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Effect of alum treated litter in reduction of ammonia, pH, and moisture level of poultry litter and its effect on the Broiler Performance

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Abstract
The present study was conducted to investigate the effect of alum as litter amendment on broiler performance. Broiler chicks were raised 1 to 42 days of age. A total 200 chicks were randomly assigned in four groups comprising of 50 each. The birds were raised on different concentrations of alum treated rice hulls. Overall performance index was significantly higher in T3 followed by T2, T1 and control groups. Litter pH of control group was significantly higher than treatments groups. Lowest pH was observed in T2 group which was non significant within T1 & T3. Moisture % of group T3 were statistically significant from group T2 and group T1. Moisture % was significantly lowest in T3 followed by T2, T1 and control Group. Nitrogen % of litter material of different groups were statistically significant among other groups. N % in litter was significantly highest in T3 followed by T2, T1 & control group.

Keywords: Performance index, Nitrogen, Allum, pH, Amendments

Introduction
Poultry is one of the fastest growing segments of the agricultural sector in India today. Their growth rate has been rising at 8 to 10 percent per annum. Broiler litter is defined as the combination of bedding material, faeces, feathers, wasted feed and water. Bedding material needs to absorb the excess moisture, dilute faecal material and insulates chicks from the cooling effects of the ground and provide a protective cushion between the birds and the floor.
Litter quality significantly influences broiler performances (Ritz *et al.*, 2005) [18]. Poultry litter is composed of a mixture of litter material, manure, spilled food and feathers. An ideal bedding material must be absorbent, lightweight, cheap and free of toxic. Furthermore, spent litters could be used to as a fertilizer or as a livestock feed. One of the major problems currently facing the poultry production, which was appeared in order to reduced ventilation during winter, is ammonia gas (NH_3) volatilization in poultry houses. High ammonia levels in poultry houses can result in poor bird performance and health and a loss of profits to the grower and integrator. When broilers and turkeys are raised on litter, amendments can be used to reduce ammonia levels in the houses and improve productivity. The production of high concentrations of ammonia in poultry house adversely affects farm workers (Donham, 2000) [8]. High concentrations of ammonia in poultry house reduce bird body weights (Kleven and Glisson, 1997; Moore *et al.*, 1999) [10]. Gain to feed ratio depress at high ammonia volatilization in poultry house (Beker *et al.*, 2004) [3]. Deaton *et al.* (1984) [7] demonstrated that egg production decrease in high levels of NH_3. Aluminum sulfate (K_2SO_4 $Al_2(SO_4)_3.24H_2O$), commonly called alum, has been shown to be effective at reducing ammonia emissions when added to broiler litter.
There has been several investigation on the use of alum as amendment of poultry litters and its advantages alum reduces phosphorus solubility by as much as 99%, alum inhibits NH_3 volatilization from litter in poultry house, increased weight gains and improved feed conversion and these improvements in poultry performances make this one of the few cost-effective management practices that reduces pollution and increases productivity. (Moore *et al.*, 2000, Nichols *et al.*, 1997., Shreve *et al.*, 1995) [20].
Alum additions to poultry litter can decrease P solubility in poultry litter by orders of magnitude (Moore and Miller, 1994) [11]. Minerals formed when Al reacts with P are relatively stable, even at very low soil pH. Shreve *et al.* (1995) [20] found that P runoff from fescue plots fertilized with alum-treated broiler litter was 87% lower than plots fertilized with untreated litter.

Similar reduction in soluble P have been noticed in poultry litter when treated with Al, and or Fe compounds (Moore and Miller, 1994) [11].

Moore *et al.* (1995, 1996) [12, 13], which showed alum amendments to poultry litter could reduce NH_3 volatilization losses by as much as 99% compared with untreated litter. Subsequent work done by Moore *et al.* (1999) showed that alum applications to poultry litter resulted in significant improvements in broiler performance, due to lower ammonia levels in the production facility. The emphasis on studies quantifying emissions is primarily a response to impending regulations on animal production facilities. Annually, animal feeding operations release large quantities of NH_3, accounting for 50 to 70% of the total release in the United States (NRC, 2003) [17].

Material Methods

To carry out the present investigation, 200 day old straight run, commercial broiler strain "VENCOB" chicks were procured from a commercial hatchery. These 200 chicks were divided in four groups, i.e. Group 1, 2, 3, 4. Each group having 50 chicks. Out of four groups, litter material of three groups will be treated with alum in different concentrations and group 1 was served as control.

Group 1(C) served as control
Group 2(T1) treated with alum @ 0.085 kg/ bird
Group 3(T2) treated with alum @ 0.090 kg/bird
Group 4(T3) treated with alum @ 0.095 kg/bird

Each pen was equipped with new litter material, feeder and waterer. All the birds were raised on pucca floor with rice hulls as litter material. Chicks were reared under uniform managemental practices and were kept up to the age of 42 days for recording various observations.

Parameters recorded

Performance Index (PI)

Performance Index (PI) was calculated using the following formula:

$$PI = \frac{\text{Live body weight(Kg)}}{\text{Feed conversion ratio}} \times 100$$

Analysis of Litter material

The proximate analysis of feeds, faeces and residue was performed as per the method of Association of Official Analytical Chemist (AOAC, 2000) [1].

At the end of rearing subsamples of litter was collected from five locations in each pen.

pH

pH was determined with a 1: 5 L to deionized water ratio.

Moisture %

Moisture level of litter material was determined by dried weighed amount of sample in a moisture cup overnight at 100 ± 2^0C to a constant weight and calculated as

$$\text{Moisture\%} = 100 - \text{DM\%}$$

$$\text{Where DM\%} = \frac{\text{Weight of dried smple}}{\text{Weight of fresh sample}} \times 100$$

Nitrogen %

The nitrogen level in litter material were analysed by micro Kjeldahl method (AOAC, 1990) [2]. A suitable quantity of litter material were digested in the kjeldahl flask with concentrated sulphuric acid with a presence of catalytic digestion mixture (copper sulphate and sodium sulphate in 1:10); an acid blank was also run along with the samples for correction of any nitrogen contribution by acid itself. The digested sample was thus quantitatively transferred in to a volumetric flask with repeated washing with water. An aliquot (10 ml) was taken for the estimation of nitrogen using micro kjeldahl distillation apparatus. To neutralize the ammonia evolved during distillation 10 ml Tashiro's indicator was used which was again titrated with N/10 sulphuric acid. The nitrogen content was obtained by the formula.

$$\text{Nitrogen \%} = \frac{\text{volume of} \frac{N}{10} \text{sulphuric acid} \times 0.0014 \times \text{aliquot factor}}{\text{Weight of sample on dry matter basis}} \times 100$$

Statistical analysis

Statistical analysis of data was done by using SPSS 20.0 software. The data obtained were subjected to variance (ANOVA) and means were compared using Ducan's Multiple Range Test.

Results and Discussion

Performance Index

The overall performance index of broiler chicken in our experiment have been tabulated in Table 1. The data revealed that the overall performance index of control group and group T1 was non significant. As well as performance index of group C & group T2 was also statistically non significant. There was no significant difference observed between group T1 and group T2. As well as group T2 and group T3 was also non significant recorded. But there was significant difference recorded between control group and group T3. Overall least performance index of group T3 (96.26±1.57) was higher than other groups i.e. control group (89.20±2.15), T1 (92.53±1.99), &T2 (93.76±0.97).

Table 1: Overall performance Index of broiler under different treatments

Attributes	Performance Index
C	$89.20^a \pm 2.15$
T1	$92.53^{ab} \pm 1.99$
T2	$93.76^{ab} \pm 0.97$
T3	$98.26^b \pm 1.51$

*Means bearing different superscripts differ significantly ($P < 0.05$)

Analysis of litter material (pH, moisture%, & nitrogen%)

Analysis of litter material i.e. pH, moisture %, & nitrogen % of different groups at the end of experiment have been presented in Table 2.

Table 2: pH, moisture %, nitrogen % of litter under different treatments

Attributes	pH	Moisture %	Nitrogen %
C	$8.82^b \pm 0.02$	$35.79^d \pm 0.32$	$3.26^a \pm 0.03$
T1	$8.59^{ab} \pm 0.03$	$34.13^c \pm 0.57$	$3.58^b \pm 0.08$
T2	$8.34^a \pm 0.17$	$31.90^b \pm 0.06$	$3.92^c \pm 0.01$
T3	$8.46^{ab} \pm 0.02$	$28.27^a \pm 0.18$	$4.15^d \pm 0.03$

Means bearing different superscripts differ significantly ($P < 0.05$) column wise

pH

The Table 2 showed that there was no significant difference between pH of control group and group T1. But pH of control group and pH of T2 group was statistically significant. The least mean pH of T2 group (8.34±0.17) was less than least mean pH of control group (8.82±0.01). There was no significant difference observed between group T2 and group T3. The pH of T3 group and control group was statistically similar. Least mean pH of litter material of T2 group (8.34±0.17) was lowest among other groups i.e. control group (8.82±0.01), group T1 (8.60±0.03) & group T3 (8.47±0.02).

Moisture%

The Table 2. showed that there was significant difference observed between least mean moisture % of control group and group T1. Least mean moisture % of group T1 (43.13±0.57) was less than control group (35.79±0.32). Control group was also statistically differed from group T2. Moisture level of group T2 (31.90±0.06) was less than control group (35.79±0.32). As well as group T3 was also statistically differed from control group. Least mean moisture % of T3 (28.27±0.18) was less than control group (35.79±0.32). There was significant difference observed between group T1 & group T2, as well as group T2 & group T3. Lowest moisture level of litter material of group T3 was recorded.

Nitrogen%

The Table 2. Showed that there was significant difference observed between least mean nitrogen % of control group and group T1. Least mean moisture % of group T1 (3.58±0.08) was higher than control group (3.25±0.03). Control group was also statistically differed from group T2. Nitrogen level of group T2 (3.92±0.01) was higher than control group (3.25±0.03). As well as group T3 was also statistically differed from control group. Least mean nitrogen % of T3 (4.15±0.03) was higher than control group (3.25±0.03). There was significant difference observed between group T1 & group T2, as well as group T2 & group T3. Highest nitrogen level of litter material of group T3 was recorded.

Smith *et al*. (2004) [21] and Choi and Moore (2008) [5] indicated that the addition of dry Aluminium chloride ($AlCl_3$) and liquid Aluminium chloride ($AlCl_3$) to swine manure or poultry litter as top dressing or spraying reduces NH_3 volatilization. Moore *et al.* (2000) [15] observed that during the first three weeks NH_3 concentration in the alum-treated houses was 6 to 20 ppm, compared with 28 to 43 ppm in the control houses. Laboratory studies were conducted by Choi and Moore (2008b) [5] using dry alum, liquid alum, and high acid alum which are acidifying agents. These treatments when added to poultry litter for 42 days reduced NH_3 volatilization, with reductions ranging from 77 to 96% for two experiments. Likewise, the differences in reduced rate of NH_3 emission by litter amendment between our results and other published data could have contributed to the lower rate of alum that were top-dressed or incorporated with rice hulls. Fundamental effects on NH_3 release from broiler litter have been reported previously, in order of ascending influence, as moisture, temperature, and pH (Elliott and Collins, 1982; Carr *et al.*, 1990) [9, 4]. Elliott and Collins (1982) [9] reported that either extremely low or high litter moisture contents reduced NH_3 volatilization, but they found no valid correlation between litter moisture content and NH_3 levels for intermediate moisture contents. Because litter pH is normally greater than 8, Coufal *et al.* (2006) [6] cited temperature and moisture as the two most important variables affecting NH_3 volatilization in commercial facilities. In commercial broiler houses, temperature and moisture may be affected by a host of factors: housing design and management, bird age and health status, drinker management and maintenance, litter age and management, and ambient weather conditions (Coufal *et al.*, 2006) [6].

There has been several investigation on the use of alum as amendment of poultry litters and its advantages alum reduces P solubility by as much as 99%, alum inhibits NH_3 volatilization from litter in poultry house, increased weight gains and improved feed conversion and these improvements in poultry performances make this one of the few cost-effective management practices that reduces pollution and increases productivity. (Moore *et al.*, 2000, Nichols *et al.*, 1997., Shreve *et al.*, 1995) [20]. Moore *et al.* (1995, 1996) [12, 13], which showed alum amendments to poultry litter could reduce NH_3 volatilization losses by as much as 99% compared with untreated litter. Subsequent work done by Moore *et al.* (1997) [14] showed that alum applications to poultry litter resulted in significant improvements in broiler performance, due to lower ammonia levels in the production facility. The emphasis on studies quantifying emissions is primarily a response to impending regulations on animal production facilities. Annually, animal feeding operations release large quantities of NH_3, accounting for 50 to 70% of the total release in the United States (NRC, 2003) [17] Alum additions to poultry litter can decrease P solubility in poultry litter by orders of magnitude (Moore and Miller, 1994) [11]. Minerals formed when Aluminium (Al) reacts with Phosphorus (P) are relatively stable, even at very low soil pH. Shreve *et al.* (1995) [20] found that P run off from fescue plots fertilized with alum-treated broiler litter was 87% lower than plots fertilized with untreated litter. Similar reduction in soluble P have been noticed in poultry litter when treated with Al, and or Fe compounds (Moore and Miller, 1994) [11].

Ruszler and Carson (1974) [19] reported that moisture releasing capacity is a more important factor than moisture absorbing capacity. Particle size of litter material affects moisture releasing capacity of litter. Litter materials with smaller particle size have a little tendency to absorb and maintain the moisture

Elliott and Collins (1982) [9] reported that either extremely low or high litter moisture between litter moisture content and NH_3 levels for intermediate moisture contents. Fundamental effects on NH_3 release from broiler litter have been reported previously, in order of ascending influence, as moisture, temperature, and pH (Elliott and Collins, 1982; Carr *et al.*, 1990) [9, 4].

Conclusion

Overall performance index was significantly higher in T3, followed by T2, T1 and control groups. Litter pH of control group was significantly higher than treatment groups which were non significant among one another.

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