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Ph, Ammonia Flux, and Total Nitrogen in Duck Litter with Chemical Blends – A Field Study

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ABSTRACT

This study was designed to evaluate the effects of chemical blend additives to duck litter on pH, ammonia (NH_3) fluxes, total nitrogen (TN) under a small pen trial. One hundred twenty 1-day-old duck (pekin) were randomly assigned to 6 pens in a completely randomized design during 6 weeks. Control received no litter treatment whereas top-dressed treatment at rates of 50 g aluminum sulfate + 50 aluminum chloride/kg duck litter were mixed into the upper 1 cm of duck litter. Duck litter pH at 2 weeks through 5 weeks was significantly affected ($p<0.05$) by chemical blend treatments compared to controls, but not at 6 weeks. During the experimental periods, NH_3 fluxes decreased ($p<0.05$) in chemical blend treatments. However, there were no remarkable difference ($p>0.05$) between treatments at 0 and 1 week. Reductions of NH_3 fluxes at 3, 4, 5 and 6 weeks were 31, 16, 29 and 24%, respectively. Chemical blend treatments as a function of time resulted in increase in TN contents compared with control. There were no significant differences ($p>0.05$) in TN between treatments at 2 and 3 weeks, except for 4, 5 and 6 weeks. Chemical blend decreases NH_3 fluxes and increases TN positively by reducing duck litter pH.

INTRODUCTION

Poultry litter is a mixture of poultry excreta, bedding materials waste feed, and feathers removed from poultry houses. It is used as an organic fertilizer because they have a high nitrogen contents and nutritional values. However, ammonia (NH_3) from poultry housing (broiler, laying hens and duck houses) has lead to environmental pollutions that can not only cause odor problems, but decrease the fertilizer N value of poultry litter (Benjamin *et al*., 2002; Li *et al*., 2008). The obvious factors that play a key role in NH_3 volatilization are litter pH in that NH_3 generation tends to increase with pH (Li *et al*., 2008). Thus, effective strategies to lower NH_3 loss can very well be adopted for improvements in the value of poultry litter as a fertilizer, as well as positive economic and environmental effects (Li *et al*., 2008). For example, one must select litter treatment product to identify the goals for cost-effective and justifiable under one or more of the following situations: reduction of ammonia in poultry litter and prolonged litter reuse (Blake & Hess, 2001). Among these litter treatments, the effectiveness of aluminum sulfate (alum, $Al_2(SO_4)_3 \cdot 14{\sim}18H_2O$) and aluminum chloride ($AlCl_3 \cdot 6H_2O$) as a litter amendment in poultry houses has been recognized in several studies that reduce ammonia volatilization by lowering litter pH, phosphorus runoff and heavy metal runoff or increase bird performance and nitrogen (N) content (Li *et al*., 2008; Lim *et al*., 2008). In addition, most studies have been attempts to reduce poultry house ammonia levels by using a single litter treatment (top dressing or spraying). However, information on the efficacies of litter amendment blends on NH_3 and

N in duck litter is meager. Eventually, determining their blends provides fundamental knowledge that will enable to develop best management practices (BMP) for duck litter management.

The objective of this study was to evaluate using chemical blends to duck litter as a new approach to reduce pH and ammonia fluxes and increase total N.

MATERIALS AND METHODS

Experimental design, birds and chemical treatment

All experiments were conducted in accordance with the animal care guidelines of animal policy at Gilhong farm (Geochang, South Korea). One hundreds twenty 1-d-old ducks (pekin, 60 male and 60 female) were randomly assigned to 6 pens in a completely randomized design and provided with a commercial starter diet (21% crude protein) and finisher diets (17% crude protein) during 6 weeks. Each pen (2.5 × 1.9 m) was equipped with a feeder and a drinker. Ducks had *ad lib* access to feed and water. Housing temperature and ventilation were controlled by automatic system, and a lighting program of 24 hours of light in a temperature-controlled room was also applied.

For the pen trial design, 6 pens of duck were designed with 2 treatments and 3 replicates (pen) of 20 birds. Before starting the experiment, about 7 cm of litter consisting of rice hulls and duck manure was tilled and deposited over concrete flooring. Two treatments consisted of control and T1 (50 g aluminum sulfate + 50 aluminum chloride/kg litter). Chemical blends (T1) were applied by top-dressing onto the duck litter surface and mixed into the upper 1 cm of duck litter within pens; no litter treatment in pen serve as controls.

Litter sampling, ammonia gas measurements and chemical analysis

Litter samples were weekly (2 weeks through 6 weeks) collected from similar points (the lower 3 cm of duck litter through the top layer) distributed in each pen using a latex glove for each pen. Duck litter samples collected were thoroughly mixed, and 50 g was weighed into a plastic bag and refrigerated until analyzed for pH and total N (TN). Ammonia fluxes from duck litter were taken weekly (0 weeks through 6 weeks) at 4 locations in each pen using a multi-gas analyzer (Yes Plus LGA, Critical Environment Technologies Canada Inc., Delta, Canada). For pH, 10 g of duck litter was extracted with 100 ml of distilled water for 2 h on a mechanical shaker and centrifuged at 3,000 rpm for 10 min. pH was immediately measured using a digital pH meter (model 691, Metrohm; Herisau, Switzerland). To measure total N, 1 g of duck litter subsamples were used. Total N was determined with the Kjeldahl method, comprising of distillation before titration and sample digestion according to AOAC (2005).

Statistical Analysis

Data analysis was done using the general linear model procedure of SAS Institute (2002) and carried out on a pen basis as the experimental unit. Comparison with respect to duck litter pH, ammonia fluxes and total nitrogen as measured across weeks of the flush cycle was used for a split plot across time using the mixed model procedure of SAS. Significant differences between means were tested using t-test at a 5% probability level.

RESULTS AND DISCUSSION

Duck litter pH at 2 weeks through 5 weeks was significantly affected (p<0.05) by chemical blend treatments (ranged from 4.67 to 7.85) compared to controls (ranged from 8.46 to 8.81) as time increased, but not at 6 weeks (Figure 1A). In other words, chemical blends caused decreases in duck litter pH. In addition, the reasons on no effect at 6 weeks for duck litter pH might probably be due to no remarkable differences in analytical data from treatment. Our studies indicate that litter additives were used as a positive control in efforts to evaluate chemical blends with alum and aluminum chloride. This finding is in agreement with the results of Moore *et al*. (2000), which reported that using with alum to poultry litter resulted in lower pH. Similarly, this observation was in line with that of Smith *et al.* (2001), who reported that when alum and aluminum chloride was applied to pig manure, the low and high rates of alum and aluminum chloride dropped the pH to around 7.3 and under 7.0, respectably, while pH in the untreated manure was around 8.0. They explained that reductions in manure pH are expected to occur due to hydrolysis by Al related to alum and aluminum chloride.

During the experimental periods, NH_3 fluxes decreased (p<0.05) in chemical blend treatments (Figure 1B). However, there were no remarkable difference (p>0.05) between treatments at 0 and 1 week, which ranged from 0 to under 1 ppm; this would be a results of the presence of similar values of

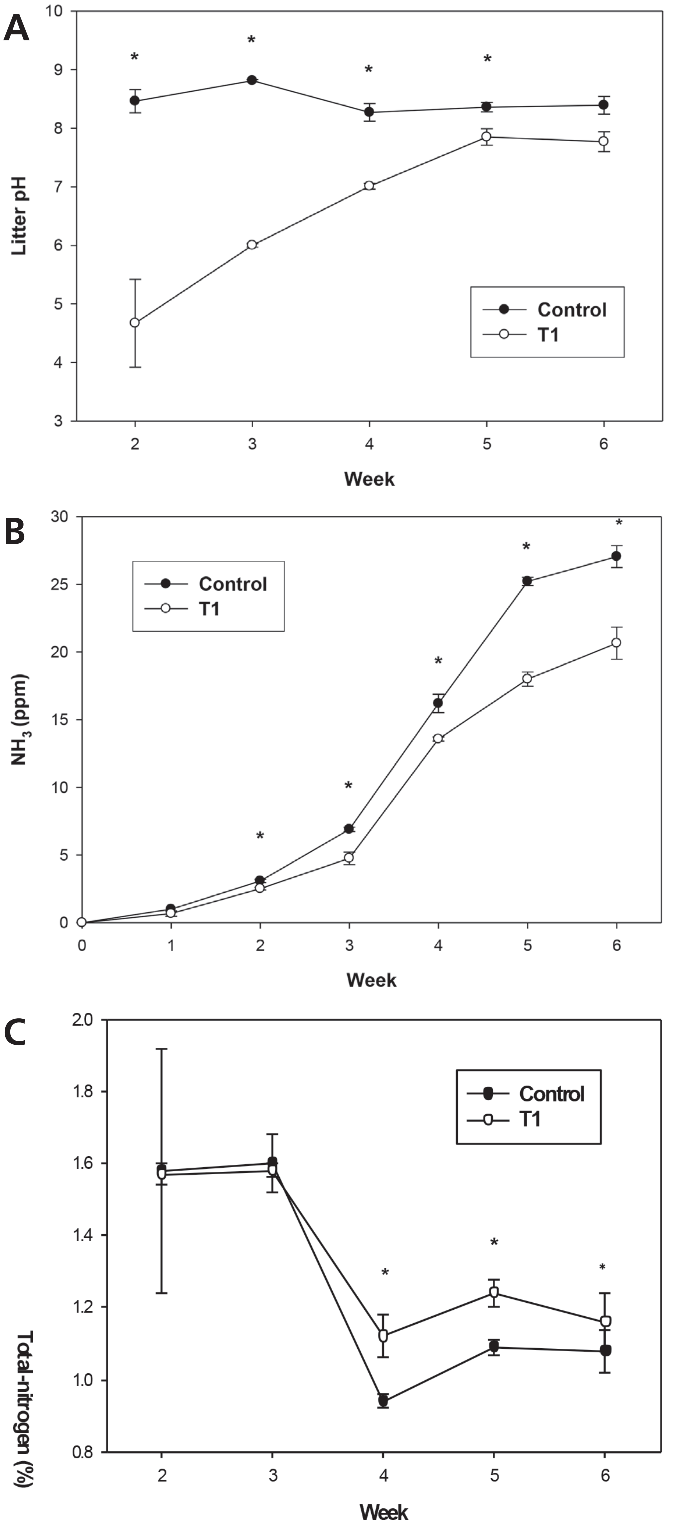

Figure 1 – Effects of the addition of chemical blends with duck litter on (A) pH, (B) ammonia (NH3) flux, and (C) total nitrogen during 6 weeks. *points above bars represent a significant difference (p<0.05). Treatment means T1 = 50 g alum + 50 g AlCl3/kg litter.

NH3 fluxes from all treatments. For control, NH3 fluxes for 2 weeks through 5 weeks ranged from 3.08 to 27.5 ppm. As time (2 weeks through 5 weeks) increased, it ranged from 2.5 to 20.6 ppm in chemical blend treatments. Consequently, reductions of NH_3 fluxes at 3, 4, 5 and 6 weeks were 31, 16, 29 and 24%, respectively. In the current study, addition of chemical blends showed a reduction in NH_3 fluxes due to low litter pH with acidification. Smith *et al*. (2004) reported that inclusion of $AlCl_3$ (0.75% level) decrease manure pH (7.48 to 6.69) and NH_3 losses (52%) for 6 week period. In addition, Moore *et al*. (2000) demonstrated an on-farm comparison of alum effect.

In general, litter pH is closely related to NH_3 volatilization. According to Blake & Hess (2001), the free NH_3 can exist in two forms as the uncharged form of NH_3 (ammonia) or ionized-ammonium (NH_4^+) depending on the pH of the litter. Increasing pH levels in litter tend to increase NH_3 fluxes. Thus, NH_3 fluxes remain small under litter pH 7 and can be substantial above litter pH 8.

In comparison with controls (ranged from 1.60% to 0.94%, Figure 1C), chemical blend treatments as a function of time (4, 5 and 6 weeks) resulted in increase in total nitrogen (ranged from 1.58% to 1.24%, TN), which would increase the value of duck litter as a fertilizer (Blake & Hess, 2001; Choi & Moore, 2008). This supports the hypothesis that chemical blend additives has proven to be effective in lowering litter pH and NH_3 and increasing TN to acidify litter. However, there were no significant differences (p>0.05) in total nitrogen (TN) between treatments at 2 and 3 weeks, due to similar values of TN from two treatments. Overall, as time increase, the tendency in decreasing TN contents showed the similar pattern between treatments.

CONCLUSIONS

The findings of this study indicated that chemical blend resulted in decrease in NH_3 fluxes and increase in total nitrogen, which would increase the value of duck litter as a fertilizer. Benefits of using chemical blends are effective in solving some of the environmental problems associated with NH_3 fluxes that are considered major issues of concern in duck production facilities or emitted from duck litter. In addition, the reason for an increase in TN and a reduction in NH_3 for blends (acidify) with alum and aluminum chloride to duck litter was related to reduced duck litter pH.

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REFERENCES

AOAC. Official methods of analysis. 18th ed. Washington: Association of Official Analytical Chemists; 2005.

Benjamin DR, Apelberg BJ, Roe S, Divita Jr. F. Livestock ammonia management and particulate-related health benefits. Environmental Science and Technology 2002;36(6):1141-1146.

Blake JP, Hess JB. Litter treatments for poultry. Minette: Alabama Cooperative Extension System; 2001.

Choi IH, Moore Jr PA. Effects of liquid aluminum chloride additions to poultry litter on broiler performance, ammonia emissions, soluble phosphorus, total volatile fatty acids, and nitrogen contents of litter. Poultry Science 2008;87(10):1955-1963.

Li H, Xin H, Liang Y, Burns RT. Reduction of ammonia emissions from stored laying hen manure through topical application of zeolite, Al+Clear, Ferix-3, or poultry litter treatment. Journal of Applied Poultry Research 2008;17(4):421–431.

Lim T, Wang C, Ni J, Heber A, Zhao L. Effects of aluminum sulfate and aluminum chloride applications to manure on ammonia emission from high-rise layer barn. Proceedings of the Mitigating Air Emissions from Animal Feeding Operations; 2008; Des Moines, Iowa. USA: Iowa State University; 2008. p.85-89.

Moore Jr PA, Daniel TC, Edwards DR. Reducing phosphorus runoff and inhibiting ammonia loss from poultry manure with aluminum sulfate. Journal of Environmental Quality 2000;29(1):37–49.

SAS Institute. SAS/STAT user's guide: version 8.2. Cary; 2002.

Smith DR, Moore Jr PA, Griffins CL, Daniel TC, Edwards DR, Boothe DL. Effects of alum and aluminum chloride on phosphorus runoff from swine manure. Journal of Environmental Quality 2001;30(3):992–998.

Smith DR, Moore Jr PA, Haggard BE, Maxwell CV, Daniel TC, Van Devander K, et al. Effect of aluminum chloride and dietary phytase on relative ammonia losses from swine manure. Journal of Animal Science 2004;82(2):605–611.