

Field Responses to the Feeding of Rumensin®

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What is Rumensin and How Does it work?

Monensin is classified as an ionophore, which by definition is a compound that transports metal ions and protons (H^+) across cellular membranes. Monensin is the active compound in Rumensin.²

Monensin's mode of action begins with an initial attachment to the cell membrane of gram positive ruminal microorganisms. An immediate loss of cellular potassium and an influx of H^+ occurs (Russell, 1997). Monensin then catalyzes the influx of sodium and an efflux of protons. In spite of this action, protons generally accumulate inside the cell, resulting in decreased intracellular pH. An attempt by the cell is made to pump the excess protons out of the cell, resulting in depletion of the cellular adenosine triphosphate (ATP). Lack of ATP prevents the cells from growing and contributes to decreased numbers of gram positive bacteria. Due to the nature of their cell membranes, gram positive ruminal bacteria are more sensitive to monensin than are gram negative bacteria. The gram negative organisms are largely responsible for production of propionic acid in the rumen. Thus, the net effect of including Rumensin in the feed is that the concentration of propionate increases in contrast to acetate and butyrate that decrease. Propionate is either used directly as an energy source or may be used for gluconeogenesis by the animal.

What has Happened Since Rumensin was Approved for Dairy Cows?

Rumensin was approved by the Food and Drug Administration (FDA) on October 28, 2005 for feeding to dairy cows (both lactating and dry) fed total mixed rations. The indication was improvement of milk production efficiency³ with monensin levels ranging from 11 to 22 g/ton of total mixed ration dry matter. Since that time, many nutritionists have learned how to adjust diets to allow dairy farmers to successfully reap the benefits from Rumensin and increase profitability.

Label Changes Since the Initial Approval

Two changes have been made following the initial approval and include:

- Allow feeding Rumensin to component-fed herds (including top dress). This change in the Rumensin 80 label allows for feeding 185 to 660 mg/head/day to lactating dairy cows or 115 to 410 mg/head/day to dry cows in a component of the total diet or as a top-dress. This provides added flexibility to the feeding program by allowing the producer to start feeding 185 mg/head/day, then increase the amount in the diet to the 275 to 350 mg/head/day range or desired level. The component feed concentration of monensin must be within the 11 to 400 g/ton range and be fed in a minimum of one pound of feed per cow per day.

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²Rumensin® is a trademark for Elanco's brand of monensin sodium.

³Production of marketable solids-corrected milk per unit of feed intake.

- Type B Bluebird label was changed to allow monensin concentrations ranging from 23 to 80,000 g/ton in Type B feeds.

These rapid changes to the label speak highly for the willingness of the FDA to quickly evaluate the label and help make it more user-friendly for the dairy industry yet maintain the rigid requirements for feeding correct levels of monensin.

What Have we Seen Regarding Rumensin Response Versus Diet Composition?

During the past year, some dairy farmers have incorporated Rumensin into their feeding programs and experienced only minimal changes in milk component composition. Some dairy farmers, however, have seen a marked reduction in milk fat percentage. Also, some producers observed milk production to increase from 1 to 8 lb/cow/day after incorporating Rumensin into the diet, while other producers maintained current production. (Note: Rumensin is approved for increased milk production efficiency which is more salable solids corrected milk per unit of feed intake.)

Nutritionists have commented that Rumensin will help evaluate whether a diet fed is pushing the limit of too much starch and/or lack of effective fiber. Based on the data package submitted to the FDA for approval and field observations, the effect on milk components is a manageable effect when feeding Rumensin. When milk components are negatively impacted in the presence of Rumensin, the level of starch and unsaturated oils may need to be reduced while effective fiber is increased.

Diets Containing Finely Ground, High Moisture Corn

Diets fed to lactating cows from the upper midwest and eastern regions of the U.S. typically are based on high moisture corn (finely ground and sometimes containing 30% moisture or higher), corn

silage, and haylage. Evaluation of feeding programs in which milk components (fat and protein percentages) were minimally impacted and milk production either remained the same or increased showed that typical levels of NDF were 30 to 32% and starch was 21 to 23% with an absolute maximum of 25% (dry matter basis). Unsaturated oil sources, such as corn distillers, were sometimes included in these diets at rates of approximately 2 to 3 lb/cow/day of dry matter.

In contrast, feeding programs in which milk fat percentages were reduced markedly showed that NDF was lower (typically 27 to 29%) and contained much higher starch levels (26 to 32%). Those diets often contained high levels of unsaturated oil sources, such as corn distillers or soybeans, in addition to high levels of finely ground high moisture corn.

Two nutritionists reported that milk fat was depressed markedly when Rumensin was fed in conjunction with small grain silage, such as rye, or ryegrass. Those forages often contribute a sizable quantity of unsaturated oils, which in the presence of sufficient amounts of starch could theoretically have a negative impact on biohydrogenation in the rumen. Others nutritionists have reported no problems with milk fat depression when feeding small grain silages. In those cases, starch levels were maintained at a maximum of 23 to 25% of dry matter, which would theoretically have limited impact on the biohydrogenation process.

Diets Containing Dry Corn

Field observations in which Rumensin is included in lactating diets containing dry corn (in contrast to finely ground, high moisture corn) has shown that starch levels can be higher (compared to diets containing high moisture corn) with minimal impact on milk components. It has also been reported that more unsaturated oils may be contained in the diet without negatively impacting

milk fat levels compared to those diets containing finely ground high moisture corn.

Maintaining the Balance Between Starch, Fiber, and Unsaturated Oils in the Diet Appears to be Critical

Research has shown that biohydrogenation of unsaturated fatty acids is reduced significantly in the presence of high levels of starch. From field reports, higher levels of unsaturated fatty acids may be included in the diet without milk fat depression if starch levels are held around 21 to 23% of dry matter in diets that contain finely ground high moisture corn. These reports are supported by Griinari et al. (1998) in which addition of corn oil to a low fiber, high starch diet reduced milk fat ($P < 0.05$) but had no effect when added to a high fiber diet. Kalscheur et al. (1997) compared ruminal trans 18:1 production and duodenal flow in diets containing either high forage or high concentrate with or without dietary buffers. In the high concentrate diet, trans 18:1 production was reduced and milk fat increased with buffer addition (increased rumen pH). These papers illustrate that both low rumen pH and a source of unsaturated fatty acids are required for synthesis of fatty acid intermediates involved in milk fat depression.

What has been the Response from Including Unsaturated Fat Sources in the Diet?

Field reports from nutritionists suggest that milk components may be affected as a result of the interaction between the amount of unsaturated oils, the availability of the oil sources, and both the amount and source of starch contained in the diet. In a Rumensin-fed herd (11 g/ton of dry matter), cows were producing 85 lb/day of milk, and milk fat percentage was reduced from 3.55 to 3.2% in response to fine grinding of roasted soybeans. When the grind was changed back from finely ground to coarse rolled (breaking the beans into 5 to 8 pieces), milk fat returned to 3.5% within 5 days. The roasted

beans were fed at a rate of 6 to 8 lb/cow/day in a diet containing a low level of starch (22 to 23% of dry matter). This suggests that highly available sources of unsaturated fats (finely ground vs. coarse cracked) may impact milk fat percentage to a greater extent than less available sources in some situations.

Some nutritionists are using the guideline of including a maximum of 5% total unsaturated fat sources (dry matter basis) when high moisture corn is contained in the diet. A typical diet based on corn, corn silage, and haylage contains approximately 3% unsaturated fat, thereby allowing 2% additional unsaturated fat from sources such as oil seeds. If dry matter intake is assumed to be 50 lb/cow/day, this equates to adding 1.0 lb of unsaturated fat from either 5 lb of soybeans or whole cottonseed. Some are including 2 to 3.5 lb of dry matter from distillers grains in diets containing approximately 32% NDF without reducing milk fat percentage. The fat in distillers is readily available in contrast to that from whole cottonseed or coarsely cracked roasted soybeans. Surveys have shown that the amount of fat in distillers grains varies widely (ranges reported from 10 to 34% fat) and must be monitored closely.

In diets containing dry corn, some nutritionists are including up to 6% total unsaturated fat (dry matter basis) with little effect on milk components.

What Starch Levels are Working?

Reports from nutritionists show a wide range in starch content (21 to 30%) of diets fed to lactating dairy cows. Closer examination shows that higher starch contents ranging from 26 to 30% may be fed with Rumensin when dry corn is sourced in the diet along with good effective fiber. However, when finely ground high moisture corn is fed, starch levels need to be reduced to a maximum of 25%, with many nutritionists targeting starch at 21 to 23% and observing no reduction in milk fat percentage

while maintaining milk production. The difference in recommended starch levels surely stems from the fact that high moisture corn ferments more rapidly and to a greater extent than dry corn with a resultant lower rumen pH. The process of biohydrogenation of unsaturated fatty acids is reduced when rumen pH is low and contributes to lower milk fat production.

What About Feeding By-product Feedstuffs?

Substituting 3 to 4 lb of beet pulp or soybean hulls in place of high moisture corn has corrected some cases of milk fat depression. This correction is probably due to providing a more desirable level of starch in the rumen because of the composition difference between those by-products compared to the corn it replaced. These by-products contain low levels of starch (5% or less vs. 72% for corn) and unsaturated oils (2.4% or less vs. 4.3% for corn) yet are highly digestible energy sources (1.79 Mcal NE_L/lb vs. 1.84 Mcal NE_L/lb for corn). Including citrus pulp has also shown to be beneficial. Both beet pulp and citrus pulp contain sugars that may also contribute to improvement in milk components and yield.

What Levels of Monensin are Being Fed Today?

Many herds feeding a TMR are targeting 11 g/ton of dry matter. Assuming dry matter intake of 50 to 59 lb/day, monensin consumption will range from 275 to 325 mg/head/day. Some have gradually increased to 16 g/ton which would equate to an intake of around 400 mg/day of monensin with an intake of 50 lb of dry matter. Increasing from 11 g/ton has been done in a slow step-wise manner, while closely monitoring milk components.

During the dry period, many nutritionists are increasing Rumensin levels to provide approximately 275 to 325 mg/head/day of monensin during the close-up period. Their reasoning is to get the rumen

adjusted to a similar amount of Rumensin that will be consumed during early lactation.

During the far-off dry period, Rumensin is typically being fed to increase efficiency. During the Elanco Rumensin trials, dry cows fed 22 g/ton of Rumensin ate less feed yet maintained the same body weight and body condition. Thus, the efficiency of feed utilization was improved.

What is the Energy Equivalent from Feeding Rumensin?

Using data from the Rumensin clinical trials, the following formula was used to calculate the energy content of the control and Rumensin-containing rations:

$$\text{Energy density} = \frac{\text{SCM energy} + \text{NEm} \pm \text{energy for BW change}}{\text{DMI}}$$

where SCM is solids corrected milk, NEm is the net energy for maintenance requirement of cows, BW is body weight change, and DMI is dry matter intake (kg/head/day).

Based on this formula, the energy content of the diets increased with increasing levels of Rumensin in the diet. From that, it was calculated that the increased energy content of the diets was equivalent to what would have been achieved by feeding 1 to 2 lb of corn grain. Some nutritionists are attributing an energy value to Rumensin in their ration balancing program and finding that Rumensin is usually brought into rations for lactating and dry cows due to its relatively low cost.

What's Working for Getting Rumensin Introduced into the Herd for the First Time?

Some nutritionists are establishing the NDF level at 34% and the starch level at a maximum of 25% (when high moisture corn is fed) before

introducing Rumensin. The fiber may then be gradually reduced with 3 weeks between changes while monitoring milk component composition. This adjustment of the diet before inclusion of Rumensin is highly recommended.

Some nutritionists are using a step-up program in which Rumensin is introduced into the diet at the lowest cleared level (185 mg/head/day for component-fed herds or 11 g/ton dry matter basis for TMR herds) then stepped up in 3 stages, each lasting 5 to 10 days until the desired level is reached. This allows slow adjustment of the ruminal microbial population to Rumensin and is recommended.

How Do I Measure the Response from Rumensin?

The indication for Rumensin in dairy cows is for “improvement of milk production efficiency”. To calculate milk production efficiency in the clinical trials, the following formula was employed:

$$\text{Milk Production Efficiency} = \frac{\text{Marketable solids-corrected milk}}{\text{Total NE}_L \text{ intake (adjusted for body-weight change)}}$$

In the 9 clinical trials, milk production efficiency was improved approximately 2 to 4% compared to controls by including Rumensin at 11 to 22 g/ton of dry matter. As indicated in the formula, cow weight changes were considered in the energetics of production and required that the cows be weighed monthly throughout the trial. Feed offered and refused daily was also measured to allow calculation of dry matter and NE_L intakes.

The method employed in the 9 clinical trials employed very precise procedures of measuring feed offered, feed refusal, and cow body weight changes that may be beyond the scope of some dairy producers. In an effort to evaluate the effect of Rumensin on efficiency, some dairy farmers are

measuring the amount of feed offered and assuming a constant refusal rate (not weighing refused feed). In addition, they calculate production of energy corrected milk to allow for variation in milk composition that may occur.

This procedure is being used to measure the effect of Rumensin on milk production efficiency on a large (4000 cows) dairy farm in Idaho. Dry matter offered was recorded daily with a constant amount of feed refusal assumed. Milk yield was adjusted to 3.5% fat and 3.2% protein using the following equation (Bernard, 1997):

$$\text{ECM} = (0.3246 * \text{lb milk}) + (12.86 * \text{lb milk fat}) + (7.04 * \text{lb milk protein})$$

The goal for that dairy farm is to produce energy corrected milk (**ECM**) per pound of dry matter consumed with an efficiency of 1.60. Efficiency was improved from 1.52 to 1.64 after inclusion of Rumensin into the lactating cow feeding program.

Guidelines for Feeding Rumensin Based on Field Reports and Observations

The following guidelines have been reported by nutritionists successfully using Rumensin in dairy cow diets (dry period and lactation).

- NDF inclusion levels of 35% in close up cows and greater than 28% (typically 29 to 32%) during lactation. Some nutritionists balance the diet using NDF as the primary parameter.
- Starch inclusion levels of a maximum of 25% (typically 21 to 23%) with high moisture corn and 26 to 28% (range of 26 to 30%) with dry corn. Some nutritionists balance the diet using starch content as the primary parameter.
- Reduce the amount of high moisture corn or replace 3 to 4 lb of it with soy hulls or beet pulp if milk fat is markedly reduced.

- Starch is often reduced by increasing the proportion of corn silage and reducing high moisture corn while being sure there is adequate effective fiber.
- Limit total fats to 6% (typical range of 5 to 6%) of dietary dry matter. Limit addition of unsaturated oils to a maximum of 2 to 3% of dietary dry matter.
- When introducing Rumensin into a feeding program, start with NDF at 33 or 34% and gradually decrease it while monitoring milk components. Wait 3 weeks between changes in fiber content.
- Use a step-up program for introduction of Rumensin into component-fed herds. Start with 185 mg/head/day, then increase in three stages to the final desired level, each stage lasting 5 to 10 days.

The Future: What is Needed for Diet Formulation?

With our knowledge of the importance of achieving a balance of dietary ingredients to optimize milk production and composition, it is apparent that the amount, particle size, and the extent of gelatinization and fermentability of starch sources must be considered. Rapid, reliable, and repeatable techniques for measuring rumen fermentable and total starch are also needed. With increasing use of technology to enhance ruminal digestibility of corn, there is a greater need for information to evaluate the extent of expected increase of starch digestibility to help determine the proper amounts of starch and fiber in dairy rations (Firkins, 1997). It is also apparent that a good practical way of evaluating the amount of effective fiber in a ration is needed. The amount of unsaturated fat must also be known so that a measure, such as the iodine value, may be employed during ration balancing. The industry is quickly moving to the point of formulating diets

based on the balance of fermentable starch, effective fiber, and unsaturated oils to support milk production and optimization of milk components. Knowledge of the requirements for and the ability to accurately balance these ration parameters will reduce the negative associative effects on fermentation in the rumen and result in greater milk production efficiency.

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