MICRO-AID®
Micro-Aid® in all feed, all the time

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An Overview of Ammonia and its Impact

Introduction

Amino acids, carbohydrates, and fats can all be used by animals in metabolic processes for the production of energy. However, compared with carbohydrate and fat, the use of amino acids for energy is a very inefficient conversion process. Not only is it inefficient, but excess amino acids affect nitrogen (N) balance and result in the liver removing excess N via the urea cycle. When these nitrogenous compounds are excreted from the body, they can be volatilized into ammonia (NH^3). Nitrogen is excreted in the form of urea or uric acid in the urine of livestock and poultry, respectively, and in the form of urea, NH^3, and organic N in animal feces. Conversion of urea or uric acid to NH^3 requires the enzyme urease, which is excreted in animal feces. This conversion occurs rapidly, often within a few days. The breakdown of complex organic N forms in feces occurs more slowly (within months or years). In both cases, N is converted to either NH^3 at higher pH levels or ammonium (NH^4) under acidic or neutral pH conditions. Factors that can increase NH^3 emissions include temperature, pH, moisture, diet (primarily high protein), health, poor ventilation, improper cleaning of pens or paddocks, and agitation of bedding or manure. Also, animals that consume large quantities of water subsequently excrete large quantities of urine that can contain ammonia and be rapidly volatilized into the atmosphere. Consequently, it is desirable to excrete more N via the feces in the form of microbial protein and less N via the urine in the form of urea.

Along with NH^3 volatilization into the atmosphere, intestinal NH^3 is a toxic catabolite of microbial amino acid deamination and urea hydrolysis. In ruminant animals, a wide range of intestinal bacteria exhibit urease activity. To our knowledge, detailed studies have not been conducted in monogastrics; however, one would speculate that the microbiota present in the gastrointestinal tract exhibit urease activity as well. Ammonia is normally absorbed from the colon and detoxified via reconversion to urea in the liver. However, NH^3 concentration in the colon can be found in concentrations that are several times greater than that required for cytopathic effects, indicating that NH^3 produced by bacterial urease could have substantial physiological effects at naturally occurring concentrations. There is evidence that microbial hydrolysis of urea and the resulting high concentrations of NH^3 depress growth. Ammonia also increases epithelial cell turnover by affecting cellular intermediary metabolism and DNA synthesis.

Humans can detect NH3 odor at concentrations as low as 5 to 10 ppm. As NH^3 concentration increases, the agitation associated with it also increases. At over 10 to 25 ppm of NH3, there is eye and respiratory irritation, while at over 50 ppm there are increased lesions to the eyes and respiratory tract. The National Institute for Occupational Safety and Health (NIOSH) standard for NH^3 exposure is 25 ppm over an 8 hour day. This means that a worker's exposure to NH^3 cannot exceed an average of 25 ppm over their 8 hour shift. If an individual is frequently exposed to NH^3 odor in their workplace, then their senses may become dulled to the smell so that after a few minutes they cease to notice it and may be exposed to high NH^3 concentrations without realizing it.

As in humans, NH^3 is an irritant to animals and can have detrimental effects on health and performance including causing respiratory infections and decreasing rate of gain and feed efficiency. Particularly in swine, it was estimated that an NH^3 concentration of 25 ppm results in eye and lung irritation and an approximate 6% reduction in average daily gain, 50 ppm results in an approximate 12% reduction in average daily gain, and 100 ppm results in an approximate 30% reduction in average daily gain and 9% reduction in feed efficiency. In poultry, intestinal NH^3 increases oxygen demand by portal vein-drained organs and is also associated with Ascites and Round-heart Syndromes.

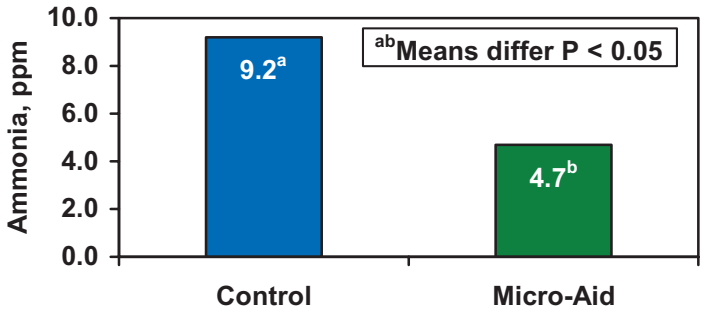
Because of increased environmental pressure by governmental agencies and all the detrimental concerns attributed to NH^3 previously mentioned, it is essential that livestock producers give serious thought and consideration to methods to alleviate these issues. Various management practices, including reduced dietary crude protein concentration, increased non-starch polysaccharide supplementation, utilization of phase feeding, and dietary modifications to manipulate intestinal microbiota, have been evaluated to determine their impact on reducing both intestinal NH^3 formation and nitrogenous compound excretion that results in atmospheric NH^3 volatilization.

Micro-Aid®

Micro-Aid® is an all natural, dry, granular feed additive that is marketed for use in animal feeds in over 50 countries. Micro-Aid® is not absorbed from the intestinal tract and as a result produces no tissue residue. Thus, Micro-Aid® has been classified in the safest classification for feed additives, "Generally Recognized as Safe" and requires no withdrawal period.

Scientific research has demonstrated that Micro-Aid® significantly reduces intestinal NH^3 (Figure 1). By reducing intestinal NH^3, Micro-Aid® maintains gut health, improves the efficiency of nutrient utilization, and enhances animal performance. This reduction in intestinal NH^3 is attributed to the pronounced affect Micro-Aid® has on intestinal microbial populations, including both fauna (protozoa) and flora (bacteria).

Figure 1. Effect of Micro-Aid on Intestinal Ammonia



Micro-Aid® suppresses protozoa by complexing with cholesterol in the cell membrane, which causes breakdown in the membrane and subsequent death of the protozoa. Protozoa compete with bacteria for nutrients within the gut by engulfing the bacteria and causing proteolysis of the bacterial protein and ultimately increasing intestinal NH^3. These anti-protozoal capabilities of Micro-Aid® were evident in an experiment that reported that the addition of Micro-Aid® to a typical high producing dairy ration deceased ($P < 0.05$) protozoa from 36,000/mL to 29,000/mL. In contrast, rumen bacteria numbers increased from 1.24 X 10(10)/mL in the Control treatment to 1.33 X 10(10)/mL in the Micro-Aid® treatment. Current research has also demonstrated that as the concentration of Micro-Aid® increased up to 0.25% in an in vitro culture, the growth of E. coli was inhibited ($P < 0.05$) by two log units. The ability to maintain a healthy population of non-pathogenic bacteria within the intestinal tract allows for enhanced animal growth and efficiency and reduced risk of disease.

Because Micro-Aid® is not absorbed from the intestinal tract it passes through the animal into the manure. Micro-Aid® continues to work within the manure in a similar fashion to enhance microbial populations which in turn utilize undigested nutrients and prevent the formation of noxious gases like NH^3. Along with reductions in intestinal ammonia, extensive research has been conducted proving the ability of Micro-Aid® to reduce aerial ammonia. As shown in Table 1, Micro-Aid® reduces aerial ammonia, on average, by over 45%.

Table 1. Summary of Research Experiments with Micro-Aid® for Reducing Ammonia

Research Experiment	Ammonia Reduction
Animal Industry Research Inst., Miaoli	48.0 %
Animal Industry Research Inst., Miaoli	78.0 %
National Inst. of Ag. Eng., Bygholm	29.0 %
Purdue University	55.6 %
Kangweon National University	49.0 %
Wilmington College	41.6 %
University of Illinois	42.3 %
University of Illinois	13.0 %
University of Iowa	43.0 %
Wayne Feeds	34.0 %
Simonsen Laboratories, Inc.	99.0 %
Texas A & M University	70.0 %
Texas A & M University	45.0 %
University of Minnesota	52.0 %
Average Reduction in Ammonia = 46.4%	

Key Technical Points

- Micro-Aid® has a pronounced positive impact on intestinal microbiota.
- Micro-Aid® maintains gut health, improves the efficiency of nutrient utilization, and enhances animal performance by reducing intestinal ammonia.
- By reducing aerial ammonia emissions, Micro-Aid® improves the health and well-being of both animals and workers.