

Ketosis in Ruminants

A PowerPage Presented By



Knowledge of ketosis in ruminants is absolutely necessary for the large animal practitioner as it is a prevalent and important disease process. Because of its importance in large animal medicine, it is imperative that you have a basic knowledge of this disease process. This PowerPage will review the basic principles of ketosis in ruminants.

Key Points

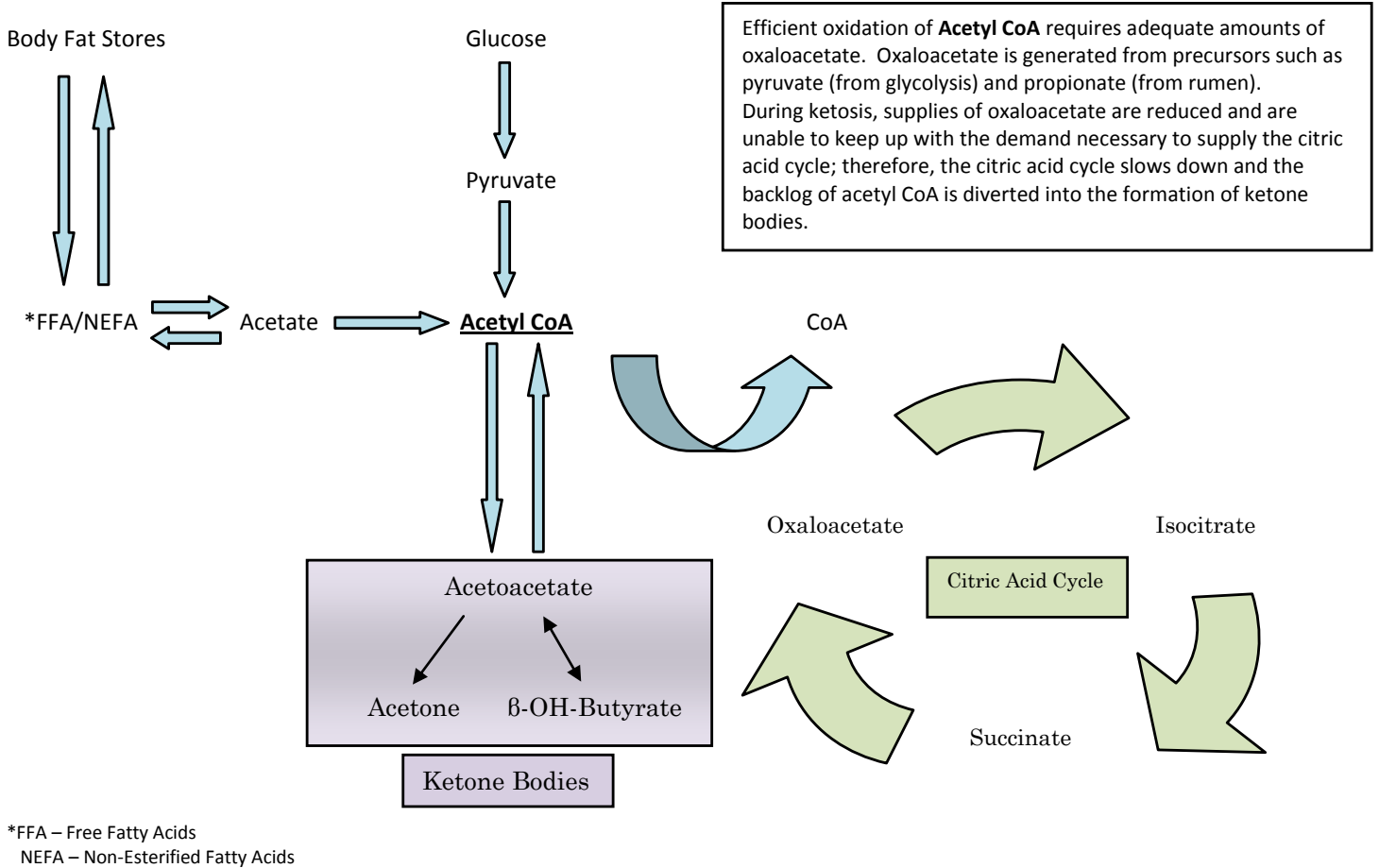
- The central process in ketosis revolves around **negative energy balance** and **inadequate feed intake**. Fats are consequently mobilized to support energy production but, in some instances, the body is unable to utilize all these fats (and/or their metabolites) thus resulting in excess production of ketone bodies.
- Clinical signs of ketosis can be non-specific and include depression, inappetance, weight loss and decreased milk production.
- The detection of ketones in the urine is a common and readily available diagnostic test to screen for ketosis in ruminants.
- Treatment aims to correct the negative energy balance by increasing the available energy to the animal via IV and oral glucose.

Pathogenesis

Pathogenesis:

- Ketosis occurs **most commonly in lactating cows** because the energy (glucose) necessary to support heavy milk production exceeds caloric and nutrient intake. The increased mammary uptake and utilization of glucose in high producing animals is not adequately offset by increased gluconeogenesis in the liver. The body attempts to increase energy production/precursors by mobilizing adipose stores in the form of free fatty acids (FFAs) to contribute to gluconeogenesis in the liver.
- Ketosis is also known as **pregnancy toxemia in ewes and does**; it occurs during the last 2-4 weeks of gestation when there is increased energy demands from rapidly growing fetuses (i.e. twins) combined with insufficient feed intake.
- When the liver is overwhelmed and unable to convert all the mobilized FFA glucose, excess amounts of ketone bodies remain in the blood. Ketosis is a disease that occurs when absorption and production of ketone bodies exceeds their use as energy resulting in elevated ketones in the blood, elevated fatty acids and decreased blood glucose.
- Other primary diseases that may result in secondary ketosis include displaced abomasum, metritis, peritonitis and mastitis, among others.
- Ketosis is characterized by elevated concentrations of the ketone bodies:
 - **Acetoacetic acid**
 - **Acetone**
 - **β -hydroxybutyric acid**

Simplified Major Pathways of Energy Metabolism & Ketone Body Formation



Clinical Signs

- Frequently non-specific
 - Depression
 - Decreased appetite
 - Weight loss
 - Refusal of grain
 - Decreased rumen motility
 - Decreased milk production
 - The **odor of ketones may also be detected on the breath** of affected animals
- Pregnancy toxemia is characterized by non-specific signs of anorexia, weakness and depression.

Diagnosis

- Based on history (recent parturition and heavy lactation)
- Elevated ketones in the blood, urine and/or milk
- Decreased blood glucose



- Liver enzymes may be elevated due to the central role that the liver plays in energy metabolism and gluconeogenesis

Treatment

- Correction of any primary disease that may be contributing to anorexia or inappetance should be initiated. Treatment directed specifically at ketosis includes a variety of proposed therapies. Some more commonly instituted therapies include:
 - IV glucose
 - Typically associated with marked improvement when administered
 - Oral propylene glycol
 - Glucose precursor will also support gluconeogenesis
 - Corticosteroids
 - i.e. Dexamethasone
 - Used to prolong hyperglycemia because of their gluconeogenic and appetite-stimulating effects
 - Insulin may be used as an adjunctive therapy to IV glucose
 - Force feeding (tube feeding)
- If treating pregnancy toxemia, induced parturition or cesarean section should be instituted along with IV and oral glucose supplementation
- Clinical signs may spontaneously resolve without treatment if an equilibrium between milk production and dietary intake can be reached

Prevention & Control

Prevention and control of ketosis includes feeding and husbandry strategies during late lactation and the dry period that aid in good body condition at calving. The interested reader is directed at reference 2 (Gerloff BJ) as a detailed review.

Hyperlipemia/Hyperlipidemia in Ponies and Miniature Horses

A somewhat similar condition to ketosis in ruminants occurs in ponies and miniature horses in which negative energy balance (typically caused by a primary disease resulting in anorexia) results in fat mobilization and potentially fat accumulation in the plasma and liver. In contrast to ruminants, fats accumulate in the body rather than ketones because equids do not form ketones to the degree that ruminants do. The condition is known as hyperlipemia or hyperlipidemia in horses (depending on the degree of elevation of triglycerides).

References

- Goff JP, Horst. Physiological changes at parturition and their relationship to metabolic disorders. J Dairy Sci 1997;80:1260-8.
- Gerloff BJ. Dry cow management for the prevention of ketosis and fatty liver in dairy cows. Vet Clin North Am Food Anim Pract 2000;16:283-92.

