ALABAMA A&M AND AUBURN UNIVERSITIES

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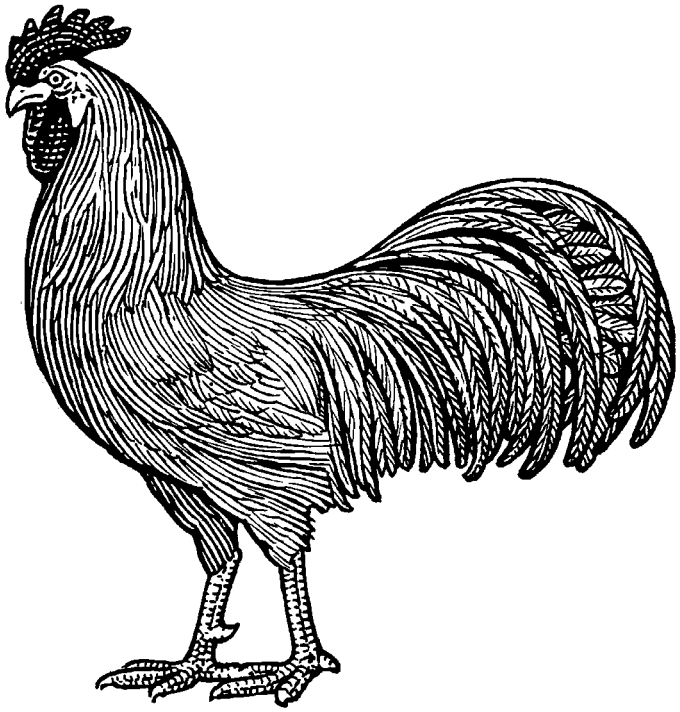
# Litter Treatments for Poultry

The detrimental effects of ammonia in poultry production have been known for years. Numerous laboratory and field studies have shown how ammonia levels as low as 10 parts per million (ppm) affect bird health and performance. Ammonia levels above 25 ppm in the poultry house can damage the bird's respiratory system and allow infectious agents to become established, leading to declining flock health and performance. *E. coli* bacteria can be significantly increased in the lungs, air sacs, and livers of birds exposed to ammonia because of damage that occurs to the tracheal cilia. Resistance to respiratory disease may be decreased. In addition, body weight, feed-efficiency, and condemnation rate may be higher in birds exposed to levels of ammonia exceeding 10 ppm.

The volatilization of ammonia has been attributed to microbial decomposition of nitrogenous compounds, principally uric acid, in poultry house litter. Litter pH plays an important role in ammonia volatilization. Once formed, the free ammonia will be in one of two forms: as the uncharged form of $NH_3$ (ammonia) or the ammonium ion ($NH_4$), depending on the pH of the litter. Ammonia concentration tends to increase with increasing pH. Ammonia release remains low when litter pH is below 7, but can be substantial when litter pH is above 8. Uric acid decomposition is most favored under alkaline (pH>7) conditions. Uricase, the enzyme that catalyzes uric acid breakdown, has maximum activity at a pH of 9. As a result, uric acid breakdown decreases linearly for more acid or alkaline pH values. One principal ureolytic bacterium, *Bacillus pasteurii,* cannot grow at neutral pH, but thrives in litter above pH 8.5. Typically, litter pH in a broiler house ranges between 9 and 10.

One primary question for those involved in poultry production is "What is the best litter treatment?" Unfortunately, this most frequently asked question has no general answer, and the difficulties in addressing this question may be complicated and numerous. There has never been an experimental study evaluating the various litter treatment products



under various management conditions. Litter moisture, brooding and lighting programs, ambient temperature, strain type, ventilation management, litter management, and disease challenge are only a few of the variables that have a potential impact on product selection, efficacy, and potential return on investment.

In the selection of a litter treatment product, one must identify the goals for application. Litter treatments may be cost-effective and justifiable under one or more of the following situations:

- high fuel prices
- extremely cold weather
- short layout periods
- persistent disease challenges
- severe vaccination reactions
- reduction of ammonia-related stress
- prolonged litter reuse
- increased bird density
- address marginal management or housing situations

In general, the control of house ammonia levels is the primary purpose for using a litter treatment. In recent years, the reasons for using a litter treatment and any potential benefits from its use have expanded to include improvements in performance and environmental concerns. Some litter treatments may be used to enhance the composition of the litter as a fertilizer or as part of a best management practice to reduce foodborne pathogens. Ammonia-reducing litter treatments offer a potentially better in-house environment for both birds and producers. They may also play a role in reducing ammonia and odor emissions from poultry facilities. Although different litter treatments vary in their ability to control ammonia, each offers a unique set of characteristics that need to be considered in selecting the appropriate product to meet an individual's needs. The litter treatment that offers the best return on investment will depend on the user's ability to select the product that best meets application goals.

## Early Attempts

There have been attempts to reduce broiler house ammonia levels by using various litter treatments. Earlier methods involved the application of a superphosphate to trap nitrogen, but by the end of a seventeen-day period, ammonia levels and pH attained a normal level. Methods that use ferrous sulfate may have some initial effect on ammonia levels, but lack a long-term effect. Paraformaldehyde flakes have also been shown to reduce ammonia gas levels in the laboratory, but failed to have any effect on reducing ammonia or litter pH when tested in the broiler house.

Many previous studies used rates that were as much as 10 to 100 times too low to compensate for the buffering capacity of the litter or compacted material after cleanout. The use of acid materials such as sulfuric acid, hydrochloric acid, and phosphoric acid plus an acid-forming material such as elemental sulfur have received little, if any, attention.

Sulfuric acid, when applied directly to the soil base in a poultry house, has proven to be effective in lowering the pH of the broiler house floor to 5.5. The acid treatment is applied only to bare soil after cleanout and before new bedding material is added. Typically, prior to application, strong ammonia odors were very noticeable, but immediately upon application, ammonia odors were no longer apparent. The use of sulfuric acid can effectively achieve a lower pH of the soil of the broiler house floor, but precautions must be observed for its use. Sulfuric acid is considered a hazardous material, and handling and transport of the material must meet strict guidelines. Transfer and mixing requires special precautions, since any accidental spillage may cause severe injury.

The use of elemental sulfur also offers potential for lowering pH, when incorporated into the soil of the broiler house floor. Naturally occurring bacterial populations of *Thiobacillus,* when fed elemental sulfur, produce hydrogen ions ($H^+$) as a byproduct of their metabolism, which effectively lowers the pH of the broiler house floor. However, in the presence of excessive levels of ammonia, the *Thiobacillus* bacteria fail to thrive, thus preventing the oxidation of sulfur that is required for acid production. Consequently, favorable conditions must exist for sulfur treatment to be successful.

## Sodium Bisulfate: Poultry Litter Treatment

Poultry Litter Treatment (PLT) is a dry granular additive used extensively by the poultry industry for poultry house ammonia control, litter acidification, and on-farm HACCP programs for pathogen reduction and in the prevention of many bacterial or stress-related poultry conditions. PLT is a unique blend of sodium bisulfate and other ingredients that have three mechanisms of action. Sodium bisulfate is considered a nonhazardous and nontoxic substance classified as a GRAS (Generally Regarded as Safe) and a food-grade substance. PLT eliminates ammonia by converting litter ammonium to ammonium sulfate and lowers litter pH to acidify litter. PLT was the first nonhazardous and nontoxic litter treatment used in an overall total litter management program.

In experiments and field tests using PLT, it was found that

- Fuel usage was decreased
- House ammonia levels were decreased
- Litter pH levels were decreased
- Improvements in performance occurred
- Bacterial populations of *Salmonella* and *Campylobacter* were reduced
- Beetle populations were lowered

## Aluminum Sulfate: Alum

Ammonia ($NH_3$) is produced in animal manure by the breakdown of urea and in poultry manure by the breakdown of uric acid. Since ammonia is unchanged, it can be emitted as a gas. The gaseous emission of $NH_3$ can be inhibited if converted to $NH_4^+$ (ammonium), which can be accomplished by lowering litter pH. Aluminum sulfate, commonly referred to as alum, is an acid that produces hydrogen ions ($H^+$) when it dissolves, and the hydrogen ions produced by this reaction will attach to ammonia to form ammonium, which further reacts with sulfate ions to form ammonium sulfate—$(NH_4)_2SO_4$. Ammonium sulfate is a water-soluble fertilizer. Because of these reactions, the amount of ammonia emitted from the litter will be reduced, which will increase the nitrogen (N) content of the litter. Alum addition to the litter will also result in the precipitation of soluble phosphorus and thus reduce phosphorus runoff.

Poultry producers have begun using aluminum sulfate to improve poultry production and reduce negative effects of litter on the environment. Research has shown that alum applications to poultry litter control ammonia volatilization and reduce phosphorus runoff from land fertilized with litter. Benefits from using alum as a litter treatment include the following:

- Reduces ammonia volatilization by lowering litter pH
- Reduces energy use
- Precipitates soluble phosphorus and reduces phosphorus runoff
- Improves bird performance
- Reduces heavy metal runoff

## Enzyme Treatment

*Yucca schidigera* extract is a natural feed additive that represents one means of reducing ammonia levels via the diet. De-oderase (Alltech, Inc.) is a *Yucca schidigera* extract that can be added to the diet for the reduction of ammonia in the poultry house. Experimental results indicate that Deoderase effectively reduces ammonia evolving from poultry manure, may contribute to energy cost savings related to decreased ventilation run times, and will contribute to improvements in bird performance.

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