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Development of environmentally safe composting method of broiler litter for use as feed and biofertilizer

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Abstract: The experiment was carried involving three treatments viz. anaerobic composting broiler litter (T_1), broiler litter with slurry (T_2) and broiler litter with earthworm (T_3) under soil surface to develop a convenient method of composting broiler litter. The sample from composted materials was collected at 0, 20, 40 and 60 days for proximate analysis. Dry matter (DM), ash and nitrogen free extract (NFE) were gradually decreased with the increase of days of composting in every method and also significantly ($p<0.01$) differed among the treatment. Incase of crude protein (CP), crude fibre (CF) and ether extract (EE), significant ($p<0.01$) differences were observed among treatments and found increasing rate with prolonged composting. Finally, it may be concluded that proximate compositions of all samples were acceptable up to the end of composting period. But T_2 was more effective than other treatments. So, it could be used as supplementary animal feed or fish feed and also used in vegetables field, nursery, tea garden, betel leaf fields and homestead gardens to improve the soil quality for successful crop production without degradation of environment.
Key words: Broiler litter, composting method

Introduction

Commercial poultry industry is growing rapidly in Bangladesh. It is reported that broiler population is increasing at the rate of 22.93% (2000-2005) per year and there are over 198.522 million broilers in the country (WPSA-BB, 2007). According to FAO (2002) there were approximately 22,570 commercial poultry farms having 84,10,000 layers and 57,84,500 broilers in 2001 in Bangladesh. These large number of broiler farms are producing approximately 4474 tons of excreta every day (1.63 million tons every year). Moreover, due to the lack of proper disposal system, the voluminous excreta is creating environmental and health hazards and foul smell near and adjoining areas of the poultry farms. As a result local communities are complaining against these poultry farms, which in the long run may become threat to the sustainability of poultry industries in Bangladesh.

Broiler litter are the wastes arising from human and animal activities that are normally solid and are discarded as useless or unwanted (Peavy, 1985). The amounts of broiler wastes are increasing day by day with the rapid increase of its population especially in urban areas. So, broiler waste creates an endangered situation for waste management in urban life and deteriorates the daily life of people with the loss of economy and environment. High consumption rate of broiler accelerates the production of broiler waste. Small-scale decentralized community-based composting plants are a more suitable option for treating broiler waste as they reduce transport costs, make use of low-cost technologies, based mainly on manual labour, and minimize problems and difficulties encountered with backyard composting (Sinha, 2004). Processing of broiler waste into compost in a decentralized manner had long been an unexplored sector in Bangladesh.

The present research work was, therefore, planned to develop a cost effective, easy and quick composting method for the proper management of broiler litter, pre and post treatment evaluation of broiler litter and to determine the utility of the post treated broiler litter.

Materials and methods

The research was conducted at the Department of Animal Science, Bangladesh Agricultural University, Mymensingh. The broiler litter was collected from a private broilers farm Boyra, Mymensingh for a period of 5 weeks. The broiler litter was carried into sac at the Animal Science Field Laboratory and stored in air tight condition. A place of comparatively high land at Animal Science Field Laboratory was selected to prepare holes where rain water was not logged. At first the place was cleaned and then 9 similar holes were prepared whose diameter was 21 inch and depth 11 inch. After collection the broiler litter was mixed properly and divided in 3 parts at the rate of 30 kg and then three treatment were practiced i.e., only broiler litter in one part (T_1), 3kg slurry mixed with another part (T_2) and 750g earthworm mixed with rest of the part (T_3).

Every treated and untreated broiler litters was divided into 3 equal parts for three replications and filled the previously marked holes located in the Animal Science Field Laboratory, covered with three inches soil layer and kept for composting for 60 days. During this composting period, average hole temperature was recorded at 32^0C which was very much comfortable to production of compost. The process of composting emitted very little odor. The samples were taken at 0, 20, 40 and 60 days for physical and chemical analysis. Representatives samples broiler litter with and without treatments before and other composting were analyzed in the laboratory of Animal Science Department and Bangladesh Institute of Nuclear Agriculture (BINA) for the determination of dry matter (DM) organic matter (OM), crude protein (CP), Crude fibre (CF), ether extract (EE), ash according to AOAC (1990). All the samples were analyzed in duplicate and mean values were recorded. The data were analyzed following factorial design in Completely Randomized Design (CRD) (Steel and Torrie, 1980) and mean

values were tested for difference with Standard Error of Mean (SEM) using statistical package MSTAT-C program. Mean values were tested with DMRT (Duncan's Multiple Range Test).

Results and discussion

Nutrient content of broiler litter was observed in this experiment that dry matter, ash, protein, fat, CF and NFE of fresh broiler litter (0 day) was 86.33%, 15.89%, 17.48%, 1.87%, 18.14% and 46.20%, respectively (Tables 1 to 6). The proximate component of pre-decompost broiler litter was almost similar to the values reported by Van Ryssen, 2000.

Effect on dry matter

At the end of 60 days of composting, the dry matter value reduced to 37.13, 39.10 and 40.10% in T_1, T_2 and T_3 respectively (Table 1) and differed significantly ($p<0.01$). The initial dry matter value was 86.33, 87.10 and 86.33% in treatment T_1, T_2 and T_3 respectively. The highest in T_2 and lowest in T_1 and T_3. DM content of compositing materials were decreased with the increase of composting duration up to 60 days. There was a change of dry matter content in first 60 days. Dry matter content decreased with the increase of composting period. The similar trend of result were also observed by Adeley and Kitts (1983) and Muller (1982) who reported that an increased in moisture content and length of composting period, therefore, decrease the dry matter content of poultry droppings. The composting processes in the present study was done during the rainy season (May to June) into soil hole might be increased the moisture content and decreased the dry matter percent of the composting materials.

Effect on crude protein

Crude protein content of different compost is shown in Table 2. The crude protein content of T_1, T_2 and T_3 at 0 day was 17.48, 17.12 and 17.48% respectively. At the end of 60 days of composting crude protein values were 29.10, 33.77 and 31.33 respectively, which differed significantly ($p<0.01$). The higher value of CP was found in T_2 and lower in T_1. It could be assumed that CP content increased with the increase of composting duration and also influenced positively by the treatment of earthworm and slurry. The highest CP content of 33.77% in T_2 at 60 days and lowest CP content of 17.12% in T_2 at 0 days. The findings of the present research are inconsistent with the result of Coddling (2006) who obtained broiler litter nitrogen efficiencies increased from 10 to 49%. Taufik *et al.* (1997) found that the carbon content of the compost decreased during the composting process, while N, K and N content increased which support the present result. Whereas, Abdelmawa *et al.* (1988) observed that CP% decreased when composted by staking. However this type of variation may depends upon classes of poultry, levels of nutrition and degree of decomposition of poultry manure.

Effect on crude fibre

Table 3 showed that maximum CF in T_1 at 60 days and lowest in T_3 at 20 days and the difference varied significantly ($p<0.01$) among the treatments. The crude fibre content at 0 day was in the range of 18.14 to 18.60% was high in T_2 and low in T_1 and T_3. At the end of 60 days of composting CF values were in the range of 19.30 to 21.07%, maximum in T_1 and minimum in T_3. There was a little change in CF content in all samples until 60 days of composting. A high crude fibre content is indicative of a high proportion of bedding in the litter and thus a lower total digestible nutrient content (TDN) (Jacob *et al*., 1997). It was also stated that as more flocks of broilers are grown on the litter, total fibre in the litter decreases.

Effect on ether extract

Ether extract content of different compost was shown in Table 4. The EE content of 0 day was in the range of 1.20 to 1.87% was higher in T_1 and T_3 and lower in T_2. At the end of 60 days composting EE values were in the range of 2.33 to 3.97% (maximum in T_2 and minimum in T_1) and showed significant difference ($p<0.01$) among the treatments. The highest EE content was 3.97% in T_2 at 60 days and lowest was 1.20% in T_2 at 0 days. The increased EE content may be resulted from prolonged composting period. The present observation is more or less similar to the findings of several researcher (Bhattacharya and Taylor, 1975 and Sikka, 1990) and they obtained initial EE content of the broiler litter were 1.18 to 1.20.

Effect on ash

There were changes in ash content (Table 5) of the samples and the difference was significant ($p<0.01$) among treatments. The initial value of ash ranged from 15.89 to 17.70%. At the end of 60 days composting ash content were 7.03 to 8.23%. The highest ash content 17.70% in T_2 at 0 day and lowest ash content was 7.03% in T_2 at 60 days. The findings of the present study contradicted with the observation of Jacob *et al.* (1997) who found that composting reduced organic matter in the litter that raises the ash content. But Zindel and Flegal (1970) stated that, due to high proteolytic activity of wet faecal waste results the rapid loss of nitrogen and organic matter and the subsequent increase of mineral matter.

Effect on nitrogen free extract

The NFE values were also calculated at every 20 days interval up to the end of composting period and the results are presented in Table 6. The initial value NFE ranged from 45.47 to 46.20%. At the end of 60 days of composting NFE content was 35.23 to 40.06%. There was little change in NFE content of the sample and significant ($p<0.01$) difference was observed among the treatments. The highest NFE content was 47.30% in T_1 at 20 days and lowest NFE content was 35.23% in T_2 at 60 days. The result also supported by Sikka (1990) who stated that the NFE content of the composted broiler litter was 38.36%.

Table 1. Effect of slurry and earthworm on dry matter content (% on DM basis) of broiler litter compost at different days

Treatment	T_1	T_2	T_3	Mean	SEM
0 Day	86.33	87.10	86.33	86.59^{a}	0.132
20 Days	55.00	60.13	61.97	59.03^{b}	0.060
40 Days	43.03	44.97	48.10	45.37^{c}	0.092
60 Days	37.13	39.10	40.10	38.78^{d}	0.129
Mean	55.37^{c}	57.83^{b}	59.13^{a}	-	-
SEM	0.108	0.111	0.090	-	-

Table 2. Effect of slurry and earthworm on crude protein content (% on DM basis) of broiler litter compost at different days

Treatment	T_1	T_2	T_3	Mean	SEM
0 Day	17.48	17.12	17.48	17.36^{d}	0.257
20 Days	18.03	19.70	19.00	18.91^{c}	0.107
40 Days	25.03	26.03	26.90	25.99^{b}	0.060
60 Days	29.10	33.77	31.33	31.40^{a}	0.178
Mean	22.41^{c}	24.16^{a}	23.68^{b}	-	-
SEM	0.121	0.139	0.192	-	-

Table 3. Effect of slurry and earthworm on crude fibre content (% on DM basis) of broiler litter compost at different days

Treatment	T_1	T_2	T_3	Mean	SEM
0 Day	18.14	18.60	18.14	18.29^{b}	0.103
20 Days	18.40	18.70	18.03	18.38^{b}	0.125
40 Days	19.20	19.20	18.60	19.00^{b}	0.096
60 Days	21.07	20.07	19.30	20.15^{a}	0.097
Mean	19.20^{a}	19.14^{a}	18.52^{b}	-	-
SEM	0.082	0.109	0.126	-	-

Table 4. Effect of slurry and earthworm on ether extract content (% on DM basis) of broiler litter compost at different days

Treatment	T_1	T_2	T_3	Mean	SEM
0 Day	1.87	1.20	1.87	1.65^{b}	0.049
20 Days	2.10	2.77	2.27	2.38^{ab}	0.071
40 Days	2.20	3.10	2.80	2.70^{ab}	0.072
60 Days	2.33	3.97	3.50	3.27^{a}	0.101
Mean	2.13^{c}	2.76^{a}	2.61^{b}	-	-
SEM	0.070	0.078	0.071	-	-

Table 5. Effect of slurry and earthworm on ash content (% on DM basis) of broiler litter compost at different days

Treatment	T_1	T_2	T_3	Mean	SEM
0 Day	15.89	17.70	15.89	16.49^{a}	0.084
20 Days	14.17	15.17	13.87	14.40^{b}	0.081
40 Days	8.07	10.13	10.47	9.56^{c}	0.070
60 Days	7.44	7.03	8.23	7.57^{d}	0.091
Mean	11.39^{c}	12.51^{a}	12.12^{b}	-	-
SEM	0.070	0.089	0.085	-	-

Table 6. Effect of slurry and earthworm on nitrogen free extract content (% on DM basis) of broiler litter compost at different days

Treatment	T_1	T_2	T_3	Mean	SEM
0 Day	46.20	45.47	46.20	45.96^{a}	0.131
20 Days	47.30	43.90	46.83	46.01^{a}	0.231
40 Days	45.50	41.53	41.23	42.75^{a}	0.158
60 Days	40.06	35.23	38.73	38.01^{b}	0.507
Mean	44.77^{a}	41.53^{c}	43.25^{b}	-	-
SEM	0.149	0.153	0.468	-	-

Mean values superscript with similar alphabet row and column do not differ significantly ($p<0.01$)
T_1 = Only broiler litter; T_2 = Broiler litter with slurry and T_3 = Broiler litter with earthworm

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