**NOTE – As of publication of this article, ionophores have not been approved for use in diets for dairy cattle in the U.S.

**Introduction**

Dairy cattle typically experience large deficits in predicted whole-body supply of glucose from dietary precursors relative to demand during early lactation (Figure 1); therefore, attention has focused recently on methods to increase glucose supply to transition dairy cows. Transition cows are almost entirely dependent upon gluconeogenesis in the liver to supply their glucose needs. The primary substrates that the liver utilizes to synthesize glucose are propionate, amino acids, lactate, and glycerol. Given that hepatic capacity to convert propionate to glucose appears to be supply-related (Overton, 1998), it would make sense to try to increase propionate supply to the cow without going “over the edge” into subacute ruminal acidosis. Ionophores such as monensin and lasalocid have been fed to growing cattle for years, typically with a result of increased feed efficiency. Although the exact mechanisms underpinning the actions of ionophores are not completely understood, the net result of feeding ionophores to ruminants is a shift in ruminal fermentation to favor production of propionate (Russell, 1997). Thus, the attractiveness of including ionophores in diets fed to transition cows is obvious in terms of increasing glucose supply and potentially increasing milk yield and decreasing ketosis occurrence during early lactation. The purpose of this paper is to review briefly some recent literature relating to supplementation of ionophores to transition dairy cows and to provide some practical recommendations after they are approved to use in diets for dairy cattle. Most of the research has been conducted using monensin; therefore, we will focus on this research.

![Figure 1. Estimated whole-body glucose demand and supply during the transition period.](image-url)
Workers from the University of Guelph recently conducted a series of experiments to determine whether monensin supplementation would decrease incidence of ketosis and enhance milk yield during early lactation. The commercial experiment involved a total of 1010 Holstein cows and heifers from 25 cooperating farms in Ontario. Animals were administered an intraruminal controlled release capsule containing either a placebo or monensin designed to release approximately 335 mg per day for approximately 95 days. Concentrations of $\beta$-hydroxybutyrate in serum were significantly reduced during weeks 1, 2, and 3 postpartum, and serum glucose concentrations were significantly increased during weeks 1 and 2 postpartum (Duffield et al., 1998a). These workers also reported that cows administered monensin lost less body condition during early lactation, although these differences averaged less than .05 of a condition score. Reanalysis of the same dataset using a threshold for subclinical ketosis of 1200 µmol/liter of $\beta$-hydroxybutyrate in serum indicated that subclinical ketosis was reduced from approximately 30% of cows to 15% of cows at two weeks postcalving (Figure 2; Duffield et al., 1998b). Results of serum ketones and milk ketones corresponded well with one another, but (not surprisingly) the milk ketone tests were not as sensitive as the serum analyses.

![Figure 2. Incidence of subclinical ketosis in control and monensin-supplemented cows (Duffield et al., 1998b).]

The data for milk yield during the first three test days of the cows in this experiment were presented in a third paper (Duffield et al., 1999a) and are shown below:

<table>
<thead>
<tr>
<th>Milk (lb/d)</th>
<th>Body condition score at three weeks prepertum</th>
<th>Test 1 (~ 30 DIM)</th>
<th>Test 2 (~ 60 DIM)</th>
<th>Test 3 (~ 90 DIM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin (&lt;3.25)</td>
<td>Fat (&gt;3.75)</td>
<td>Thin (&lt;3.25)</td>
<td>Fat (&gt;3.75)</td>
<td>Thin (&lt;3.25)</td>
</tr>
<tr>
<td>Monensin</td>
<td>Placebo</td>
<td>Monensin</td>
<td>Placebo</td>
<td>Monensin</td>
</tr>
<tr>
<td>72.5$^a$</td>
<td>76.0$^a$</td>
<td>75.8$^a$</td>
<td>75.0$^a$</td>
<td>81.1$^a$</td>
</tr>
</tbody>
</table>

Means in columns with different superscripts differ, P < .05.
These data make sense biologically. First, thin cows that are less susceptible to metabolic problems after calving did not respond to monensin in terms of milk yield. Cows in moderate condition responded only at the second test day, and this effect did not carry over to the third test day. Fat cows that are more susceptible to postpartum metabolic problems responded well at all three test days. Although the authors did not discuss the body condition score effects independently, it appears from the table above that cows that were categorized as thin (76.0 lb/day) and fair (75.6 lb/day) averaged more milk during the first three test days than those that were fat (74.1 lb/day) at three weeks prepartum. These data support our current recommendation to dry cows off at a body condition score of 3.25 to 3.50 and neither gain nor lose body condition during the dry period.

The researchers did not make the following measurements, but we would think that the thinner and moderately conditioned cows ate more postcalving, mobilized less body condition, and thus had decreased concentrations of nonesterified fatty acids (NEFA) in blood. Because the liver would have taken up fewer NEFA, the processes of oxidation and lipoprotein export would not have been overloaded and fewer triglycerides would have accumulated in liver. Because dry matter intake (and glucogenic precursor supply) would have been greater, fewer ketone bodies would have been produced because NEFA would have been more completely oxidized.

Recently, the health data from this experiment have been reported (Duffield et al., 1999b). Cows receiving monensin had significantly decreased incidence of displaced abomasum and multiple illnesses. Monensin tended to decrease the incidence of clinical ketosis; as would be expected, this effect was stronger in cows of greater body condition score. Despite these effects on health, there were no effects of treatment on reproductive parameters, including days to first insemination, conception rate, and days open.

In a subsequent experiment conducted at the University of Guelph, Green et al. (1999) administered the same intraruminal controlled release capsule containing either a placebo or monensin at three weeks prepartum to 11 heifers and 41 cows. Body condition scores averaged 3.65 and 3.60 for heifers and cows, respectively, during the last two weeks prepartum. Diets were fed for ad libitum intake during the last two weeks prepartum and the first two weeks postpartum, then restricted to 90% of ad libitum intake from weeks 3 through 5 postpartum before returning to ad libitum intake during week 6 postpartum. Dry matter intake and blood parameters during the two weeks prepartum were minimally affected by monensin. Dry matter intake during the 6-week postpartum period was not affected by monensin treatment, but monensin decreased concentrations of β-hydroxybutyrate in serum and increased concentrations of glucose in serum during the 6-week postpartum period. Heifers and cows responded similarly to monensin treatment during the 6-week postpartum period.

The lack of a response to monensin during the two weeks precalving makes sense. The cows and heifers were consuming approximately 17 and 25 lb per day of dry matter during the last two weeks prepartum. Given that the demands for glucose and reliance on body fat stores for energy are much less before calving than after calving, one would not expect to see a response to monensin before calving unless there were major problems with intake or energy imbalances in the closeup ration. The only rationale for including monensin in rations for closeup cows is to allow time (~ 3 weeks) for the rumen to adapt to monensin.
This experiment has some design considerations that must be kept in mind when evaluating these data. First, dry matter intake was restricted during a large portion of the postpartum period and averaged 24.5 lb per day for heifers and 32 lb per day for cows. Cows in well-managed herds will average 45 lb or more of DMI per day and heifers will average 35 lb or more of DMI per day during the first 6 weeks after calving. These researchers demonstrated that supplementation with monensin improves metabolic health when dry matter intake is restricted to levels substantially below that of well-managed commercial herds. The true question is whether monensin improves metabolic health when fed to well-managed cows, and treatments to determine the answer to this question were not included in this experiment.

Conclusions

Beneficial responses to ionophores will occur when targeted for use in herds with overconditioned dry cows or other factors that predispose cows to metabolic disorders after calving, but responses in well-managed herds in which body condition is moderate and cows are not at great risk for metabolic disorders probably will be minimal.

References


