**Introduction**

Maxiban® is an anticoccidial premix containing 36 grams of narasin and 36 grams of nicarbazin per pound. This approved product is an ionophore and chemical combination. This combination maximizes the benefits of each component and may minimize their potential negative interactions. This synergistic relationship between the product’s two active ingredients classifies Maxiban as a potentiated chemical.

**Mode of action on a molecular basis**

The ionophore (narasin) and chemical (nicarbazin) that make up Maxiban each impact the coccidial cell’s energy through different routes. Ultimately, this is the disruption of the cell’s energy supply that leads to the control and death of the parasite. At a cellular level, coccidia primarily rely on two energy cycles known as glycolysis and the electron transport system. Glycolysis dominates the intracellular stages of the coccidial life cycle while in the bird’s intestinal lumen. The electron transport system (ETS) dominates the parasites’ stages after invading the cells of the intestinal wall. Glycolysis, acting in the absence of oxygen, generates two energy units per glucose molecule that are used for growth and reproduction, but operates only when molecular oxygen is present. As the coccidiosis progresses through the bird’s digestive tract, narasin acts on the coccidial cell membranes,4 only when molecular oxygen is present. This electron transport system (ETS) dominates the parasite’s stages after invading the cells of the intestinal wall. Glycolysis, acting in the absence of oxygen, generates two energy units per glucose molecule that are used for growth and reproduction, but operates only when molecular oxygen is present. As the coccidiosis progresses through the bird’s digestive tract, narasin acts on the coccidial cell membranes,4 only when molecular oxygen is present.

**Key points**

- Maxiban is a potentiated chemical—a combination of narasin and nicarbazin.
- Maxiban kills coccidia by depleting the parasite’s energy through two different paths.
- The synergistic effect increases coccidial control while reducing potential resistance.
- The synergistic effects of these dual modes of action allow for less drug exposure.

**Response in broilers**

The objective for controlling coccidiosis in broilers is to walk the fine line between too much and too little control. Coccidia can exist at less than optimum levels, and a negative impact on broiler performance may be evident. However, commercial broiler breeders are infected with ubiquitous coccidial populations, so the alternative practice of not using anticoccidials is not only detrimental to the bird’s well-being but also results in poor performance and economic returns.2,3 Maxiban’s formula delivers a synergistic approach to coccidia control. Using the combination, allowing for optimal disease control, reduces the bird’s level of drug exposure to both the ionophore and the chemical. This prudent use of anticoccidial remains dose-dependent negative interactions.

**Summary**

Maxiban is a combination of narasin and nicarbazin. Each molecule affects a different energy pathway and is active during different stages of the parasite’s life cycle. This combination presents substantial obstacles to resistance development and optimizes the effect of each molecule, allowing for reduced levels.
**Resistance**

The American Veterinary Medical Association says resistance occurs when a micro-organism develops the ability to survive and reproduce in the presence of an antimicrobial that used to prevent these actions. True resistance rarely occurs with ionophores. The term resistance is often inappropriately applied to organisms demonstrating reduced sensitivity to a particular anticoccidial. This creates confusion when discussing program effectiveness and should be discouraged.

The rigidity of the cell wall is the most probable mechanism whereby the parasite develops reduced sensitivity to ionophores. Physiological changes to the highly complex cell membrane require multiple genetic mutations. Therefore, mutations are less likely to occur in the correct combinations. As the cell wall becomes more rigid, it requires a greater concentration of the ionophore to facilitate the movement of sodium into the cell. More rigid membranes, however, present the dilemma that the parasite does not replicate as efficiently as those with more normal (less rigid) membranes. This is a disadvantage to the resistant parasite and these organisms do not compete well with the sensitive population.

Nicarbazin’s activity is most prominent during the intracellular stages of the coccidial life cycle. This is coincidental with the activation of the bird’s immune system caused by the parasite entering the host cell. As with the ionophore, the bird’s immune response can assist in controlling the disease. The combined activity of narasin and nicarbazin places the parasite at a severe disadvantage. Those sporozoites not inactivated by the ionophore enter the host cell in a state of significant energy depletion requiring the parasite to invade the cells of the bird’s intestinal wall where nicarbazin is active. Nicarbazin blocks the ETS immediately after being absorbed into the host cell in a state of significant energy depletion and diminished reproductive capabilities. Nicarbazin’s activity is most prominent during the intestinal wall where nicarbazin is active. Nicarbazin blocks the ETS immediately after being absorbed into the host cell in a state of significant energy depletion requiring the parasite to invade the cells of the bird’s intestinal wall where nicarbazin is active.

The development of an immune response reduces resistance development and complements the activity of the anticoccidials. However, this does not account for the complete benefit of the drug combination. Immunity is active when either of these molecules is used alone, but the actual combined impact is greater than what could be expected to occur. The two-pronged approach to coccidiosis control, coupled with multiple genetic mutations necessary for resistance development, accounts for much of the long-term success of the ionophores.