# Application of Ionophores in Cattle Diets

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## Introduction

Ionophores are feed additives that are used in the diets of cattle to increase feed efficiency and body weight gain. Ionophores are compounds that alter rumen fermentation patterns. Ionophores can be fed to any class of cattle and can be used in any segment of the beef cattle industry. Similar to many other feed additives, ionophores are fed in very small amounts and supplied via another feedstuff as carrier for intake. Ionophores decrease the incidences of coccidiosis, bloat, and acidosis in cattle.

## Mode of Action

Commercially available ionophores include monensin (Rumensin®), lasalocid (Bovatec®), and laidlomycin propionate (Cattlyst®). Ionophores are classified as carboxylic polyether antibiotics and they disrupt the ion concentration gradient ($Ca^{2+}$, $K^{+}$, $H^{+}$, $Na^{+}$) across microorganisms membranes causing them to enter a futile ion cycle. The distruption of the ion concentration prevents the microorganism from maintaining normal metabolism and causes the microorganism to expend extra energy. Ionophores function by selecting against or negatively affecting the metabolism of gram-positive bacteria and protozoa in the rumen. The affected bacteria are those that decrease efficient rumen digestive physiology and the energy supplied from the ruminal digestion of feedstuffs. By controlling certain protozoa and bacteria in the rumen, less waste products (methane) are generated (Guan et al. 2006) and ruminal protein breakdown is decreased which results in a decreased ammonia production. The shift in ruminal bacteria population and metabolism allows beneficial bacteria to be more efficient through an increase in the amount of propionic acid and decrease acetic acid and lactic acid produced. Therefore, cattle experience an increase in the overall energy status and utilize feed resources more efficiently.

Even though ionophores are classified as an antibiotic they are not therapeutic antibiotics. Anitbiotic resistance is an increasing concern within the public discourse. However, the increase in antibiotic resistant bacteria as a result of ionophore use is not well supported for a number of reasons: 1) ionophores have never been (nor are likely to be) used as antimicrobials for humans, 2) ionophores have a very different mode of action from therapeutic antibiotics, 3) ionophore resistance in bacteria seems to be an adaptation rather than a mutation or acquisition of foreign genes (Russell and Houlihan, 2003), 4) ionophores can translocate across cell membranes of animals which limits their use as therapeutic antibiotics, 5) the complexity and high degree of specificity of ionophore resistance in targeted bacteria (Callaway et al., 2003).

## Applications

Ionophores have feeding applications in a number of different manners. Most frequently, ionphores are included in either dry or liquid manufactured supplements. Inclusion of ionophores in manufactured supplements allows for specific formulations of ionophore concentrations and the option for controlled intake of the supplement. Ionophores can also be included in loose mineral mixtures. Inclusion of ionophores in mineral mixtures can be used to limit intake of the mineral, particularly when monensin is utilized because of palatability characteristics associated with monensin in loose form. Ionophores are included in small amounts when mixed in formulated supplements. Additionally, ionophores are a

medicated ingredient and as such, the government regulates the manufacture of ionophore containing feeds. Thus, ranch mixing is not allowed for feed or mineral supplements. Ionophores have no withdrawal time relative to sale or slaughter of cattle. This means that cattle can consume ionophore-containing feedstuffs up to the day of sale or slaughter.

Ionophores are used in a variety of cattle production scenarios. Growing cattle consume the majority of ionophores; however mature cows can benefit from the consumption of ionophores. Table 1 demonstrates the variety of feeding scenarios in which ionophores have been offered in forage-based nutrition for cattle. Application of ionophores is appropriate in nearly every forage type and quality encountered by cattle. The carrier or supplement that contains the ionophore should complement the forage base and cattle requirements. However, cattle that consume ionophores may not be eligible to enter natural and are not eligible for organic market production chains.

**Table 1.** Effect of the concentration of ionophores during supplementation on growing calf gain offered different diets.

| Diet | Ionophore | Concentration, mg/day | Calf body weight, lb | Control suppl. gain, lb/day | Ionophore suppl. gain, lb/day | Ionophore gain differential, lb/day |
|---|---|---|---|---|---|---|
| Bermudagrass | Monensin | 200 | 550 | 0.93 | 1.04 | +0.11 |
| | | 200 | 573 | 1.15 | 1.50 | +0.35 |
| Bermudagrass | Monensin | 25 | 343 to 518 | 1.24 | 1.55 | +0.31 |
| | | 50 | | | 1.61 | +0.37 |
| | | 100 | | | 1.72 | +0.48 |
| | | 200 | | | 1.56 | +0.32 |
| Bermuda-Bahiagrass | Monensin | 180 | 457 | 0.76 | 0.52 | -0.24 |
| Bahiagrass | Lasalocid | 50 | 480 | 0.76 | 0.66 | -0.10 |
| | | 100 | | | 1.02 | +0.26 |
| | | 200 | | | 0.71 | -0.05 |
| | | 300 | | | 0.82 | +0.06 |
| | Monensin | 200 | 480 | 0.76 | 0.91 | +0.15 |
| Stargrass | Lasalocid | 50 | 480 | 1.25 | 1.34 | +0.09 |
| | | 100 | | | 1.35 | +0.10 |
| | | 200 | | | 1.27 | +0.02 |
| | | 300 | | | 1.33 | +0.08 |
| | Monensin | 200 | 480 | 1.25 | 1.50 | +0.25 |
| Wheat pasture | Monensin | 180 | 542 | 2.31 | 2.87 | +0.56 |
| Prairie hay | Monensin | 200 | 460 | 0.55 | 0.55 | 0.0 |
| Dormant range | Monensin | 150 | 474 | 0.64 | 0.92 | +0.28 |
| Feedlot receiving | Monensin | 48 | 268 | 2.08 | 2.02 | -0.06 |
| | | 96 | | | 2.21 | +0.13 |
| | | 143 | | | 2.17 | +0.09 |

Equines should not consume ionophores or feeds containing ionophores. Equine are incapable of metabolizing ionophores in the concentrations that are formulated for cattle diets. In cattle, sheep,

chickens, dogs, and other animals the ionophores can be absorbed across the small intestine, transported to the liver, metabolized, and excreted in bile with the ultimate elimination through feces.

**Animal Response**

Reviews of numerous grazing trials using steers and heifers indicate that supplementation with 155 mg/day of monensin results in an improvement in average daily gain of 0.18 lb/day or 13.5% increase compared to non-supplemented control cattle (Kunkle et al., 2000). When the amount of monensin increased to 200 mg/day, cattle gained an additional 0.20 lb/day or 16% improvement compared to cattle not offered an ionophore. Offering supplements containing monensin at 200 or 400 mg/day on alternate days can increase growing calf gain by 0.17 and 0.18 lb/day, respectively (Muller et al., 1986). The preceding responses were collected over a variety of pasture forage qualities. Cattle grazing bermudagrass and supplemented 200 mg/d of monensin in the summer have been reported to increase daily gain by 0.22 to 0.46 lb/d, a 24 to 44% increase over cattle consuming supplement without monensin (Rouquette et al., 1980; Oliver, 1975). Table 1 provides a summary of growing cattle performance when offered an ionophore.

Ionophores have been utilized to positively affect reproductive processes in the beef cow herd. The post-partum interval can be decreased in cows that are gaining body weight and body condition score as a result of improved nutritional status associated with ionophore supplementation. However, cow body weight and condition score change during the supplementation period strongly influenced overall post-partum interval response (Sprott et al., 1988). Onset of puberty in growing heifers can be hastened by supplementation with ionophores. Research has demonstrated that in growing heifers gaining at acceptable growth rates (0.75 to 1.32 lb/day) age at puberty can be decreased and the percentage of heifers pubertal at target breeding body weight is increased.

**Economics of Performance Response**

In the stocker cattle segment and replacement heifers, the use of ionophores increases average daily gain by 5 to 15% and improves feed efficiency by 8 to 12% (Lawrence and Ibaruru 2008; Elam and Preston 2004). The economic effect on stocker cattle contributes an impact of 1.46% on the breakeven price, and $11.51 effect on the cost of production (Table 2). In the feedlot, ionophores improve average daily gain by 1 to 6% and improve feed efficiency by 3.5 to 8% (Lawrence and Ibaruru, 2008; Elam and Preston, 2004). Similar to the stocker sector, ionophores in the feedlot contribute a smaller but significant effect on breakeven price and production cost per head differential (1.18% and $12.43, respectively) compared to not using ionophore technology. Production practices that combine the use of ionophores and implants likely result in a synergetic effect (Elam and Preston 2004) on growth performance of cattle. Ionophores increase the amount of energy available from the diet and the application of implants stimulate lean tissue growth which utilizes the increased available energy.

**Table 2.** Effect of ionophore technology on average daily gain (ADG) and estimated cost of production in the stocker and feedlot segment compared to no use.[1]

| Industry section | ADG, % | Breakeven price, % | Cost per head, $ |
|---|---|---|---|
| Stocker | 7.74 | 1.46 | 11.51 |
| Feedlot | 2.90 | 1.18 | 12.43 |

[1] Adapted from Lawrence and Ibarburu (2008).

**Conclusions**

Incorporation of ionophores into supplements and the diets of beef cattle elicit a positive increase in growing cattle performance. Ionphores should be considered for use by beef cattle producers to increase calf gain and gain efficiency in a cost effective manner. The response to ionophores is related to forage availability, forage quality, and concentration of ionophore used.

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