HOARD'S DAIRYMAN

# Urine pH: Not too high, not too low

*by Pedro Melendez, D.V.M.*

HYPOCALCEMIA (low blood calcium) affects dairy cattle during the peripartum period. Even though milk fever (clinical hypocalcemia) is treatable, animals that suffer from hypocalcemia have a greater predisposition to develop more severe immunosuppression. It may also have other effects on organs with smooth musculature (including the uterus, teat sphincter, abomasum, and so forth).

Animals may be more likely to develop retained fetal membranes, metritis, mastitis, and displaced abomasum. These conditions indirectly lead to less milk production and reduced fertility. Therefore, prevention becomes essential in order to reduce the negative impact of this metabolic disease on the cow's productive performance.

Among the preventive strategies, the use of anionic diets has taken on a real significance in recent years, due to its positive impact and effectiveness in reducing milk fever, especially on multiparous cows. The rationale behind the anionic compounds is to induce a mild metabolic acidosis. This leads the parathyroid hormone (PTH) receptors to become more responsive to this blood calcium-regulating hormone.

The result is better bone calcium resorption and greater calcium absorption at the level of the digestive tract due to an enhanced activity of vitamin $D_3$. The end outcome is an elevated blood calcium concentration.

The desired degree of metabolic acidosis, which can be monitored through measurement of the urine pH, has been an extremely controversial topic among dairy cattle nutritionists. Scientific evidence shows that the ideal urine pH to prevent milk fever has not been well established.

Research has shown that diets with a dietary cation-anion difference (DCAD) of -25 to -100 mEq/kg dry matter, using any of the proposed equations, are sufficient to induce a mild metabolic acidosis that will improve the availability of calcium in the blood. This includes using the equation suggested by Iowa State University's Jesse Goff, which comprises the contribution of the rest of the minerals that have an effect on the acid-base balance of the organism [(K + Na + 0.15Ca + 0.15 Mg) - (Cl + 0.6S + 0.5P)].

It has become common for some dairy nutritionists to recommend urine pH levels of 5.8 or less, and they say this approach reduces hypocalcemia more efficiently. We must remember that the pH scale is logarithmic, and when the urine pH is reduced from 8.5 to 5.5, the excess of protons excreted by the cow's kidney is multipled by 1,000.

## Beware of high acidity

In my experience, and in that of several others, including Goff, one of the most prolific researchers in the area of hypocalcemia, the impact of reducing urine pH to less than 6 or 6.2 on the incidence of milk fever is worthless compared to the damage that can be caused to the animal as a result of this high acidity. Remember that the cow is pregnant, and we do not know what impact there may be on the fetus.

The cow is a ruminant, and naturally it is a species that consumes grasses rich in potassium (alkalogenic diets). They function with a body pH higher than the omnivores or carnivores.

Lowering the pH to less than 7 is already unnatural, and therefore, we must be very careful with the management of anionic diets so as not to induce an uncompensated metabolic acidosis. Many studies have shown that lowering urinary pH from 8.5 to 7 dramatically reduces the incidence of milk fever, from 5% to 2%. If urinary pH drops to 6, the incidence of milk fever is reduced to 1%. By lowering the urinary pH to 5.5, the decrease in milk fever can reach only 0.9%, which is an insignificant reduction of 0.1%.

To evaluate the potential negative impacts of reducing the urine pH to less than 6, we carried out two field studies, which were presented at the American Dairy Science Association (ADSA) annual meetings in 2019 and 2020. In the first study, we aimed to establish the association between urine pH and the incidence of postpartum disorders in prepartum cows fed anionic diets. The results of the study are summarized in Table 1.

Cows with a urine pH less than 6 were 2.39 times more likely to have a stillbirth than cows with a urine pH greater than or equal to 6. This finding makes a lot of sense, since a metabolic acidosis certainly can negatively impact the fetus. In diabetic women suffering ketoacidosis, the likelihood of fetal demise is raised several times compared to normal women at delivery.

## The effects on calcium

In the second study, we wanted to determine the association of prepartum urine pH with plasma total calcium, magnesium, phosphorus, and ketone bodies beta-hydroxybutyrate or B-hydroxybutyrate (BHB) concentrations at parturition on Holstein cows fed anionic diets. The results showed that there was a quadratic effect of urine pH on total calcium.

Blood total calcium was higher between urine pH 6 and 7.5 (2.24-2.3 mmol/L); it was lower under pH 6 and above pH 7.5 (less than 2.22 mmol/L). The mean concentration of BHB was 0.86 mmol/L.

Interestingly, there was a trend for a quadratic effect of urine pH on the concentration of plasma BHB (mmol/L) at parturition. BHB was higher when urine pH was below 6 and above 7.5. We concluded that cows with prepartum urine pH less than 6 and greater than 7.5 had a lower concentration of plasma total calcium and tended to have a higher concentration of BHB.

In light of these results, we strongly recommend that anionic compounds should be fed with caution, with a target urine pH between 6 and 7. The goal is to not unnecessarily over-acidify the prepartum dairy cow.

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**Table 1. Incidence of periparturient disorders and adjusted odd ratios (95% confidence intervals) for cows with low, intermediate, and high urine pH**

| Urine pH | Stillbirth | Milk fever | Dystocia | RFM | Metritis | Ketosis | LDA | Mastitis |
|---|---|---|---|---|---|---|---|---|
| <6.0 | 13.6[a] | 0 | 18.2 | 4.6 | 13.6 | 27.3 | 0 | 22.7 |
| (22) | (3) | (0) | (4) | (1) | (3) | (6) | (0) | (5) |
| 6.0 to 6.9 | 8.7[b] | 4.2 | 10.9 | 2.2 | 13.0 | 26.1 | 4.3 | 23.9 |
| (46) | (4) | (2) | (5) | (1) | (6) | (12) | (2) | (11) |
| >7.0 | 4.4[b] | 2.3 | 20.7 | 8.1 | 14.0 | 23.0 | 3.0 | 14.8 |
| (135) | (6) | (3) | (28) | (11) | (19) | (31) | (4) | (20) |
| **Comparison urine pH** | | | | | | | | |
| <6 vs. >6 | 2.39 | 0.68 | 0.89 | 0.65 | 1.05 | 1.16 | 1.55 | 1.09 |
| AOR | (1.06 to 5.40) | (0.15 to 3.17) | (0.49 to 1.63) | (0.34 to 1.27) | (0.58 to 1.92) | (0.71 to 1.89) | (0.68 to 3.52) | (0.67 to 1.74) |
| (95% CI) | P=0.035 | P=0.62 | P=0.72 | P=0.21 | P=0.86 | P=0.53 | P=0.29 | P=0.73 |

Source: Melendez et al., 2019; J. Dairy Sci. vol. 102, suppl. 1, abs:217, pp 157