Ammonia Emission Rates of Paddy Husk-based Broiler Litter Exposed to Different Artificial Lighting Environments

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ABSTRACT
High atmospheric ammonia is detrimental to poultry health. Objective of the study was to investigate the potential to reduce ammonia emissions (AE) from broiler litters by managing intensity of red light (RD). Light treatments, T1 (high intensity RD [HI]; 320 lux), T_2 (medium intensity RD [MI]; 20lux), T_3 (dim intensity RD [DI]; 5lux); T_4 (white/ control [CN]; 20 lux), T_5 (negative control [-ve CN]; 0 lux) were randomly arranged in a complete randomize design with 6 replicates each. Three litter samples were taken from each cage on 36d. Litter samples taken from each cage were pooled and analyzed for moisture, pH and AE. Litter samples were incubated for 5h, and the emitted NH_3 was trapped with boric acid and then titrated with HCl to determine the AEs. Significantly the highest AE (26.29±1mg/kg/hour) was recorded from high intensity-RD exposed litter. Medium Intensity-RD (20.09±3 mg/kg/hour) and dim intensity-RD (18.56±1mg/kg/hour) exposed litters received second and third places, respectively. NH_3 emission rate of control (7.67 ±1mg/kg/hour) showed significantly lower value ($p<0.05$) compared to RD intensity treatments. Significantly the lowest ($p<0.05$) amount of NH_3 (3.6± 1mg/kg/hour) was emitted by the negative control treated litter. There was a relationship between moisture % and AE. The highest AE was marked with the lowest moisture (47.14±12) in high intensity- RD light treatment. Among RD light treatments, the lowest AE was marked with the highest moisture (55.47±13) in dim intensity-RD. However pH values did not show any correlation with the AE rates. To conclude, light management can be used to reduce ammonia emission from broiler litters. Dim intensity-RD is effective in minimizing NH_3 emission. Keeping birds in dark also minimizes ammonia emission.

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Introduction

Ammonia is a major aerial pollutant of poultry buildings. Ammonia emissions from commercial poultry houses have been of concern to the poultry industry for several years that can not only cause environmental problems, but also detrimental to health, welfare and performance of birds. High ammonia concentrations in poultry houses reduce growth rate (Moor *et al.* 1999), feed efficiency (Caveny, 1978) and egg production (Deaton *et al.*, 1984). Ammonia is a known respiratory irritant, with occupational limits set at 50 ppm for the 8h permissible exposure limit, and 300 ppm is considered immediately dangerous to life and health of the birds. The current exposure limits for ammonia of 25 ppm are set on the basis of human safety rather than animal welfare (Kristensen and Watches, 2007).However, recommended ammonia concentration in broiler houses is 25 to 50 ppm.

Ammonia is formed from the breakdown of nitrogenous waste (undigested proteins and excretory uric acid) in poultry manure by micro-organisms. Factors that directly control the ammonia formation are moisture level, temperature and pH of the litter (Carr *et al.*, 1990). Various dietary manipulations and chemical litter amendments have been found to reduce the ammonia emission of poultry. However AE under different light environments for broilers has not been much focused for investigation.

Red light (RL) showed higher preference, improved weight gain (WG) compared to green, blue and white colour lights in broilers (Senaratna *et al.*, 2010). Further, improved WG and reduced behaviours were recorded by dim intensity RL and the use of white light at dim intensity for commercially housed broilers is common. However, high intensity RL improved behaviour of birds in relation to higher scratching floor behavior (Senaratna *et al.*, 2016). It is hypothesized that active birds engaged in more scratching floor behavior elevates ammonia emission by losing litter material. The objective of the study was to compare ammonia emission rates by the paddy husk litter exposed to different red light intensity environments.

Methodology

Birds, Rearing Environment and Experimental Protocol

Hundred day old broiler chicks (strain Cobb) (unsexed) were obtained from a local hatchery and were brooded under normal brooding light up to 14 days. On 14 d, birds were weighed (avg. 471.45 ±29) and 3 birds were randomly assigned per experimental cage (3'x 2'). Light treatments; T_1 (High intensity [HI]; 320 lux RD), T_2 (Medium Intensity [MI]; 20lux RD), T_3 (Dim Intensity [DI]; 5lux RD); T4 (Control [CN]; 20 lux white [WT), T_5 (negative control [-ve CN]; 0 lux) were randomly arranged in a complete randomize design with 6 replicates each. All treatments received artificial light from 2200 hours to 1800 hours and the light break was given from 1800 hours to 2200 hours. Birds were exposed to different light environments during 15-35d and were fed with commercial feed according to their age specifications.

Avoiding the areas around the feeders and drinkers, 3 litter samples were taken from 3 randomly selected places of each cage on 36 day using a co-sampler. Three sub samples taken from each cage were pooled and analyzed for litter properties. Litter ammonia emissions were determined as described by Moore *et al.,* (1996), with slight modifications in arranging the apparatus. Two hundred and fifty grams of fresh litter samples were weighed into conical flasks. Flasks were equipped with air inflow and outflows. The samples were incubated at 30 °C for 5 hours. Air was continuously passed through each flask, and ammonia volatilization from litter samples in conical flask was trapped in 100ml of 0.32N H_3BO_4 solutions. The trap was titrated with 0.1N HCL to determine the ammonia emission. The emission rate was calculated as milligrams of ammonia emitted /kilogram of fresh litter/hour.

Moisture content of the litters exposed to different intensities of RD light were assessed by the Gravimetric method as a percentage of oven dry weight basis. Three composite sub samples of about 50-100 g of litter from each replicate sample were placed into moisture cans of known weights. Then the moist samples were weighed immediately. Then they were dried in a forced drying oven at 105°C for 8 hrs to reach constant weights which were obtained after cooling in desiccators. pH values of the samples were determined by preparing 1:5 suspension. Litter samples of 5g sieved through 2mm mesh, air dried and there after 25 ml of de-ionized water was added. The litter suspension was stirred (1:5 v/v soil: water) and reading was taken after calibrating the instrument with standard pH values of pH 4 and pH 5.

Statistical Analysis

Data were tested for normality prior to statistical analysis using the Statistical Analysis Software. The data were subjected for the interpretation of results using one way analysis of variance technique with completely randomized design. Treatment means were compared by Duncan Multiple Range Test.

Results and Discussion

Rate of AE, litter moisture and pH in relation to different light treatments are shown by Table1. The emission of NH_3 (mg/ kg/ hour) was significantly ($p<0.05$) different among treatments and the highest emission (26.29 ±1mg/kg/hour) was recorded from high intensity-RD exposed litter. Medium intensity-RD (20.09 ±3mg/kg/hour) and dim intensity-RD(18.56±1mg/kg/hour) exposed litters received second and third places, respectively. Rate of AE by the control (7.67% ±1mg/kg/hour) showed significantly ($p<0.05$) lower value compared to RD intensity treatments. Significantly the lowest amount of ammonia (3.6%± 1mg/kg/hour) was emitted by the negative control treated litter.

Table 1: Litter chemical properties and ammonia emission under different light treatments

Litter quality parameter	Treatment				
	High Intensity (320 lux)	Medium Intensity (20 lux)	Dim Intensity (5 lux)	Control/ White (20 lux)	Negative Control (0 lux)
Moisture (%)	47.14^{c} ±12	50.56^{b} ±16	55.47^{a} ±12	53.58^{a}±11	55.31^{a} ±18
pH	8.19± 3	8.04± 4	8.23± 2	8.29±3	8.15± 2
Ammonia Emission Rates (mg/kg /hr)	26.29^{a} ±8	20.09^{b} ±6	18.56^{b} ±5	7.66^{c}±3	3.61^{d}± 2

^{a,b,c} Means within a raw bearing different superscripts are significantly ($p<0.05$) differ

The reasons for higher rate of AE from HI-RD may be on a one hand slight heat increment associated with HI. As the birds were more active under HI-RD(Senaratna *et al.*,2016), more active birds might have loosen the litter particles by scratching floor like behaviors further enhancing more AE. As emission of higher ammonia is not favorable for the birds that leads to respiratory problems and also for lesions, DI

is more favorable among RD light treatments. There was a relationship between moisture % and AE. HI-RD exposed litter showed significantly lower moisture % compared to other treatments. Slight increment of the heat associated with the HI-RD would have been contributed to dryness of the litter by showing the lowest moisture percentage in HI treated litter. HI marked lowest moisture % and the highest AE further proving our findings, Effect of litter moisture level on ammonia emission is inconclusive. Ammonia emission has been found to be positively and negatively (Carr *et al.,* 1990) correlated with litter moisture content. However pH values did not show any correlation with the AE rates in this study.

The recommended AE rate for paddy husk-based broiler litter is 21.25 mg/kg of litter per hour (Carr *et al.,* 1990). In the current study HI exposed birds emitted ammonia comparatively at a higher rate (26.29%±1mg/kg/hour) that is exceed the accepted level whereas the other treatments emitted ammonia at a lower rate. Ammonia is generated from the microbial breakdown of nitrogenous waste products in poultry manure. Higher temperature, pH, and moisture levels of litter have found to increase the conversion of manure N into ammonia (Carr *et al.,* 1990). Further supporting our findings Carr *et al.,* (1990) found that as litter pH normally exceeded 8, litter moisture and temperature were the two most important factors affecting the variability of AE in a poultry house. Though white colour light resulted lower AE compared to the RD colour treatments, the early findings (Senaratna *et al.,* 2016) showed that RD colour treated birds at DI showed superior performance over WT.

In conclusion, light management can be used to reduce ammonia emission from broiler litters. Dim intensity (5lux) is effective to minimize ammonia emission. Keeping birds in dark also minimize ammonia emission.

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