathyroid hormone (PTH) receptors and the kidneys and the hydroxylation of vitamin D into 1,25 di-hydroxy cholecalciferol. So, at any degree of metabolic acidification, insufficient bioavailable magnesium could result in cows still developing hypocalcemia. For another possible mineral interaction that could be involved, excess dietary phosphorus can also disable our attempts to mobilize calcium via negative DCAD diets.

   There is still much that we don't know about what else is happening, perhaps not even related to calcium, to the cow under the extreme metabolic acidotic conditions that might be imposed by negative DCAD diets. Keep in mind that the metabolic acidosis that we create is not the natural acid-base situation in which the cows' metabolism is designed to function. We manipulate that acid-base status for a short period of time because we now realize that it will enhance calcium mobilization, but it may also be doing other things that are not so good for the metabolism.

   I expect that now that universities are studying the effects of extreme metabolic acidification of the close-up cow, some answers will be provided as to whether it's good, bad, or not really any different compared to more moderate acidosis. We need to remember that the concept of applying extreme acidosis did not come from the academic community in the first place. Recommendations for extreme acidosis came into the industry along the same path that many other extreme recommendations (phosphorus levels, crude protein levels, starch levels in dairy diets) followed - that if a little is good, more must be better.

Q: What level of calcium in grams should be fed with a moderate DCAD diet?

A. There is emerging data that supports the concept that dietary calcium likely plays only a small role in calcium flux or blood calcium concentrations. If you study Riond (2001, Animal Nutrition and Acid Base Balance, Eu. J. Nutr. 40:245), you will note that a metabolically acidified cow may excrete up to 12 grams per day of calcium in the urine. Calcium that is excreted in urine is the calcium that was made metabolically active either by absorption from the digestive tract or resorbed from bone. From either source, it entered the blood, and the kidneys noticed that blood calcium concentration might be rising above normal homeostatic boundaries. So the kidneys removed a little, just enough to get blood calcium concentration back to a "normal range". Some of the recent reports [Leno et al., 2017 (J. Dairy Sci. 100:4604, table 4); Grünberg et al., 2011 (J. Dairy Sci. 94:727, table 4); Lopera et al., 2018 (J. Dairy Sci 101:7907, table 2)] in which urinary calcium excretion has been measured substantiate that about 8 to 12 grams per day is what we expect to become metabolically active. So if only 12 grams per day is being mobilized and excreted, and a large part of that is likely coming from bone, there should not be much justification for a large amount of supplemental calcium in the pre-fresh diet – at least with regard to affecting the drop in blood calcium that occurs at calving, or blood calcium concentration at calving. With that said, I point out a potential caveat. If we have some supplemental calcium in the pre-partum diet, some of this calcium will be distributed throughout the digestive tract when the cow calves. Some of it will still be passing the absorptive sites in the intestine on the first, and maybe even the second day of lactation. Since cows may not be eating much of their lactating cow diet during the first couple of days, but they are already pumping lots

(maybe 25 to 50 grams/day) of calcium into milk and switching from bone calcium to dietary calcium to support that milk synthesis, perhaps that small, transient "reservoir" of pre-partum calcium could help a little. This is just my supposition, and I know of no research to support this idea.

So, to my recommendation for dietary calcium amount for cows fed negative DCAD diets. Considering my rationale above, I recommend around 100 grams per day. The basal diet with no supplemental calcium might supply somewhere around 50 or 60 grams, depending on ingredients, DMI, etc. So another 40 or 50 grams supplemental calcium would be fine. Again, whether we have any supplemental Ca or not may not affect blood Ca dynamics at calving.

Q: Do you have any comments on the levels of other macro minerals in DCAD diets? For example, I see recommendations for very high P levels, which seems contrary to what it should be.

A. I mentioned the involvement of magnesium above. I like to see a minimum of 0.4% Mg in the diet. If supplemental Mg is needed, I prefer for most of it to come from chloride or sulfate forms. If you must use magnesium oxide, either for cost control or because of its high Mg content, make sure it is a very bioavailable form. Many are not.

Regarding P, it is important to meet the requirement of the cow, somewhere around 0.28 to 0.30% of diet DM. Additional increments of P may begin to work against calcium mobilization mechanisms and reduce blood calcium concentrations. Peterson et al., (2005, J. Dairy Sci. 88:3582) fed different amounts of P to cows on negative DCAD diets, and found that 0.44% P reduced blood calcium concentration on day of calving. Thus, my recommendation is to meet her requirement, but try to avoid an excess.

Q: Have you seen any difference in milk fever cases between the extreme and moderate DCAD approach?

A. I have not been able to make that comparison in the field. In the very few research trials that have compared moderate to extreme DCAD, the incidence of milk fever has been so low that differentiating the incidence has not been possible. In the case study that we reviewed in the webinar (Melendez and Poock, 2017, Frontiers in Nutrition, Vol., 4, article 26), there were 2 cows out of 10 diagnosed with subclinical hypocalcemia (total blood Ca < 2.0 mM) at each level of metabolic acidification, but no cases of clinical hypocalcemia during the study.

In Lopera et al. (2018, J. Dairy Sci. 101:7907), which we also reviewed in the webinar, there was one case of clinical milk fever on the moderate and one on the extreme DCAD treatment. Regardless of the threshold used to diagnose subclinical hypocalcemia, moderately and extremely acidified cows had the same incidence of hypocalcemia. These researchers examined a number of the dynamics associated with evaluating hypocalcemia post-partum, and these are explained in the paper. But if you just take for example, the diagnostic value of 2.0 mM total blood Ca, they reported between 50 and 60% subclinical hypocalcemia for both extreme and moderate metabolic acidification. I won't hypothesize on why the incidence was this high even though the cows were metabolically acidified, but to address your question, the incidence was not different for extreme vs. moderate acidification.

Q: Would you recommend DCAD diets just for milk fever control, or as a way to promote higher milk production and health, even in herds not having MF issues?

A. Without a doubt, the largest economic benefit to be derived from implementing negative DCAD management for pre-fresh cows comes from the reduction in subclinical hypocalcemia and the secondary disorders that can

be associated with it to some degree. Even herds that have a very low incidence of milk fever will likely make money by implementing negative DCAD. Economic benefits come in many forms, including reduced incidence of a number of disorders and diseases, improved reproduction, improved early lactation and total lactation milk production, and decreased culling rates. In addition to the economic benefits, just being around healthier, more productive cows is an emotional benefit to those who work with them.

Q: My question relates to the fact that I have seen a significant number of cows on extreme DCAD with mild hyperkalemia and mild hyponatremia.

A. Sorry, but I am not able to put forth a possible reason as to why extreme DCAD might result in abnormally high blood potassium and abnormally low blood sodium. As alluded to during the webinar, the kidneys involve a number of dynamic mechanisms as they attempt to remove the excess acidity that we put into the blood with negative DCAD diets. When we push the kidneys to employ extreme measures to prevent collapse of blood homeostasis, we know that they could be depleting the blood of some of its buffering mechanisms, whether that be phosphate buffers, carbonate buffers, or others. I don't know specifically how these might be related to their association with their normal cation components (potassium and sodium) in the blood.

Q: What is SoyChlor's view on feeding Na in close ups diets?

A. Cows do have a sodium requirement, somewhere around 0.14% of diet DM. That requirement should be met. In my experience, it usually does not take any sodium supplement (such as sodium chloride) to meet the 0.14% requirement. Any dietary sodium above that requirement simply increases the anions needed to achieve metabolic acidification.

Q: Do first calf heifers need (negative) DCAD diets?

A. A very practical and frequently asked question, with perhaps a changing answer over time. I used to say that heifers could benefit from negative DCAD diets, just not as much as mature cows. That was based solely on the fact that heifers have a lower incidence of milk fever and subclinical hypocalcemia. There is some concern that the decrease in DMI that occurs both in heifers and cows, might be a greater concern for heifers since they are still growing and need all the energy and other nutrients they can get. But the decrease in DMI with negative DCAD diets is directly related to the degree of metabolic acidosis, so a moderate application of DCAD yields only a moderate reduction in intake. Everything is relative in this moderate versus extreme discussion.

Since there is strong evidence that DM intake will be depressed more as metabolic acidosis becomes more extreme, I certainly would not recommend extreme DCAD (average urine pH <6) for the heifers

In the perfect, ideal situation, heifers would never have to co-mingle with mature cows, even throughout their entire first lactation. Few places have the luxury of facilities that will allow such an ideal. If I had the opportunity to work in such an ideal situation, I would determine on that farm whether heifers would benefit from a negative DCAD diet. I am not sure there is a sufficient consensus of research to give strong guidance there. I would try it for a few months on that farm and keep careful records of everything I could think of related to health and production, and they I would to a while without the negative DCAD diet.

In the rest of the real world, where heifers likely are housed with mature cows pre-partum, there is no doubt that feeding the entire group a negative DCAD diet is a money maker.

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Q: In the research presented today, at what DIM was blood Ca tested in fresh cows?

A. In the Lopera study, blood samples were taken on day 0, 1,2,3,4,5,7,14 and 21 post calving. They did a lot of different evaluations of the effects of treatment on different aspects of post-partum blood calcium concentration. In the case study of Melendez and Poock, the blood samples were taken within 6 hours after calving.