



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





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Agenda

- What do negative DCAD diets do?
- Why test urine pH?
- Variability in urine pH
- Extreme vs. moderate DCAD
- Importance of test strip brand

Negative DCAD Diet: What Happens?

- Chloride and sulfate absorbed rapidly from the digestive tract.
 - As strong anions, they **make the blood more acidic.**
 - Kidneys are **protecting the blood from this metabolic change** we are inducing. **Small** shift in the acid-base balance is all that is needed to benefit calcium metabolism.
- As kidneys work quickly to remove these strong ions and acidity from the blood, for excretion from the body, **the urine becomes more acidic.**
- This is a continuous competition between the **rate of absorption of anions from the digestive tract and the rate at which the kidneys can remove those anions (and associated acidity).**

Why monitor acid-base status?

- To stay in **healthy range** of **mild, compensated acidosis**.
 - You want to create **enough** acidosis to improve calcium flux, **but not so much** acidosis that you're interfering with other metabolic functions.
- Calcium flux = increased movement of calcium out of bones into the blood.
- **Increased calcium flux = increased movement of calcium in the body**
 - **more calcium ready to move in to blood when mammary gland pulls calcium out of blood for colostrum synthesis**

How to monitor acid-base status?

- Several tests measure acid-base status
 - Blood base excess
 - Blood bicarbonate reserve
 - Urine Net Acid Excretion (NAE)
 - Urine Net Base Excretion (NBE)
 - **Urine pH**

Why do urine pH testing?

- Indirect reflection of blood calcium status
 - **Best metric we have** to look at how acidified we've made the cow
 - **Best** way to measure acid-base status on farm
 - But, it is only useful over a narrow range.

Urine pH as Monitor

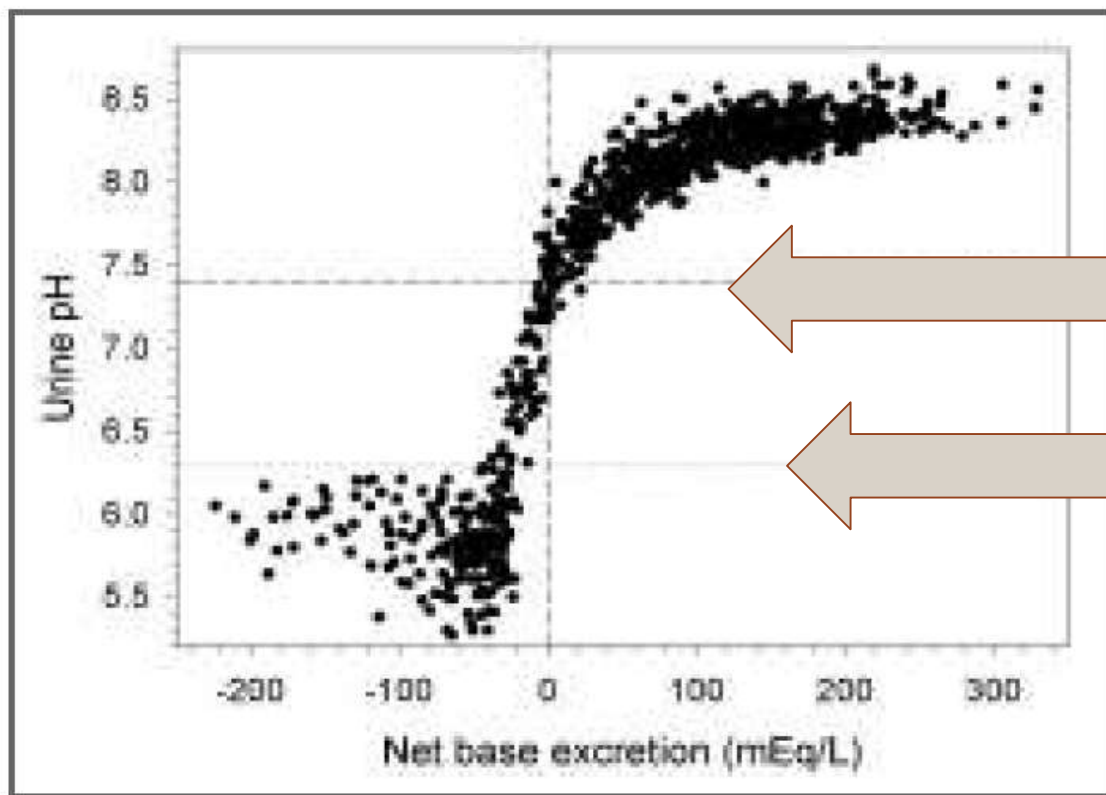
- **Normal alkalotic state**
 - Urine pH > 8
 - Does not tell us *how much or what type of* blood buffering capacity the cow has. Just tells us **she has an excess** for preventing change in blood acid-base homeostasis.
- **Extremely acidotic state**
 - pH < 6
 - Urine pH doesn't say anything about *how much or what type of* blood buffering capacity the cow has, **just that she's used most of it up.**

Complexities of measuring acid-base status

- Urine Net Base Excretion (NBE) is complex result of the content and interactions of the following in urine:
 - Strong ions – sodium, potassium, calcium, magnesium, **chloride**, and **sulfate**
 - Volatile buffer ions – bicarbonate and ammonium
 - Non-volatile buffer ions – phosphate and creatinine
- **Cows with positive NBE** have some blood buffers in reserve to use to maintain blood acid-base homeostasis.
- **Cows with negative NBE** have used up their blood buffers, and blood acid-base status is more subject to shift in the acidic direction.

Constable et al., 2009

Net Base Excretion and Urine pH

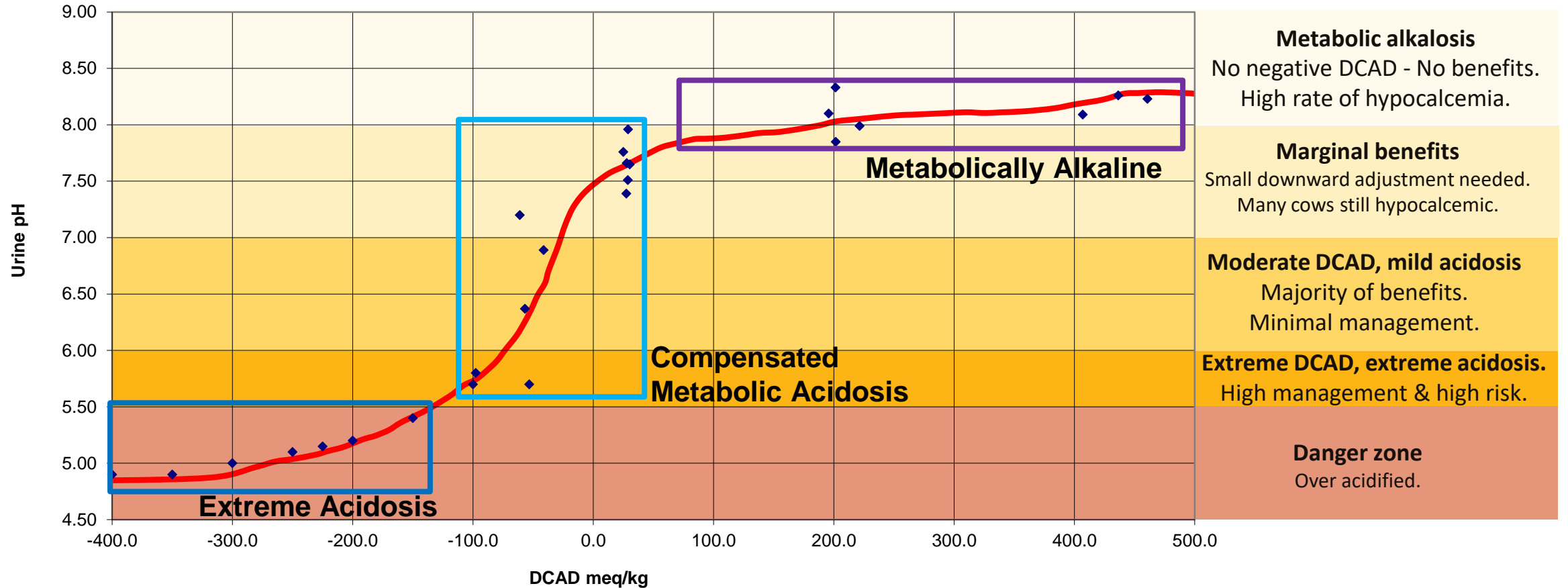


when urine pH gets down to 7.4, it becomes a sensitive indicator of net base excretion (NBE)

urine pH < 6.3 becomes poor indicator of NBE

Urine pH Variation at Different Metabolic States

Urine pH more variable with compensated metabolic acidosis



Variability in pH

Moderately Acidified Cows

- **Individual cow pH readings subject to great variability due to:**
 - DCAD level in diet, & general degree of compensated acidosis
 - Time since last anion consumption and amount of anions
 - Interval since last emptying bladder
 - Acidity of new urine produced since last emptying bladder
 - Time urine sample taken, relative to above
 - **For cows all consuming the same diet, it is not uncommon to have pH readings ranging from upper 5s to nearly 8 for individuals with mild, compensated acidosis.**

Intake influences acidification

- At any negative DCAD level (Meq/kg), differences in intake result in differences in net intake of anions (Meq/day).
 - Can be **cow-to-cow differences on any given day**
 - or **day-to-day differences for any given cow.**
- Greater net anion intake produces a more acidic condition, and vice versa.
- Intake influencers include:
 - Body size, type, condition, age, social status, stocking density, daily temperature fluctuations, proximity to calving

For example...

- Cows don't eat exactly the same amount each day.
 - You have a diet with -100 meq/kg DCAD. One day, a cow eats 10 kg of this diet. She takes in a net of 1000 meq of anions.
 - The next day, she eats 12 kg of this diet. She takes in a net of 1200 meq of anions.
 - She is more acidotic from her anion consumption on the second day than on the first day.
- If this cow is **mildly acidified (pH 6 to 7)**, we should **expect urine pH to vary in response to this difference in anion consumption.**
- If the cow is **extremely acidified (pH<6)**, urine will only tell us that she is extremely acidified, but **it will not reflect this difference in anion consumption.**

Urine pH consistency at different degrees of acidification

- **Moderately acidified cows**

- Fluctuations in degree of acidosis **are reflected** as variability in urine pH.

- **Extremely acidified cows**

- Fluctuations in the degree of acidosis **are no longer reflected** by changes in urine pH

- **Variability in urine pH does NOT mean your DCAD program is broken**

Extreme vs Moderate DCAD

pH with mild, compensated acidosis

- Kidneys can “catch up” quickly on removing excess acidity from the blood. When they do this, net base excretion becomes positive again, and the pH of newly formed urine rises rapidly.
- This is the indication that the kidneys have not been overwhelmed in their work to maintain blood homeostasis.
- This does not mean that mobilization of bone calcium is diminishing.

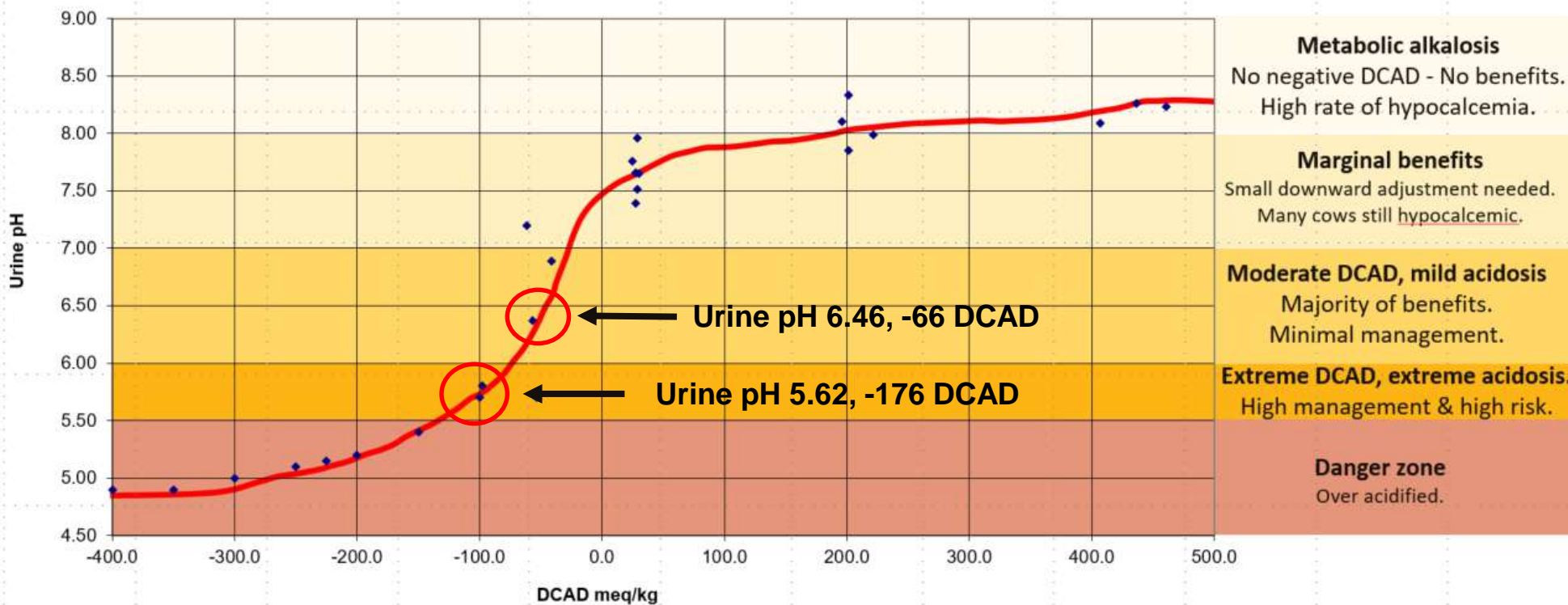
pH with more extreme acidosis

- For cows with extreme metabolic acidosis, the kidneys are removing acid from the blood as fast as they can, and urine pH remains constantly low.
- The kidneys have resorted to “auxiliary” methods (ammonium ion, glutamine) of removing acid from the blood, and **urine pH is no longer a good reflection of the degree of metabolic acidosis.**

Lopera et al., 2018

J. Dairy Sci. 101:7907

Two levels of negative DCAD



Lopera et al., 2018

University of Florida

Pre-partum measure of acid-base status

	<u>-66 DCAD</u>	<u>-176 DCAD</u>
Urine pH	6.46 ^a	5.62 ^b
Blood pH	7.42 ^a	7.39 ^b
Blood base excess	1.75 ^a	-2.26 ^b

Lopera et al., 2018

Diagnostic Values

	<u>-66 DCAD</u>	<u>-176 DCAD</u>
Urine pH	6.46	5.62 ^b
Pre-partum blood ionized Ca, mM	1.23 ^a	1.27 ^b
Pre-partum blood total Ca, mM	Same for both DCAD levels	
Post-partum blood iCa, mM	1.12	1.13
Post-partum blood total Ca, mM	2.21	2.20

Lopera et al., 2018

Health and Production Outcome-based Results

	<u>-66 DCAD</u>	<u>-176 DCAD</u>
Pre-partum feed intake, kg/d	10.7 ^a	10.2 ^b
Colostrum yield, kg	6.8 ^a	4.0 ^b

- **Level of acidification did not affect**
 - 42 day yield of milk, ECM, 3.5% FCM, fat% and yield, protein % and yield
 - incidence of retained placenta, metritis, puerperal metritis, mastitis, or displaced abomasum.
 - incidence of hypocalcemia post-partum, nor the risk of leaving the herd by 305 days of lactation.

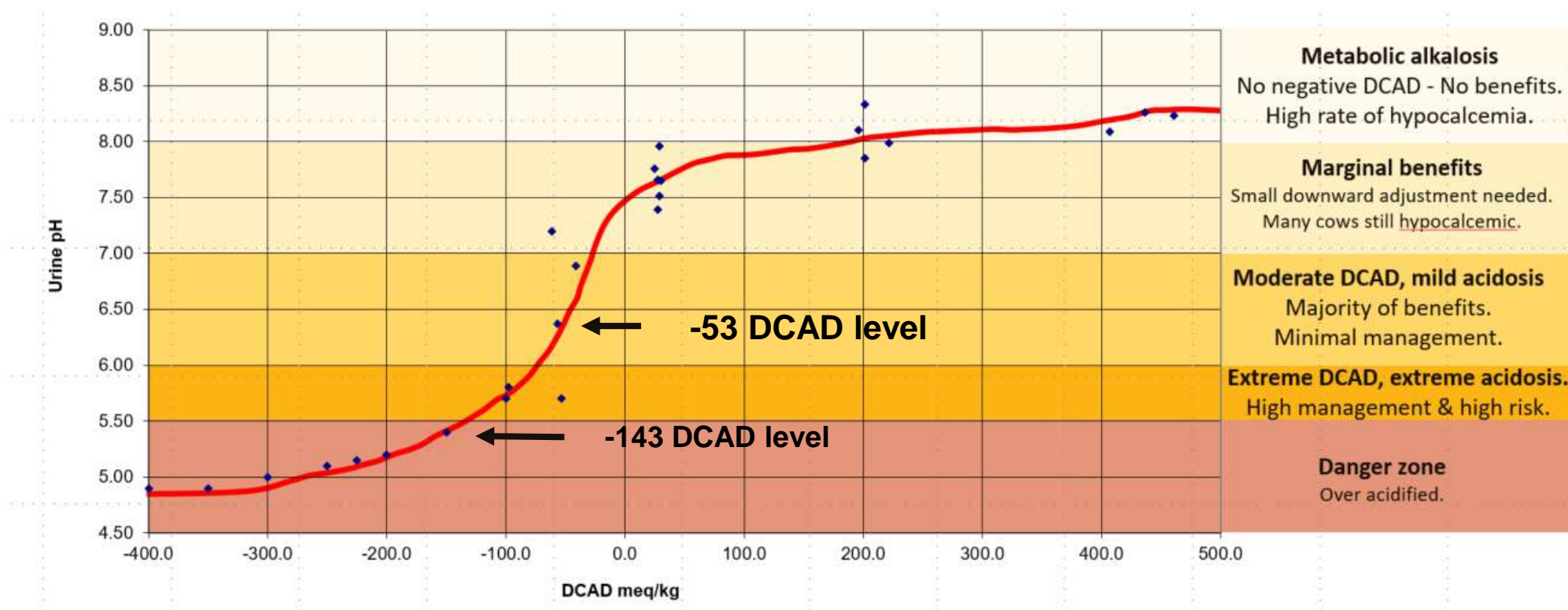
Lopera et al., 2018

University of Florida

- More extreme DCAD reduced pre-partum DMI and colostrum yield, without measurable benefits in health or production outcomes.
- There were **no health or production benefits derived from the more extremely negative DCAD diet.**

Melendez and Poock, 2017

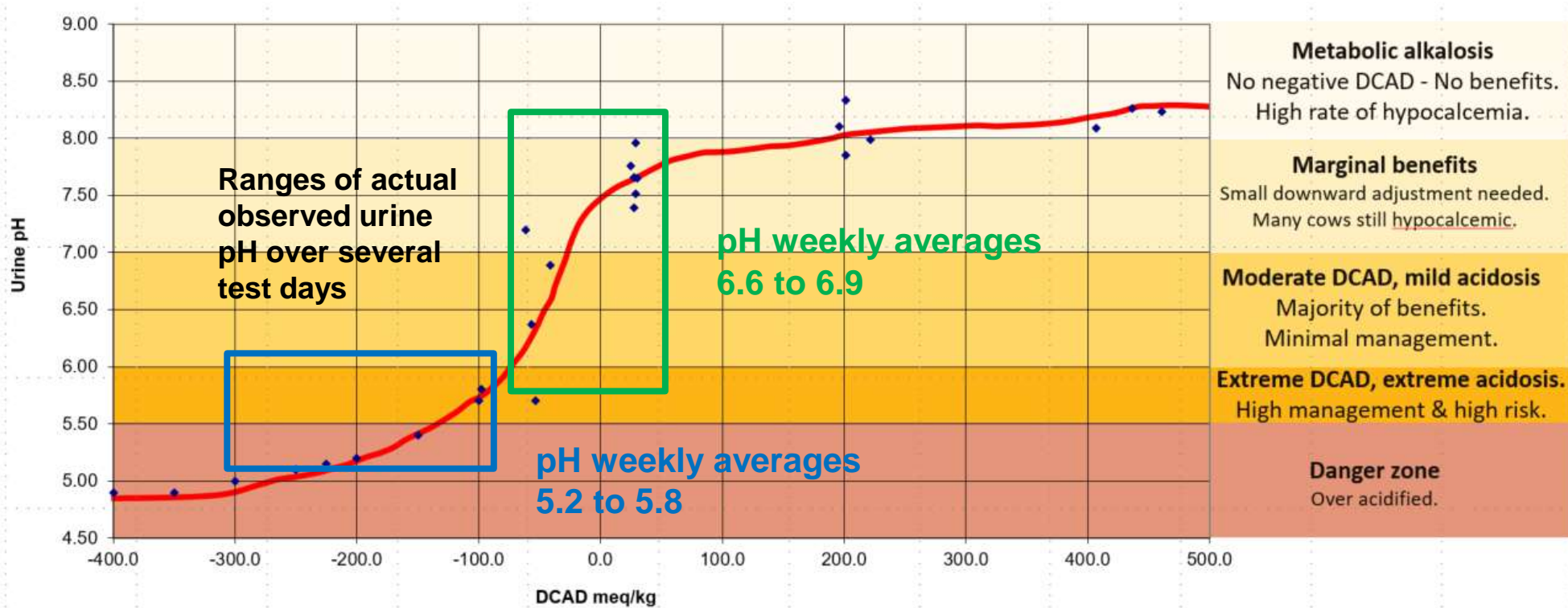
Frontiers in Nutrition, Vol. 4, article 26



Melendez and Poock

Frontiers in Nutrition, 2017

Cows in both groups had blood calcium concentrations of 2.11 mmoles/liter on day of calving



Melendez and Poock, 2017

Results:

	<u>-143 DCAD diet</u>	<u>-53 DCAD diet</u>
Average Urine pH	5.48 to 5.81	6.58 to 6.90
Actual Urine pH	5.22 to 6.20	5.70 to 8.23
Actual Urine pH range	1.09 pH units	2.53 pH units
Blood total Ca, mM	2.11	2.11

Blood calcium did not increase due to lower DCAD nor tighter urine pH range

Any benefits to extreme DCAD?

- Dr. José Santos, 2018 ADSA meetings said current data does NOT tell us the ideal negative DCAD that optimizes production and minimizes health problems in parous cows.
- In Lopera et al. (2018), extreme acidification showed no health or production benefits and only increased *ionized* blood Ca pre-partum.
- In case study by Melendez and Poock, blood total calcium concentration was not improved by extreme acidification.
- **Urine pH is more consistent when cows are extremely acidified. This has not been linked to any health or production benefits.**
- ***Consistent urine pH levels do NOT equal more consistent nor higher blood calcium levels***

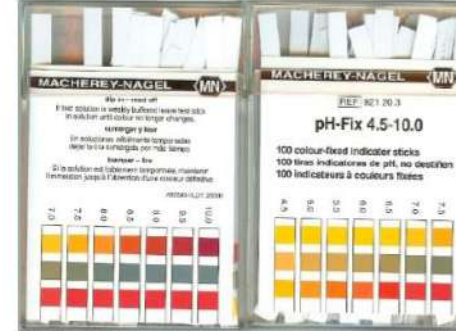
Cons to extreme DCAD?

- Feeding more anionic supplement = **more cost**.
- **More work** needed to monitor for signs of over-acidification.
 - Urine pH testing is common on-farm tool, but it's value is diminished with extreme acidification.
- Farm reports of “**unexplainable problems**” with extreme DCAD.
- Extremely acidified cows **consume less feed**.
- Research and dairy farms report **less colostrum yield from extremely acidified cows**.
- Emerging data suggests extreme pre-partum acidification **may create a glutamine deficit that lingers into lactation, decreasing milk protein**.

pH Test Strip Brand

Evaluation of pH test strips for accuracy in determining pH of cow urine

- Only 1 brand got it right the majority of the time.
- There are other accurate brands out there. Check against a meter or a brand of known accuracy to verify.
- Abstract #M3, ADSA Annual Meeting, 2015



Accuracy is important

- pH ion Balance brand was most accurate
- Visit www.DairyNutritionPlus.com and sign up to receive a free bottle of pH strips, along with pH testing quick guide.



Summary

- Remember *why* we use urine pH, and *what* it is a reflection of
- Variability in pH is not a bad thing
- When extremely acidified, pH no longer a good indicator of acid-base status
- Moderate DCAD works, and inconsistent pH does not mean it's failing
- Accuracy of pH measurement matters

Recommendations



Remember, DCAD is not one size fits all. SoyChlor can be fed in more moderate or more extreme approach.

With a moderate DCAD pre-partum program:

- Target group average urine pH between 6 and 7.
- Avoid management mistakes that affect intake
- Check pH at same time relative to delivering feed to the cows.
- Let cow health and appearance guide you
- Ok to have some individual readings outside target range
- Use reliable pH strips or a calibrated pH meter

Questions? We are happy to help.



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