

The What's, Why's, and How's of Ketosis

[including revisions in 2007]

R. Tom Bass, II, DVM, PhD, Renaissance Nutrition, Inc.

What is ketosis?

- Ketosis is a metabolic disorder that occurs in dairy cattle when energy demands (e.g. high milk production) exceed energy intake and result in a negative energy balance. This most commonly occurs in cows with poor appetites or fresh cows at a high level of production. Ketotic cows sometimes have low blood glucose (blood sugar) concentrations [but blood glucose concentrations often remain in the normal range].
- When large amounts of body fat are utilized as an energy source to support milk production, fat is sometimes mobilized faster by a cow than her liver can properly metabolize it. If this situation occurs, ketone production exceeds ketone utilization by the cow, and ketosis results.
- Dairy cattle normally produce ketones at low levels for use as energy substrates. It is only when ketone production exceeds demand that problems arise and ketosis occurs.

What are ketone bodies?

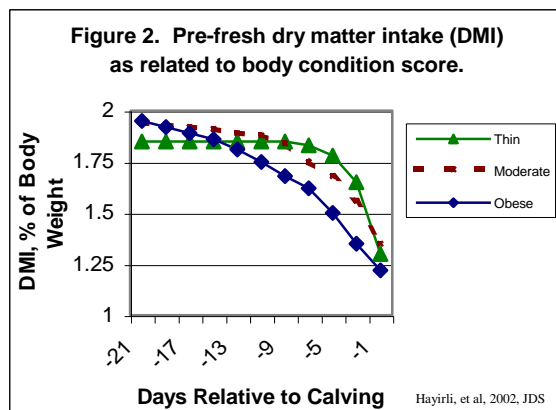
- Ketone bodies, or ketones, arise primarily from the incomplete utilization of fat as an energy source. Acetoacetic acid, acetone, and beta-hydroxybutyric acid are the ketone bodies produced in the cow during this process.
- Ketone precursors may also exist in high levels in legume and grass silages containing high levels of butyric acid [this occurs most commonly in wet silages—less than 32% dry matter]. They can increase the risk of ketosis by increasing the supply of ketone precursors to cattle. High levels of butyric acid and other nitrogen-containing compounds (polyamines such as cadaverine, putrescine, and tryptamine) present in some silages can also reduce silage palatability and feed intake, thereby decreasing energy balance and increasing the risk for ketosis.

Why is ketosis important?

- Ketosis is important because it decreases feed intake in affected cows and greatly increases the risk of other diseases (Figure 1). Ketosis results in almost a nine-fold increase in the risk of a cow getting a displaced abomasum (DA)!
- It is a cost to the dairy producer. Each “uncomplicated” case of ketosis has been estimated to cost \$159.

What are the risk factors?

- Anything that causes a cow to experience a significant negative energy balance can result in ketosis.
- Cows that freshen with poor appetites (for whatever reason, [including heat stress, overcrowding, lameness, excessive energy in the far off dry cow diet(?), etc.]).
- Fresh cow diseases (DAs, metritis, lameness, etc.) greatly increase the risk of ketosis. Ketosis can therefore be either the cause of other fresh cow problems or the result of them.



milk (3X higher ketone concentration in urine than in blood, on average). Therefore, a slight color change in **urine** (not milk) is acceptable in early lactation, high producing cows.

- **[Fresh]** Cows with low concentrations of ketones in their urine need to be monitored closely to ensure that the situation does not worsen.

How do you treat it?

- Dextrose given in the vein will increase a cow's blood glucose concentrations for 1-3 hours after treatment, making her feel better and hopefully encouraging her to eat more.
- **ONE** dose of dexamethasone **as long as** the cow is not pregnant and is not sick. Repeated doses of steroids can decrease a cow's immunity and increase her risk of becoming sick. Discuss the specifics of this treatment with your veterinarian before trying it.
- Feed or drench the cow with glucose precursors (discussed below).

How do you prevent it?

- **The most important consideration is eliminating any factors that are limiting dry matter intake in pre- and post-fresh cows!** These factors can be management- and/or nutrition-related, and are the first priority in addressing problems with ketosis.
- Now that it has been approved in the US for lactating dairy cattle, Rumensin[®] (monensin sodium) fed to cows during early lactation and/or during the pre-fresh period will reduce problems with ketosis and fatty liver. Its mechanism of action is to alter rumen microbe populations such that more propionate is produced. Increased supplies of this glucose precursor help decrease the incidence and/or severity of ketosis. The author's suggested Rumensin[®] "dose" (amount consumed in the daily ration) to reduce the risk of ketosis in Holsteins is 275-330 mg/head/day.
- If ketosis is a problem in a given herd, consider feeding **niacin** in the pre-fresh ration at the rate of 6-10 grams/head/day. This feeding strategy is also appropriate during early lactation (first 2-3 weeks). However, **niacin is unpalatable**, so be certain this practice does not affect (reduce) dry matter intake! Strategies to overcome the palatability problem include feeding rations as TMRs and feeding palatable ingredients (e.g. good quality corn silage, soybean meal, distiller's grains, bakery product). [\[Niacin has recently become available in a rumen-protected form that should eliminate the palatability concerns and improve the likelihood that the cows will respond positively to this strategy.\]](#)
- A second strategy for reducing the incidence and/or severity of ketosis is to feed **glucose precursors**. Glucose precursors should increase glucose production by the liver, thereby reducing the need to mobilize body fat to meet energy demands, and reducing the risk of ketosis.
- The two commonly available glucose precursors are **propionate**, in the form of Ca⁺ propionate (NutroCAL[™], Kemin Industries, Inc.), and **propylene glycol**. Ca⁺ propionate can be included in pre-fresh and/or fresh cow rations at the rate of ¼ pound/head/day. Propylene glycol is an unpalatable glucose precursor that is available in liquid form [\[a dry, "feedable" form has recently become available that has shown positive results in some trials, but not all\]](#). Cows should be drenched with 10-12 ounces of propylene glycol once a day to decrease problems with ketosis [\[as either a treatment or a preventative strategy\]](#). Alternatively, ¾ to 1 pound of calcium propionate can be dissolved in water and administered by a drench gun or oral pump system. Use only one of these treatments at a time, or reduce the propylene glycol dose to a maximum of 6-8 ounces when combining treatments. [\[Glycerol is a third glucose precursor that has recently become commercially available. To date, research evaluating glycerol as a ketosis treatment or preventative has yielded varied results.\]](#)
- Another potential strategy for preventing/reducing ketosis is to feed Reashure[™] (rumen-stable encapsulated **choline**) at the rate of 2 oz/head/day during the pre-fresh period +/- the first 30 days of lactation. In theory, choline provides additional substrates or precursors to the liver to increase the production of certain lipoproteins. These lipoproteins are needed to export fat from the liver (to the udder and other body tissues for use as an energy source) and can't be made fast enough when cows are in a significant negative energy balance. Choline helps speed up the removal of fat from the liver (or the buildup of fat in the first place), thereby decreasing the occurrence and/or severity of ketosis. Research to date has shown variable responses to the use of this product. [\[The body of research yielding positive results has increased over the past 5-6 years, as has the author's confidence that the product will yield beneficial results on-farm, particularly if the majority of the close-up dry cows are carrying excessive body condition.\]](#)