Effect of the coconut-shell biochar incorporation on ammonia emission from broiler litter

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Introduction

Emission of ammonia from poultry litter has a range of environmental, economic and social impacts. Ammonia is formed due to the microbial conversion of nitrogenous compounds mainly uric acid present in faecal materials and wasted feed material. Though some litter amendments are proven to reduce the emission of ammonia from poultry litter, high cost and less availability of these amendments have limited the use of them. Therefore, cheap litter amendments are needed. A number of studies (Linhoss *et al*., 2019; Ritz *et al*., 2011) have attempted to use biochar as a litter amendment under various conditions. This study determined the effects of coconut shell biochar (CSB) as a litter amendment on broiler growth performance, welfare and ammonia emission from litter.

Methodology

Chicks (Cobb, male) were brooded until day 10 and thereafter, 360 birds (body weight=273±4.5g) were randomly allocated into 30 floor pens on day 11. 330g of paddy husk per bird was provided for each pen at the beginning of the experiment. Biochar was produced from partial burning of coconut-shell. Biochar was washed with running water to reduce to its pH from 9.2 to 7.2, dried and grinded. pH and carbon content of grinded biochar were 8.2 and 56%. Litter was amended with CSB at 0, 2, 4, 6 and 8% on w/w basis. The total amount of biochar of each pen was applied in two split doses; day 20 (34%) and day 31 (66%). Birds were fed *ad libitum* with a commercial broiler feed and clean water. Feed and water consumptions were recorded daily. On day 40, two randomly selected birds from each pen were inspected and scored for the level of foot pad dermatitis, hock burn damage and breast blister. Birds were reared until day 42 and weighed weekly. At the end of the experiment, one bird from each cage was randomly selected and slaughtered to determine the carcass weight. Final litter weight of each pen was taken. Litter samples were collected on day 42 for the determination of moisture, pH and nitrogen level. Moisture content was determined using oven dry method. Nitrogen contents of the litter samples were determined using Kjeldahl method. Ammonia emission was determined using mass balance method (von Bobrutzki *et al*., 2013). Data were statistically analyzed as a completely randomize design, using SPSS. Welfare scores were analyzed using Kruskal-Wallis test. Other parameters were analyzed using GLM procedure.

Results

Feed intake, live weight, FCR and the dressing percentage were not significantly affected (P>0.05) by the litter biochar amendment level (Table 1). Litter moisture (46.6 - 51.4%) and N (4.1- 4.3%) content and the incidence of foot pad dermatitis, hock burn damages and the breast blisters were not significantly different (P>0.05) among the treatments.

Table 1. Growth performance of broilers reared on litter amended with coconut shell biochar at four levels

Growth parameters	Biochar amendment levels (%)					SEM	P value
	0	2	4	6	8		
Feed Intake (g)	2974	3001	2807	3013	3019	100.5	0.54
Live weight (g)	2390	2334	2330	2347	2292	90.31	0.96
Feed Conversion Ratio	1.73	1.82	1.70	1.80	1.88	0.05	0.21
Dressing percentage	74.31	75.75	77.40	75.46	75.39	0.97	0.27

Of the 59.6 g of N inflow per kg of bird (Table 2), feed accounted for 76.2%, followed by day old chicks (22.5%) and the paddy husk (2.3%).

Table 2. Nitrogen budget of broilers reared on litter amended with coconut shell biochar at four levels

Nitrogen Content (g N / kg bird)	Treatments (Biochar levels in %)					SEM	P value
	0	2	4	6	8		
N inflow (g N/kg bird)							
Initial Bird	14.00	13.43	13.50	13.11	13.19	0.36	0.946
Feed	46.32	45.83	44.04	45.44	46.09	1.26	0.729
Litter	0.73	0.69	0.71	0.68	0.69	0.05	0.940
Total Input	61.05	59.94	58.24	59.23	59.97	2.04	0.902
N outflow (g N/kg bird)							
Final bird	29.37	29.58	29.55	29.51	29.61	0.27	0.975
Mortality birds	1.85	0.32	1.61	0.95	0.29	0.63	0.295
Litter	16.04	16.04	15.47	15.53	16.57	0.93	0.916
Loss to environment	13.79	14.00	11.60	13.25	13.50	1.42	0.769
NH_3 g/ kg bird	16.75	17.00	14.09	16.09	16.40	1.719	0.769
% feed N export							
Final Bird	48.5	49.49	51.05	49.90	49.42	1.270	0.735
Mortality bird	2.8	0.49	2.73	1.50	0.45	1.015	0.286
Final litter	26.33	26.80	26.52	26.17	27.64	1.306	0.937
Loss to Environment	22.20	23.22	19.70	22.43	22.49	1.876	0.725

The total N outflow (g N/ kg bird) with final live weight, mortalities, spent litter and as gaseous losses were also not affected by the litter biochar levels. The mean N outflow with final live weight, mortalities and spent litter were 29.5, 1.0 and 15.9 g N/kg bird while the balance between the total N in and the sum of above three outflow sources (13.2 g N/kg bird) was estimated as gaseous N losses. Percentage partitioning of feed N among final live weight, mortalities, spent litter and gaseous losses were also not affected ($P>0.05$) by the litter amendment levels. On average 49.6, 1.5, 26.6 and 22.0% of the feed N were exported with final live weight, mortalities, spent litter and as gaseous losses. The estimated emission of ammonia from the litter was also not affected ($P>0.05$) by the amendment level. The mean NH_3 emission rate was estimated to be 16 g /kg bird.

Discussion

Growth performance levels were similar to those reported under normal open house conditions. Absence of any adverse effects on growth performance, litter qualities and welfare parameters such as foot pad dermatitis, hock burn damages and breast blisters indicates the suitability of biochar as a litter amendment, if it reduces the NH_3 emission. Our findings related to growth and welfare parameters are in line with those with Linhoss *et al*. (2019). Contrary to our findings, Linhoss *et al*. (2019) observed that the application 10 - 20% biochar for wood shaving litter reduced the litter moisture level.

The percentage of N accumulated in live broilers and litter and, that lost as gasses were similar to those values reported by Patterson *et al*. (1998). N losses as gasses reported in literature range from 21 to 3% (von Bobrutzki *et al*., 2013). Even under Sri Lankan closed house conditions, Atapattu *et al*. (2016) reported lower N losses with litter (21%) and as gasses (13%). Unless properly disposed and utilized, N accumulated in spent litter causes numerous social and environmental issues such as NH_3 emission, odour problems and water pollution. Therefore, improvement of feed N utilization efficiency has been identified as a critical aspect for the environmental and social sustainability of broiler production.

As in the present study, Ritz *et al*. (2011) found a reduction in NH_3 emission from the litter amended with acidified coconut husk char and pine chip char, but not with the normal peanut hull char. NH_3 reduction was related to the litter pH reduction. Biochar at the time of application of this study was 8.2. Therefore, acidification of char and/or increased application rates is/are suggested. Nevertheless, results of this study found that the emission of NH_3 from litter of open house conditions is as high as 16 g of NH_3/ kg bird. The corresponding value for Sri Lankan closed house condition was as low as 6.1 g NH_3/kg.

Conclusions

Amendment of broiler litter with coconut shell biochar at 2-8% had no effect on growth performance, welfare parameters and ammonia emission. Loss of feed N with spent litter and as gaseous was found to be as high as 26.6 and 22%, respectively. Under Sri Lankan open house conditions, emission of NH_3 from litter was found to be as high as 16 g/ kg bird. The study highlights the importance of improving N utilization efficiency of the broilers, reducing NH_3 emission from litter and proper disposal and utilization of spent litter, for the sustainable broiler production.

References

ATAPATTU, N. S. B. M., GUNAWARDANA, W. W. D. A., ABEYWICKRAMA, L. M. AND MUNASINGHE, M. (2016) Nitrogen Budget of Broiler Production under Closed-House Management Conditions, Proceedings of the 22nd International Forestry and Environment Symposium. 43.

LINHOSS, J. E., PURSWELL, J. L., STREET, J. T. AND ROWLAND, M. R. (2019) Evaluation of Biochar as a Litter Amendment for Commercial Broiler Production. *Journal of Applied Poultry Research* **28(4):** 1089-1098.

PATTERSON, P. H., LORENZ, E. S., WEAVER, W. D. AND SCHWARTZ, J. H. (1998) Litter Production and Nutrients from Commercial Broiler Chickens. *Journal of Applied Poultry Research* ***7*(3):** 247-252.

RITZ, C. W., TASISTRO, A. S., KISSEL, D. E. AND FAIRCHILD B. (2011) Evaluation of Surface-Applied Char on the Reduction of Ammonia Volatilization from Broiler Litter. *Journal of Applied Poultry Research* **20:** 240–245.

VON BOBRUTZKI K., AMMON C., BERG W. AND FIEDLER M. (2013) Quantification of Nitrogen Balance Components in a Commercial Broiler Barn. *Czech Journal of Animal Science*. **58:** 566 – 577.a