Avitech
Knowledge | Nutrition | Innovation

# Technical Bulletin

JANUARY 2012

# Managing Ammonia in Poultry Farms

As the poultry industry has grown, so have concerns about environmental management aspects, including air and water quality. There is a growing concern related to ammonia emission from poultry operations. Ammonia is a colorless, lighter than air, highly water-soluble gas present in the atmosphere of every poultry house. Ammonia volatilization from poultry litter commonly causes a buildup of ammonia in the atmosphere of chicken houses that has a negative impact on both farm workers and birds. Ammonia is an irritant which readily impacts the eyes and respiratory tract of poultry increasing their susceptibility towards respiratory infections mainly caused by airborne pathogens. The combination of ammonia and wet litter is responsible for a large number of health and density related welfare problems in poultry. The release of this ammonia can also contribute to environmental problems such as haze and acid rain.

## Effects of ammonia on birds

Ammonia concentrations are particularly damaging to the birds during periods of minimum ventilation like winter or during the brooding period. In the US, maximum levels of ammonia in poultry houses have been set at 25 ppm by the National Institute of Occupational Safety and Health (NIOSH) and 50 ppm by the Occupational Safety and Health Administration (OSHA). These levels have been established based on human safety and represent the limits for 8 hours of exposure. People can generally smell ammonia at concentrations between 20 and 30 ppm. Reduction of ammonia level inside poultry houses is not only important to gain compliance with current air quality regulations and laws, but also to improve performance.

Studies show that operations from chicken farms generate about eight times more ammonia

emissions annually than oil refineries and steel mills combined in poultry heavy states. Unfortunately, many poultry growers who have worked in an ammonia-laden environment for years are unable to detect ammonia below 50 ppm. However the recommended level for ammonia is no greater than 35 ppm only.

The negative effects of ammonia on poultry begin at 25 ppm (parts per million) and become very serious at 50 ppm. The symptoms of ammonia irritation in chickens include watery eyes, closed eyelids, blindness, poor growth rate, and ultimately the chickens cannot find food to eat. Day-old chickens show the symptoms of ammonia exposure at four to five weeks of age. Chickens exposed to 20 ppm over a period of 42 days show pulmonary congestion, edema and hemorrhage. The trachea and lung lesions render the birds more susceptible to bacterial infections such as E. coli. Chickens exposed to 40 ppm ammonia exhibited a low ability to clear E. coli from their system, making it unsafe and deadly for human consumption. At 50 ppm, the rate of infection of Newcastle virus (an airborne disease) was double that of control birds.

A decrease in egg production, food consumption, weight gain and delayed sexual maturity by as much as two weeks have also been reported due to the presence of ammonia. Hens exposed to 100 ppm showed a reduction in respiration rate, due to negative changes in the ultra structure of the lungs. Hens in the midst of 100 ppm for six weeks also developed keratoconjunctivitis and showed a slowed egg production rate. Ammonia is the leading cause of keratoconjunctivitis and tracheitis in chickens.

Ammonia levels have also been associated with a high incidence of contact dermatitis: foot, hock and breast burns. If the foot lesions are serious, lameness and leg problems may occur. The occurrence of ascites, gastrointestinal irritation, and respiratory diseases has been correlated with high levels of ammonia. Many of these pathologies can be quite painful and stressful for the birds, therefore control of ammonia has become an important issue in the poultry industry.

## Ammonia levels and consequences

- 10 ppm : Trachea irritation (in turkeys).
- 20 ppm : Increased rate of infection of Newcastle disease vaccination.
- 25 ppm : Impaired growth rate of feed conversion. Reduced final body weight.
- 25 ppm : 50 ppm: Air sac inflammation.
- 50 ppm : Increased levels of keratoconjunctivitis.
- 100 ppm : Increased chick mortality.

**Figure 1.** Main known consequences of ammonia levels to poultry health.

Ammonia is a considerable problem in the production of poultry, such as egg laying hens, and its effect is manifested through an increase in problems such as infectious coryza, laryngo tracheitis and mycoplasmosis. This is due to the fact that ammonia destroys three primary defense mechanisms which are the ciliate epithelium, mucous secretion and the alveolar macrophages that eventually cause physiological problems in the animal, resulting in important economic losses.

## Mechanism of ammonia production

Ammonia (NH3) is a natural common by-product of the metabolism of nitrogenous compounds. It is of two types:

1) Environmental Ammonia

2) Intestinal Ammonia

Environmental ammonia is caused by fecal breakdown on the house beds and it affects the respiratory passages, depressing the bird's breathing and thus reducing the capture of oxygen. Moisture, in conjunction with high temperature, promotes bacterial growth, which will decompose organic material producing ammonia in the process.

Intestinal ammonia is the byproduct of the urea breakdown by the bacterial enzyme urease. When there is a high intestinal ammonia concentration, the bloodstream's pH is altered, as well as the blood's capacity to transport oxygen leading to characteristics of the ascitis syndrome. Ascitis is a syndrome that is characterized by the appearance of fluids in the abdominal cavity, due to an insufficiency in the capturing and transport of oxygen. One of the factors that predisposes birds to ascitis is environmental and intestinal

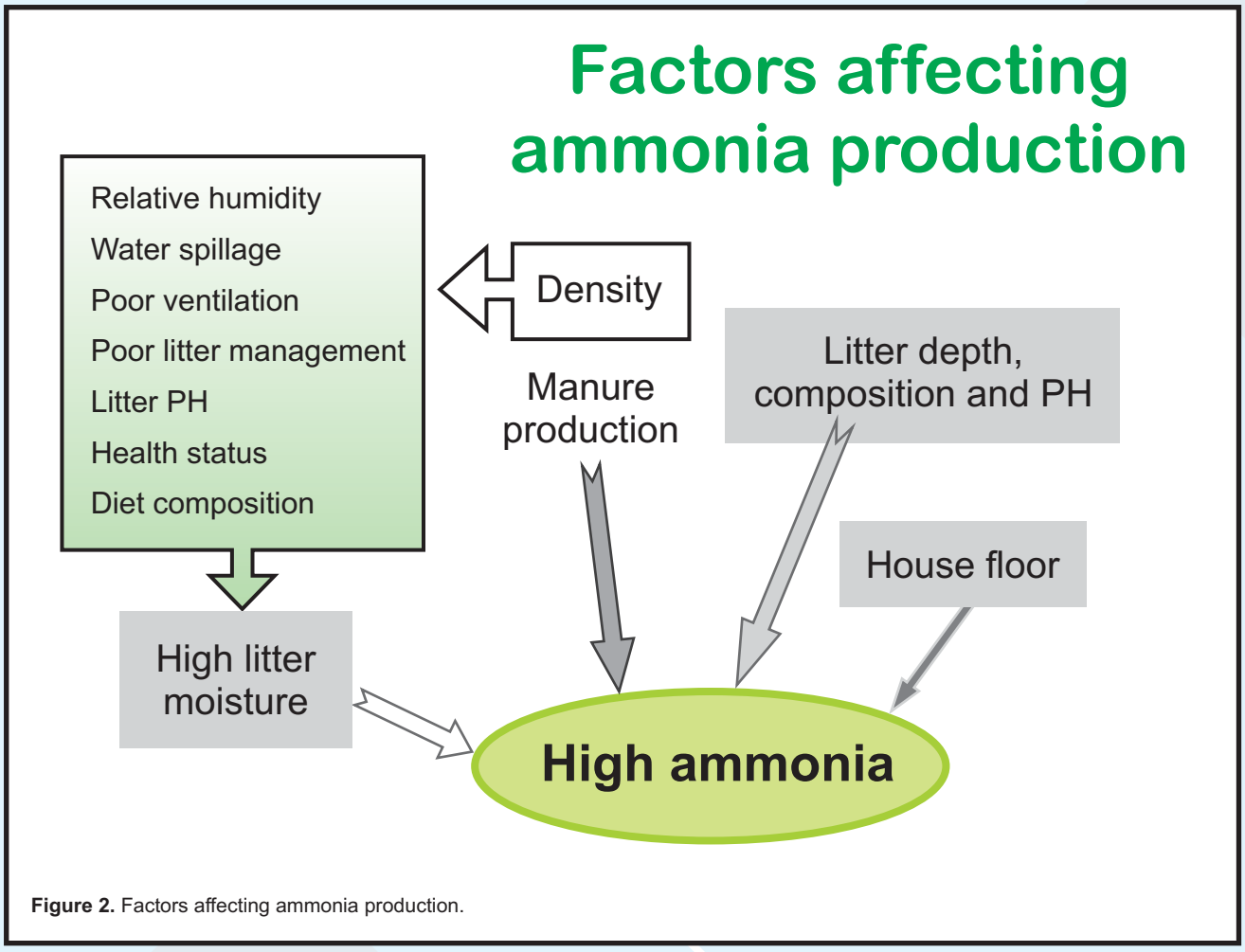



**Figure 2.** Factors affecting ammonia production.

ammonia.

Normal intestinal flora is made up by some bacteria that contain urease enzyme capable of degrading the urea in ammonia and carbon dioxide, also causing a production of ammonia in the digestive system. Because ammonia is very water soluble, it tends to dilute the plasma, causing a series of reactions such as important pH changes in the blood that bring as a consequence a diminishing affinity of hemoglobin for oxygen, thus reducing the levels of this compound in the blood.

## Measures to control ammonia in farms

Potential strategies for control of ammonia in poultry production include:

**a) Ventilation**

Ventilation has been the primary method of removing and controlling NH3 from poultry houses. Traditionally, improving air quality in poultry houses has been largely accomplished through ventilation. Increased ventilation rates reduces NH3 concentration within the house but translates directly into higher emissions. As the use of built-up litter systems has increased, NH3 volatilization has increased, leading to higher levels of NH3 in poultry houses and increased corresponding NH3 emissions. Seasonal variation, however, in NH3 concentrations can occur as growers reduce ventilation rates during the winter months to reduce heating expenses. Ventilation is, therefore, more of an in-house air quality control method than a strategy to inhibit the formation and emission of NH3. Biofilters and scrubbers can clean exhaust air, but the practical application and sizing of such technologies to treat the volume of air exhausted from modern commercial poultry facilities may be severely limited by cost, size restraints, and technical problems due to high dust volume. Moreover, only mechanically ventilated buildings can be equipped with air cleaning devices, and air-cleaning devices do not reduce the NH3 inside poultry houses.

**b) Dietary manipulation**

Dietary strategies aimed at nutrient reduction, particularly dietary protein content, can result in a reduction of NH3 formation. Feeding reduced protein diets can reduce N excretion and subsequent NH3 volatilization. Other dietary manipulation strategies that can optimize N digestion and reduce N excretion include feed formulation based on amino acid requirements rather than Crude Protein, optimizing the dietary amino acid profile with bird requirements, phase feeding for current growth and production, selection of feed ingredients with low nutrient variability to reduce protein margins of safety, and use of feed enzymes and additives. Better accounting for ingredient Crude Protein, amino acid variability, and digestibility can reduce over-formulation and N excretion.

**c) Litter management**

Litter amendments are used to mitigate ammonia problems. Poultry litter typically consists of wood shavings, rice hulls, or peanut hulls etc. Ammonia production in the poultry houses require manure, heat and moisture. Probably the most important of these factors in litter management is moisture control. Good litter management starts with controlling litter moisture, even before it is put into the house.

Microbes in the litter convert the bird's excreta and spilled feed into ammonium ($NH_4^+$), which can bind to litter and also dissolve in water. Depending on the moisture content, temperature, and acidity of the litter, a portion of the ammonium will be converted into ammonia ($NH_3$) gas. Ammonia production is favored by high temperature and high pH (i.e. alkaline

conditions). Adding litter amendments can reduce ammonia in poultry houses. There are many types of litter amendments, such as acidifiers, alkaline materials, adsorbers, inhibiters, or microbial treatments. However, only a few have been evaluated and found to be effective in controlled studies.

**d) *Yucca schidigera* extract as a feed additive**

Poor performance in poultry due to high levels of ammonia gas can be corrected by using extract of the *Yucca schidigera* plant as feed additive. The *Yucca schidigera* extract when added to animal feed has been shown to lower noxious ammonia gases in animal wastes, dramatically curbing dangerous and foul odors. The extract has also been found to increase animal performance by lowering intestinal and blood ammonia levels.

It is now known that saponins, a natural steroid derived from the plant trunk, physically binds ammonia, reducing the level of free ammonia. As the food passes through the stomach, ammonia is held by the extract in the feed. It is also bound once outside the animal.

*Yucca schidigera* extract in poultry feed can dramatically increase the performance of stock. A chicken house receiving 100 ppm of extract in the feed experienced a significant reduction of ammonia production compared to one that did not. In a two month feed study with *Yucca schidigera* extract in an experimental caged layer operation, ammonia levels decreased. When broiler chickens are fed with 100 ppm of Yucca extract, they grow significantly heavier than control chickens. The effects of *Yucca schidigera* saponins in the diet of broiler chickens are continuous throughout their growth cycle increasing the survival rate of the chickens and the feed efficiency. The uses of the *Yucca schidigera* extract as a feed ingredient or when added directly to litter pits have proven to be effective in reducing ammonia levels and improving performance. The *Yucca schidigera* plant is a safe and natural answer to animal inefficiency caused due to ammonia.

## About *Yucca schidigera*

The *Yucca schidigera* plant can be found only throughout the Southern Western United States, and in the Central Baja California desert, where it is more abundant. The plant was widely used by native Americans for food purposes. All parts of the plant were used for food, including the fruit, seeds, seed pods, flower petals, roots and leaves. The *Yucca schidigera* plant was also used for herbal teas and fermented beverages needle and thread poles for houses, soaps and shampoo for bathing, and objects for religious practices and rituals.

Today the *Yucca schidigera* extract is used as a natural medicine, a foaming agent and flavor enhancer in the food and beverage industries, and as an additive for feed in the poultry, swine, and cattle industries. The extract is also employed as a surfactant agent for the processing of grains and as a soil enhancer and biological promoter in the agriculture world. Additionally the extract is used in sewage processing for the reduction of ammonia and other chemical components causing foul odors. The *Yucca Schidigera* extract presents beneficial properties for animals, due to presence of mainly two important biochemical components and those are Saponins and Glycocomponents.

**Saponins** ar\e steroidal glycosides that have a great surfactant activity, and hence play an important role in nutrient absorption through intestinal walls, and because of being tensioactive they allow for better nutrient absorption by the animals. The *Yucca schidigera* saponins in the diet of broiler chickens help them to grow continuously throughout their growth cycle and render than significantly heavier than control chickens. It has been reported that survival rate of the chickens was increased by 6 percent and feed efficiency by 3 percent in broilers fed with a diet containing *Yucca Schidigera* extract. Saponins contained in the *Yucca schidigera* extract also have a strong anti-protozoal activity. Saponins have a great influence on the permeability of the fungus cell membranes, having a toxic effect on microorganism. The activity of saponins takes place at the intestinal level mainly; this is because it interacts with the membranes. The amount of saponins absorbed is not significant because its action is in the intestine's lumen in the permeability of the membranes. This is due to the fact that saponins interact with the sterols of the membrane, allowing or limiting the passage of compounds, such as cholesterol.

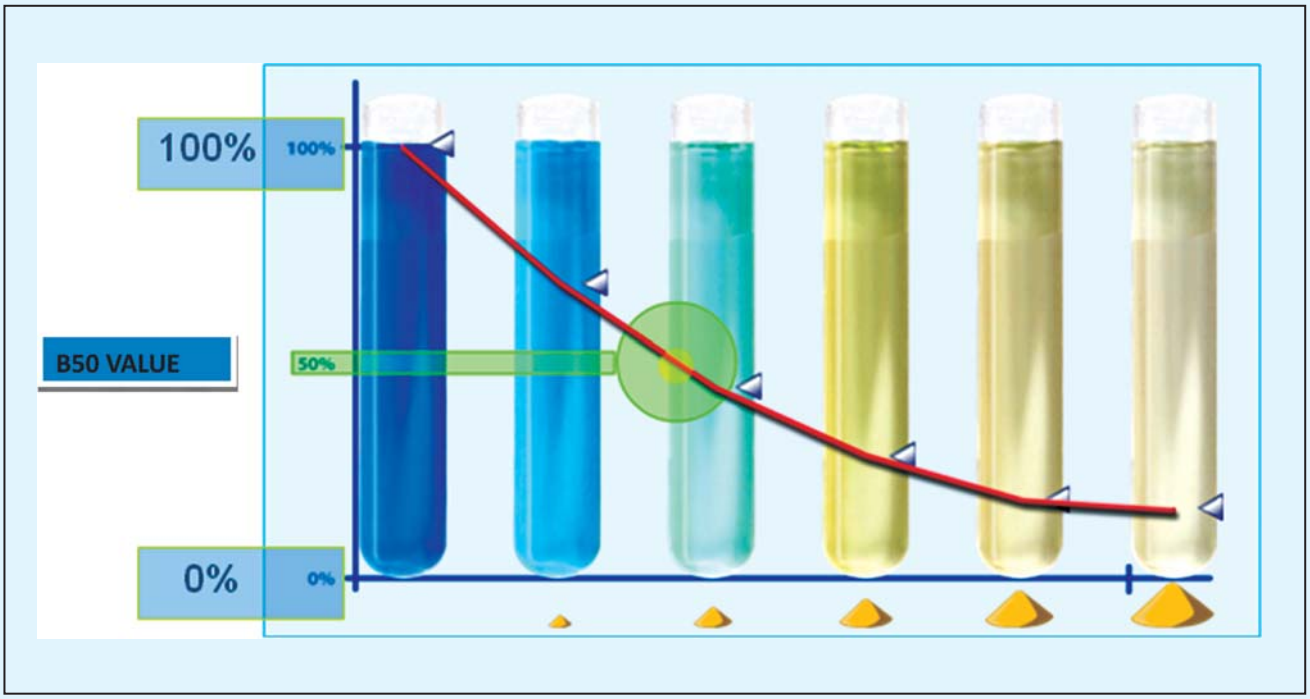
## Glycocomponents

The glycocomponents are molecular structures, highly thermostable and have the property of binding the ammonia in the digestive tract and in the metabolic processes. This neutralizes the harmful effects of ammonia and converts it to another type of non- toxic nitrogenous compound. The conditions are improved so that the intestinal flora increases its degrading activity, giving a more complete digestion.

## B50 value of Yucca extract

The B50 value of Yucca extract is a measure of efficiency and is measured by assessing the amounts of milligram of *Yucca schidigera* extract necessary to reduce ammonia in an aqueous solution by 50%. For effective ammonia binding, the maximum amount of *Yucca schidigera* required should not be greater than 4 mg.

The *Yucca Schidigera* plant is a safe and natural way to bind ammonia and improve animal efficiency. The use of *Yucca schidigera* extract as a feed ingredient or as a direct additive to tanks or



litter pits has proven to be effective in reducing ammonia levels and improving performance.

## Conclusion

Employing specific practices can reduce ammonia emissions. A number of practices are available but not all are suited for all operations. Various abatement methods, including dietary manipulation, chemical amendment of litter, and improvement in ventilation system management have been used to control ammonia concentrations from livestock facilities, but these methods are perceived to be too expensive, to impair bird growth, or to add to pollution in some other form. The *Yucca schidigera* plant is environmentally safe because it is 100% natural. It is best solution to the challenge of lowering toxic ammonia levels in animal barns and to improving the quality and potential output of animals. Careful consideration and selection from different yucca extract products available in market by poultry producers will surely help them to achieve the desired results.

**References are available with author and can be made available on request.**

**Dr Pooja Tarar**
M.V.Sc. (Animal Biotechnology)
B.V.Sc. & A.H. (Anand Agricultural University)

Avitech
Knowledge | Nutrition | Innovation


**AVITECH NUTRITION PVT LTD**
(An ISO 9001 Certified Company)
GP-37, Udyog Vihar, Sector-18, Gurgaon-122001 Haryana, India.
Tel: +91-124-4011147, 4278511/12 Fax: +91-124-4013620
Email: info@avitechnutrition.com Website: www.avitechnutrition.com