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Using Hepatic Oxidation Theory to Optimize Transition

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Introduction

The transition period of the dairy cow can be associated with a high incidence of metabolic disorders and infectious diseases. The suppression of feed intake and altered metabolism increase the risk for ketosis, displaced abomasum, milk fever, metritis, and mastitis. Feeding strategies that can promote feed intake and limit fat mobilization will help optimize cow health, long-term milk yield, reproductive success, and farm profitability.

Hepatic Oxidation Theory

Hepatic oxidation theory is based on the concept that feed intake is controlled by the oxidation of fuels in the liver. The increased oxidation in the liver results in a satiety signal and decreases meal size. The laboratory of Dr. Mike Allen at Michigan State University has extensively studied hepatic oxidation control of feed intake in ruminants. In dairy cows, intake is limited not only by gut fill, but by hepatic oxidation. The primary fuels oxidized in the liver include *propionate* produced by ruminal fermentation and *fatty acids* from the diet or from body reserves. It is important to know that the pattern of oxidation of fuels (minute to minute) is what affects feeding behavior because the amount of oxidation over longer periods of time (hours or days) is relatively constant. Knowing the pattern of liver (hepatic) oxidation is not possible on a commercial dairy, so we need to identify indirect variables that can affect liver oxidation.

Diet Variables Affect Hepatic Oxidation

Cows vary in their response to diets through their lactation as their physiological state changes. By using the hepatic oxidation theory, we can feed cows more effectively based on their metabolism and physiological responses. According to the hepatic oxidation theory, feed intake during the transition period is controlled primarily by oxidation in the liver, whereas ruminal fill becomes a primary limitation to intake as milk yield increases. Given these differences, several considerations for diet formulation are mentioned below.

1. Limit body fat mobilization in transition cows. During the transition period, cows mobilize body fat, resulting in increased fatty acids and ketones in the blood. Although these fuels provide energy to support lactation, they can also be oxidized in the liver and generate satiety signals, leading to decreased feed intake. Therefore, it is important to limit mobilization of body fat by controlling body condition during lactation and controlling energy intake of dry cows. Cows should not lose more than 1 unit of body condition score in the first 30 days of lactation.

2. Maintain ruminal fill in transition cows. Formulating diets to maintain gut fill with ingredients that are retained in the rumen longer and with high ruminal digestibility will benefit transition cows. Ruminal fill will provide more energy over time when feed intake drops at calving. Maintaining good rumen fill during the transition period will help maintain blood glucose, limit body fat mobilization, and decrease the risk of acidosis and displaced abomasum. Cows should be provided with some long fibers such as grass hay and wheat straw during the dry period. After calving diets should provide enough forage to maintain a good rumen mat and maintain adequate buffering capacity in the rumen. The easiest way to determine if you have enough forage in the diet is to examine the manure of fresh cows. You do not want to see gray colored pasty manure or loose bubbly manure. You want to formulate a diet with a moderate rate of starch fermentation to supply adequate propionate without rapid production within a meal to trigger satiety. To promote feed intake and capture the benefits of feeding long-fiber ingredients, *transition cows can be supplemented with QLF molasses supplements to increase palatability, reduce sorting, and enhance fiber digestibility.*

3. Avoid feeding excessive amounts of highly fermentable starch sources to fresh cows. In addition to the above-

mentioned fact that increased blood fatty acids suppress intake in fresh cows, feeding excessive amounts of highly fermentable starch sources will further depress feed intake by decreasing meal size. Diets with high concentrations of grain and finely chopped forages should be avoided during this period. Starch sources with a moderate rate of ruminal fermentation and high digestibility in the small intestine, such as dry ground corn, will provide glucose precursors and less propionate to stimulate oxidation and suppress feed intake. To avoid the negative intake response caused by liver oxidation of propionate, fresh cows can be supplemented with QLF liquid supplements.

In addition to the benefits of increased palatability and reduced sorting from liquid feeds, *sugar fermentation in the rumen produces butyrate, which spares glucose oxidation by the ruminal epithelium, counteracting its negative effect. Butyrate also enhances gut tissue health and provides energy for milk and milk fat production*. Key components of QLF liquid supplements are sucrose and fructose. *Fructose can be converted to glucose more directly than propionate without stimulating liver oxidation activity.*

4. Feed intake is controlled more by gut fill as lactation proceeds. Feed intake is controlled more by effects of gut fill and less by oxidation of fuels in the liver as lactation proceeds toward its peak. These cows have high glucose requirements due to high milk output, and thus propionate is less likely to decrease intake because most of it goes to glucose rather than getting oxidized in the liver. The satiety signals are low in these cows and the goal of this stage of lactation is to provide less filling and more fermentable diets to maximize energy intake and microbial protein production while maintaining normal ruminal pH. To reduce ruminal fill and maintain a healthy rumen, cows should be fed with forages that have high NDF digestibility. *A recent meta-analysis found that when total dietary sugar is between 6.75 to 7.5% dry matter in the ration, cows had the best NDF digestibility and milk response*. Cows should supplemented between 1.5 and 2.25 lb. of added sugar to optimize NDF digestibility and feed intake, which would equate to 4 to 6 lb. of most QLF products.

Summary

Consideration of physiological and metabolic changes during the transition period are needed to optimize diets for transition cows. The hepatic oxidation theory provides a new perspective to help us better understand what controls feed intake and formulate diets more effectively. Feeding QLF molasses supplements to cows at various stages of lactation is consistent with the hepatic oxidation theory and can help limit satiety signals, optimize feed intake, increase fiber digestion, promote cow health, and enhance milk production.

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