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Research Article

Safe Management of Litters in Poultry Housing Systems in the Rural Area

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ABSTRACT

This study elucidates the present scenario of poultry litter management practices and development of a technique for safe management of litter at farmer's level. Survey-based data were collected through pre-tested questionnaires from some purposively selected 42 poultry farms erected within the areas of Mymensingh, Gazipur, Netrokona, and Jamalpur districts. A large amount of poultry litters were generated from broiler and layer farms daily. Most of the farmers dumped this litters in open places (50%) which caused a serious environmental and health hazards. A self-aerated composting technique was designed and developed to effectively manage and mitigate the environmental and health hazards evolving from poultry litters. A compost heap was prepared with rice straw, water hyacinth, and poultry litters with the proportion 1:2:4 respectively by weight at the optimum C:N ratio of 30:1 incorporating the provision for air entraining into the bulk compost heap. Temperature and moisture contents at time interval of three days, and pH, C/N ratio, volume, and microbial properties at time interval of seven days were observed throughout the composting period of 60 days. Analysis was accomplished taking representative samples from the compost heap using the random sampling technique. The quality of compost in terms of nitrogen, phosphorus, potassium, and organic carbon was evaluated in accordance with the Indian and Australian Standards. This technique is found environmentally safe, functional and cost-effective. The developed self-aerated composting technique would be an alternative option for safe management of poultry litters for the farmers in the rural areas.

Introduction

There are over 150,000 poultry farms in Bangladesh (Star Business Report, 2017). Poultry sectors in Bangladesh currently produces 1.5 to 1.6 percent of the country's GDP (Karmoker, 2022). About 4.52 million tonnes of fresh poultry litter waste is produced annually in Bangladesh (Rahman et al., 2022). Due to the conventional system of litter management, it subsequently ferments and produces gales and pollutes the environment by spreading foul odor (Anderson et al., 2021). Poultry litter excretes several contaminants such as pathogenic microorganism e.g. bacteria, fungi, viruses, parasitic protozoa, and pathogenic microbes with antibiotic-resistant genes; hormones, heavy metals and pesticides (Jenkins et al., 2015). Leaching and runoff of these substances have resulted in contamination of surface water and groundwater resources (Hubbard et al., 2020). Also, greenhouse gas emissions in the form of nitrous oxide from poultry litter affect the environment by reducing air quality and changing climate as well as production problems for the owners (Anderson et al., 2021). Food-borne diseases are other major issues associated with poultry litter management (Hafez et al., 2019).

The poultry litter is rich in macronutrients, nitrogen (3-5%), phosphorus (1.5-3.5%) and potassium (1.5-3.0%), also contains calcium, magnesium, sulfur, and micronutrients (Amanullah et al., 2010). The high nitrogen and balanced nutrients are the reason that poultry litter compost is the best kind of organic fertilizer to use. Benefits of poultry litter composting return essential macro and micro nutrients and organic matter to the soil; building soil fertility, also reduction in land-filling problems; biodegradation of toxic compounds; and other organic contaminants (Gomez, 1998; Sesay et al., 1997). Among the various processes used to manage poultry litter (e.g. land-fill, incineration), only the biological process of composting results in the stabilization of poultry litters, allowing a more complete recovery of resources and alternative use endpoints (Beffa et al., 1996b; Finstein et al., 1983).

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Composting is a simple, natural, aerobic process that produces a uniform, stable, odorless soil-like material called compost. The microorganism involved in composting requires balanced sources of organic materials, C/N ratio, oxygen and water to produce compost. Composting process is carried out by the microorganisms which multiply using carbon and nitrogen respectively as energy and nutrient sources.

A successful composting needs some cardinal parameters: Oxygen concentration (5-15%); Temperature (Thermophilic: 40-60^{0}C Mesophilic: 20-40^{0}C); pH (5.5-9.0); C/N ratio (25:1-30:1); Moisture Content (40-60%); Time (15 days to 4 months) (Walker, 2004). Several successful studies were conducted on pile composting (Jouraiphy et al., 2005; Huang et al., 2004), windrow/agitated pile composting (Dhal et al., 2012; Dhal et al., 2011), Novocom composting (Seal et al., 2012), Pilot scale rotary drum composter (Singh et al., 2012), Forced-aeration pile composting (Tiquia & Tam, 2002). To compost, fresh poultry litter should be mixed at different ratio of carbon and nitrogen source. The carbon source is also needed to be a bulking agent that facilitates the aeration of the compost heap, reducing the moisture content and controlling the initial C/N ratio. The C/N ratio of 30:1 is a *sine qua non* for effective composting. The abundance of rice straw as an organic waste can be used as a bulking agent (Sidhu & Beri, 2008). Water hyacinth is also an organic material that has a nutrient content of nitrogen 0.28%, phosphate 0.0011%, and potassium 0.016% and can be used as a nitrogen source for good quality compost (Penzi et al., 2015).

The objectives of the present study are (i) to identify the present status of litter management practices in some selected poultry housing systems in the rural areas, and (ii) to develop a hygienic, self-aerated, and cost-effective method of compost preparation using the poultry litters.

Materials and Methods

Locale of survey study and sample size

The survey-based study areas were purposively selected in the rural areas under the districts of Mymensingh, Gazipur, Netrokona and Jamalpul considering the intensity and availability of poultry farms. A total of 42 farms were selected for collecting the primary data as shown in Table 1.

Table 1. Category of poultry farms visited and sample size

Farm category (bird nos.)	Number of visited farms					
	Mymensingh		Gazipur sadar	Netrokona sadar	Jamalpur sadar	Total
	Sadar	Trishal				
Small (500-1500)	5	3	6	8	6	28
Medium (1501-4000)	2	2	3	3	4	14
Total	7	5	9	11	10	42

Data collection technique and data collection

This study adopted a random sampling method for sample selection. A pre-tested interview schedule was prepared for collecting the information from the farm-owned respondents or their representatives through physical observance of the farms. Data were collected focusing mainly on the following parameters:

i) Farm size (area of the farms, including the type of birds reared)
ii) Volume of litter generated (amount of litter in kg/batch of 35 days for broiler and in kg/16 weeks for layer farms)
iii) Existing litter management practices
iv) Problem faced by the respondents

Locale of experimental study and duration

The preparation of compost and related activities were carried out beside the Concrete and Materials Testing Laboratory under the Department of Farm Structure and Environmental Engineering at Bangladesh Agricultural University (BAU), Mymensingh during the period from March 1 to April 30, 2022. The laboratory analysis of the compost was accomplished at the Humboldt Laboratory of Soil Science department of BAU.

Composting Materials

Poultry litters were used as the main material for composting together with water hyacinth and rice straw. The poultry litter was collected from the Poultry Farm of BAU. Rice straw was collected from the BAU Agronomy field. Water hyacinth was collected from the lakes situated near the BAU campus. The physical and chemical properties of water hyacinth, poultry litter and rice straw are summarized in Table 2. The mix design of the raw materials for compost at different proportions with the C/N ratio are shown in Table 3.

Table 2. Physical and chemical properties of raw materials used for composting

Parameter*	Water hyacinth	Poultry litter	Rice straw
Moisture content (%)	93.2±1.7	69.3±1.4	13±1.1
pH	6.9±0.2	7.4±0.2	5.2±0.1
Total organic carbon (TOC) (%)	36.37±1.1	45.86±0.6	34.5±0.0
Total organic nitrogen (TON) (%)	1.82±0.02	0.96±0.01	0.70±0.01

*mean and standard deviation of three replicates

Table 3. Raw materials for compost at different proportions with C/N ratio

Organic materials used	Purposes	*C/N ratio	Mixing ratio (by weight)	Proportioning
Rice straw	Sources of Carbon (C) and acts as bulking agent	80:1	1	80:1
Poultry litter	Sources of Nitrogen (N) and augments activity of microorganisms	25:1	2	50:2
Water hyacinth	Sources of Nitrogen (N)	20:1	4	80:4
Total			7	210:7 (30:1)

Composting Method

At a selected upland and flat area, all the material combination was formed into a truncated square pyramid-shaped compost heap with 1m height, 1.5m at top edge and 2m at bottom edge having a total volume of $3m^3$ (Figure 1). The compost heap contained approximately 680kg of different materials combination to get a desired C/N ratio of 30:1. The initial moisture content was adjusted to approximately 60% by adding water. The fresh water hyacinth and rice straw were chopped into small pieces of about 1.5 inches in size using a chaff cutter to increase the surface area for microbial action. The poultry litter was thoroughly mixed manually with chopped rice straw and water hyacinth at the proportion of rice straw: poultry litter: water hyacinth equals 1:2:4 (by weight) as shown in Figure 2. The mixed material was spread over a 2m x 2m floor up to 30cm in height. Four pieces (each with 2.1m length) of bamboo (5cm diameter) were placed 1m apart horizontally over the material forming a grid and another four pieces (1m in length) were placed vertically at the cross-over points of horizontally placed bamboo. The rest mixed materials were stacked so that the overall height was 1m and the top surface of the heap was covered with a 2.5cm thick clayey soil layer to preserve warmth and moisture content (Figure 3). The air passages into the compost heap were ensured by jerking the bamboo pieces and moisture content by spraying water as required. The bamboo pieces were pulled out when the compost bulk was found self-restraint to withstand the hole left by them (Figure 4). Composting process was continued for a total period of 60 days.

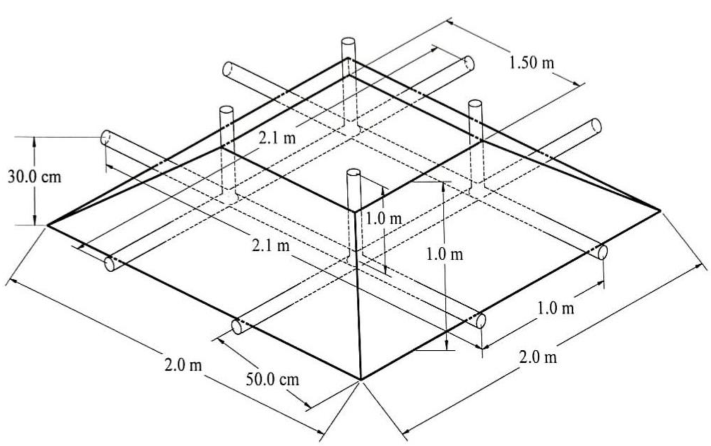

Figure 1. Isometric view of skeletal compost heap

Figure 2. Prepared raw materials for compost

Figure 3. Experimental compost heap

Figure 4. Self-restraint hole in the heap

Sampling at different stages of composting

Samples were collected from the top, middle, and bottom of the heap during the composting. Temperature and moisture contents at a time interval of three days, and pH, C/N ratio, volume, and microbial properties at a time interval of seven days were observed during the whole composting period of 60 days. The samples were stored at 4^0C until microbial analysis was performed (<72 hours after collection). After completing the process, six grab samples were collected from different portions of the end product. All the samples were mixed**,** air-dried and sufficiently grinded so as to pass through a 0.2mm sieve, and stored for nitrogen, phosphorus, potassium, sulfur and total organic carbon content analysis (Dhal et al., 2012).

Measurement of parameters

Temperature: The temperature in the compost heap was measured and recorded at a depth of 15 cm (Macias-Corral et al., 2019). A temperature probe (0-80°C) was used to measure the temperature as shown in Figure 5.

Figure 5. Acquisition of data on temperature by probe thermometer

Physico-chemical Properties: The prevailing use of compost is to mix it with soil to form a good growing medium for plants, for which pH is important criteria for consideration (Watson, 2003). The pH of samples was determined using an electronic pH meter and the moisture content using the standard oven-drying method (Tiquia & Tam, 2002). The C/N ratio was computed based on the concentration of total organic carbon (C) and nitrogen (N).

Microbial Properties: The population size of microorganisms in the sample was estimated using the most probable number (MPN) method (Woomer, 1994). The denitrifying bacterial population was quantified by inoculation of tubed liquid media (Tiedje et al., 1983) using the MPN method.

Compost Heap Volume: The volume (in terms of length, width, and height) of the compost heap was calculated at an interval of seven days to assess the speed of biodegradation.

Laboratory Analysis: Each air-dried sample was analyzed for the subsequent parameters: total organic nitrogen using the Kjeldahl method, total organic carbon using Shimadzu Solid Sample Module (SSM 5000A), total phosphorus (acid digest) using Stannous chloride method (APHA, 1995) and potassium (acid digest) analysis using flame photometry (Dhal et al., 2012).

Statistical Analysis: Frequency and percentage analyses were performed on the data obtained from the pre-tested questionnaire and a table was created for each question (Adebayo et al., 2016). The variations in physical, physicochemical and microbial parameters at different portions of the compost heap were analyzed statistically at P = 0.05 using one-way analysis of variance (ANOVA) with SPSS software (version 20).

Statistical analysis in terms of mean and standard deviation (±SD) was performed using SPSS software. All the results reported are the means of three replicates.

Polynomial curve fittings to experimental data: The polynomial curve is fitted through the experimental data points to characterize the composting process. The nature of the curve is a polynomial minimax, the equation to which is of the form:

$$P_n(x) = a_0 + a_1x^1 + a_2x^2 + a_3x^3 + \dots\dots\dots\dots + a_nx^n$$

such that $2|P(x_i) - y_i|$ is minimum for a given set of data points (x_i, y_i) where i =1,2, 3, ..., n and x-values are in ascending order.

Cost Analysis: The overall cost of items determined for compost preparation was the variable cost including the cost for poultry litter, water hyacinth, rice straw, transportation and labor and, the fixed cost including the costs for bamboo, tools, and polythene sheets.

Results and Discussion

Farm size

There were broiler and layer farms in the study areas and 66.67% respondents were involved with small farming (Table 4).

Table 4. Category of visited farms based on farm size

Farm category (bird nos.)	Number of farms		Frequency/Farms	Percent, %
	Broiler	Layer		
Small (500-1500)	14	14	28	66.67
Medium (1501-4000)	7	7	14	33.33
Total	21	21	42	100

Volume of litters generated

The quantity of litter generation is connected to the number of birds reared, variation of diet, age, and health of birds. The broiler farms (2002 kg/day) generated higher amount of litters compared to that of layer farms (875 kg/day) as shown in Table 5.

Table 5. Volume of litters generated in poultry farms

Farm category (bird nos.)	Broiler farm					Layer farm				
	No. of farms	Litters (kg/35 days)	Av. (kg/ day)	Total (kg/ day)	Percent (%)	No. of farms	Litters (kg/16 weeks)	Av. (kg/ day)	Total (kg/ day)	Percent (%)
Small farm (500-1500)	14	1405	41	574	29	14	2756	25	350	40
Medium farm (1501-4000)	7	7130	204	1428	71	7	8330	75	525	60
Total	21			2002	100	21			875	100

Existing litter management practices

The majority of the small farmers (50%) disposed of their poultry droppings in open places (Table 6). The runoff of these products can result in the death of aquatic life. Also, they can get into the food chain resulting in food poisoning for both the humans and the animals (Gündüz et al., 2019). Twelve percent of farm owners disposed of fresh poultry litter to the crop field and ponds. But, fresh poultry litter can burn and damage plants (Saliga et al., 2013) and it is not suitable for feeding fish directly because of containing some toxic substance and release of large amount of N and P to the water body which may cause eutrophication (Sarker et al., 2009). Existing litter disposal systems are shown in Figure 6.

Table 6. Present status of poultry litter management practices

Poultry litter management practice	Frequency/Farms	Percent,%
Sun-drying	2	4
Dumping in open place	21	50
Direct dumping in the pit	9	22
Road side and drain	5	12
Direct dispose to crop field and fish ponds	5	12

a) b)

Figure 6. Litter disposal systems: a) in an open place, and b) in a confined concrete house

Problem faced by the respondents

The litters causing environmental pollution is shown in Table 7. About 88% of respondents opined that poultry litters caused environmental pollution and about 12% released their opinion that it did not cause pollution. The poultry litters result in generating ammonia alongside awful odor to the environment and thereby causing air pollution that can be harmful to people living in and around the farm premises (Gündüz et al., 2019).

Table 7. Effect of poultry litters on environmental

Perception of respondents	Frequency/Farms	Percent, %
Odour	17	40.48
Leaching	4	9.52
Flies	16	38.10
Gas (Ammonia)	5	11.90

The litters causing health problems is summarised in Table 8. The most of the respondents' answer was negative on the query of health problems related to poultry litter. About 60% respondents opined that poultry litters caused health problems. It was observed that among the farmers 40% suffered from ammonia gas emission, 30% suffered from physical weakness, 16% suffered from eye irritation and the rest 14% suffered from skin infection.

Table 8. Health problems due to poultry litter

Perception of respondents	Frequency/Farms	Percent, %
Suffered from ammonia gas emission	17	40
Physical weakness	12	30
Eye irritation	7	16
Skin infection	6	14

Composting process

The ANOVA test unconcealed that composting at different portions of the heap was non-significant in terms of temperature (Figure 7), moisture content (Figure 8), pH (Figure 9), C/N ratio (Figure 10) and microbial properties (Figure 11).

Temperature: The typical temperature pattern followed for the composting process were the thermophilic phase (40-60^{0}C), the mesophilic phase (20-40^{0}C) and the cooling and maturation phase, where the temperature stayed constant and close to the ambient temperature (Fialho et al., 2010). In Figure 7, the temperature reached to the maximum of 65.9^{0}C (top), 63.3^{0}C (middle) and 62.7^{0}C (bottom), and enter into the thermophilic phase (40-60 ^{0}C) within 12 days. During the maturation phase (51 to 60 days) the temperature was observed at 37^{0}C. Temperatures in different portion of compost heap reached an ambient level of 37^{0}C (average) and was the same until the end of the composting process (60 days), and the temperature curve almost parallel to *x*-axis confirmed that the composting process was complete (Tchobanoglous, 1977). A little variation in temperature at different portions of the heap suggested that aeration varied at the bulk compost heap. Despite these variations, no significant differences (P>0.05) were found by ANOVA test.

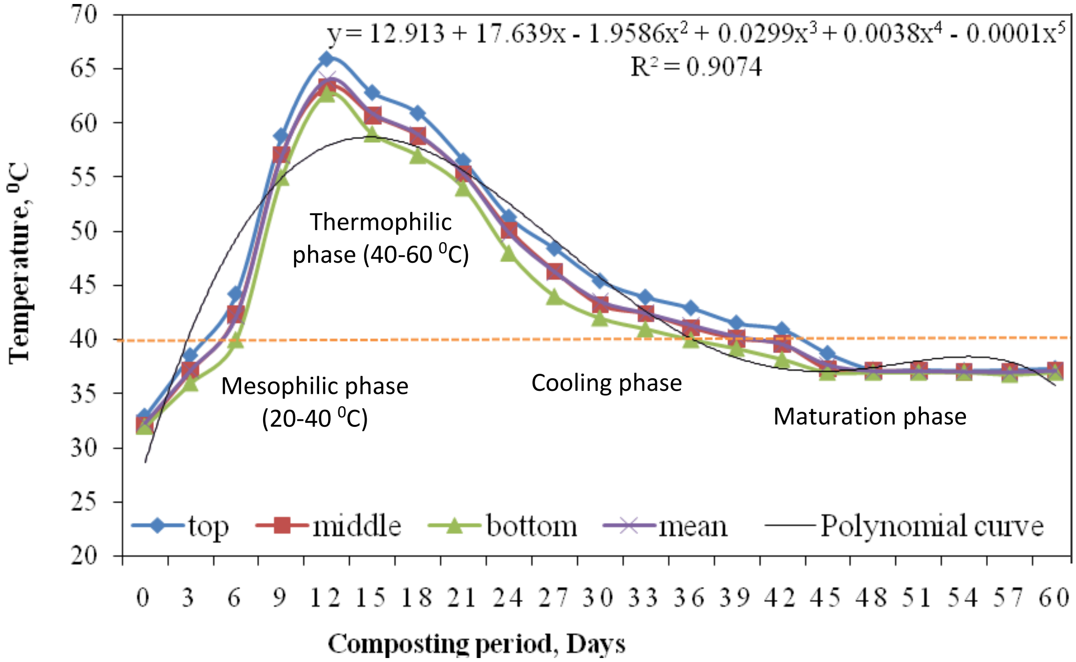

Figure 7. Changes in temperature during composting. Temperature (P=0.697, not significant)

Moisture content: The moisture loss throughout the composting process can be shown as an index of decompositions rate since heat generation which accompanies decomposition derives moisture loss there (Liao et al., 1997). The higher initial moisture content of 69.3% was observed which further dropped to 33.6% at the maturation phase as shown in Figure 8. However, no significant differences (P>0.05) were found among the samples of different portions of the heap.

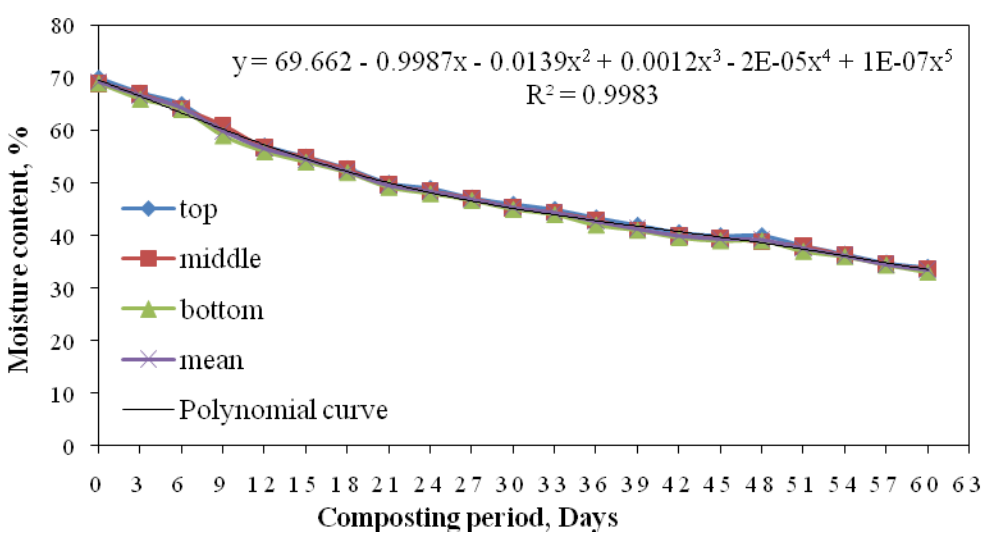

Figure 8. Changes in moisture content during composting. Moisture content (P=0.978, not significant)

pH values: The results of the observed pH of the composting mixtures are shown in Figure 9. During the initial stage of composting pH tends to be slightly acidic. However, towards the end it turns into slightly alkaline (Venegas-González et al., 2005). Observations found that pH was reduced to 6.5 during the initial 14 days, and further increased up to 7.8 at day 49 which remained the same till day 60. Increased aeration rates tend to decrease CO_2 levels in the compost, which in turn will increase pH (Haug, 1993). On analyzing the results by ANOVA, the differences in pH at three different portions were not significant (P>0.05).

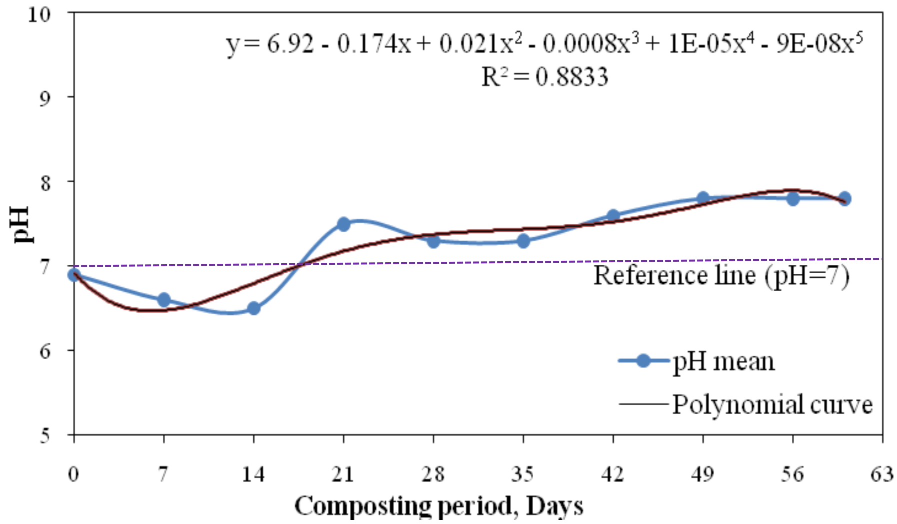

Figure 9. Changes in pH during composting. pH (*P*= 0.972, not significant)

C/N ratio: The values of the C/N ratio determined in the compost heap showed a significant decrease from the initial 29.8 to the final 12.0 (Figure 10). This is due to the consumption of organic carbon during composting. Results showed that the C/N value was 12.87 to 12.0 from day 49 to day 60. The final C/N values were similar to 10-15 rumored by Rao et al. (1995) as indicative of an advanced technique of composting and good retention of the nitrogen content. There were no significant differences in the C/N ratio observed at three different portions of the heap (*P*>0.05).

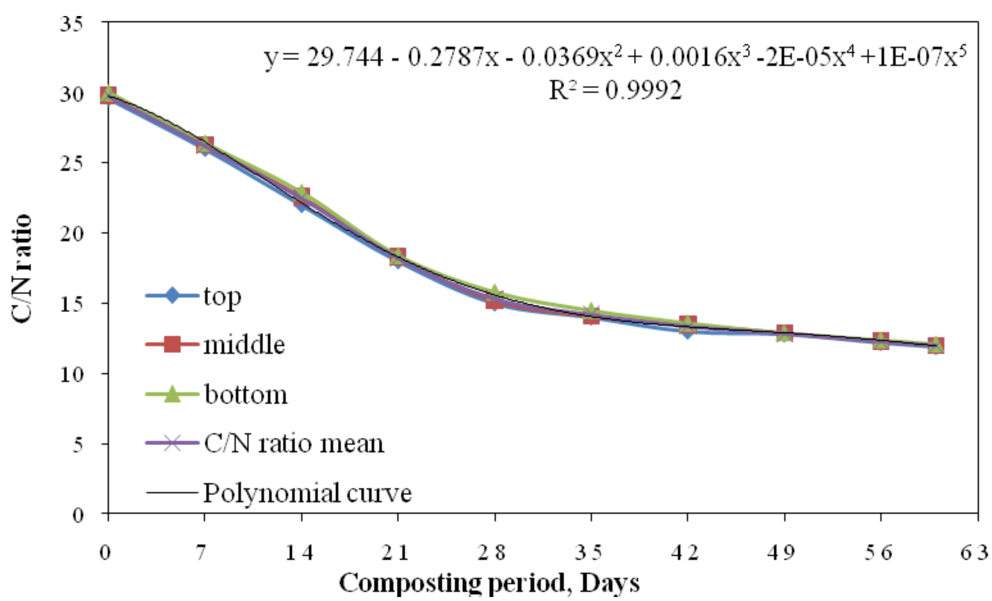

Figure 10. Changes in C/N ratio during composting. Data are expressed on a 105^{0}C dry weight basis. C/N ratio (*P* =0.988, not significant)

Microbial populations: The number of denitrifying bacteria is 8.6x10^5 g^{-1}, the log value of which is 13.67, at day 0, indicating the presence of anaerobic pockets in the compost heap as shown in Figure 11. As the composting progressed, their number decreased to 2.1x10^3 g^{-1}, the log value of which is 7.67, at day 60, indicating that very little de-nitrification took place once the air was blown into the heap. When the temperature of the compost mixture reached at 63^{0}C (Figure 7), it was effective in reducing the bacterial growth (Fournel et al., 2019). However, a non-significant difference in the statistical analysis (*P*>0.05) indicated that the microbial group was mostly similar in all three portions of the compost heap.

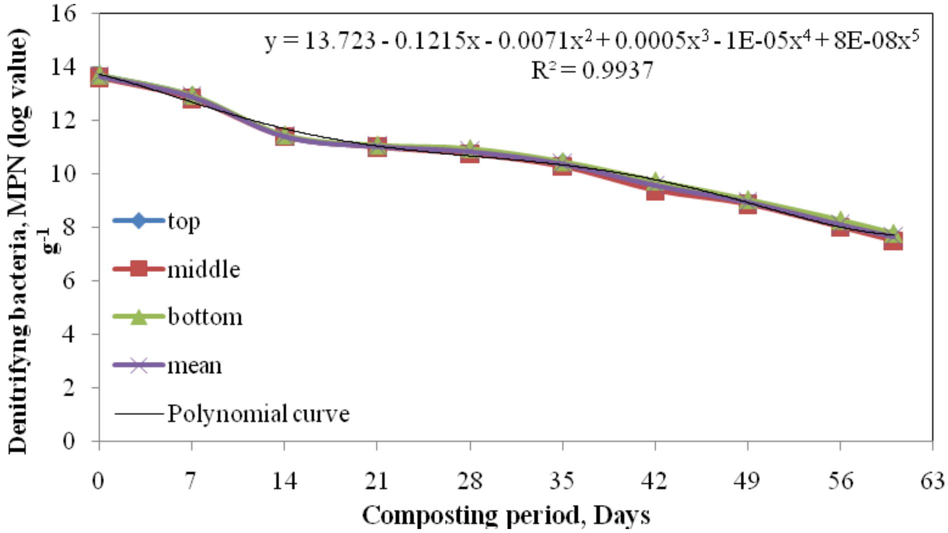

Figure 11. Changes of microbial population size (denitrifying bacteria) during composting. Denitrifying bacteria (P = 0.867, not significant). MPN (log value), Most Probable Number

Compost heap volume: The volume reduction curve for the compost heap confirmed that there was a speedy reduction in volume (20, 30, 40.1, and 58.47%) during the initial 7, 14 and 28 days respectively (Figure 12).

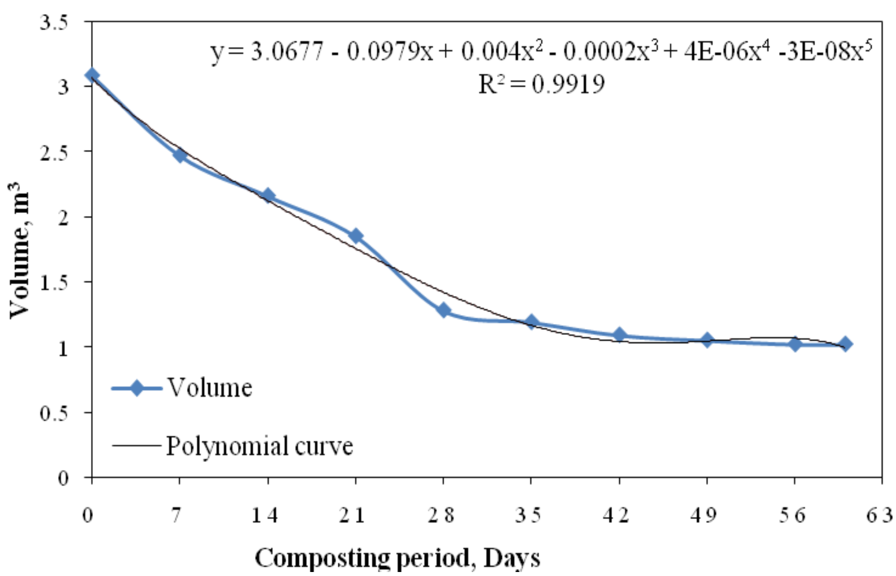

Figure 12. Changes in volume of compost heap during composting

At the initial stage of composting, microbial activity caused the structural degradation of organic matter as a result of which there was a decrease in volume. However, after 28 days, the rate of reduction slowed, and at day 35 the net reduction (from day 0 to day 35) was ~ 61.35%. At day 42, the volume reduction rate slowed further, and the net volume reduction was 64.53% from day 0 to day 42. A small (3.18%) reduction in volume was recorded from day 35 to day 42 might be due to the loss of moisture from the compost heap rather than the deterioration of organic matter. After 42 days there was no reduction in volume and the curve became nearly parallel to the x-axis. Volume measurement on day 56 declared that there was a further decrease of only 1.002% in volume from day 49.

Quality of the final compost

A qualitative analysis was carried out to assess the potential of the composting technique for the production of high-quality compost. Samples were collected after finishing the composting process (day 60) for analyzing the physical, physicochemical, and fertility parameters.

Physical parameters: At the end of the composting process (60 days), the product showed a granular and uniform appearance. The color of the compost was dark brown and had no foul odor. The final moisture content was 33.6% (Table 9) that is within the optimal moisture content of maximum 35% (WHO Standards, 2003).

Table 9. Quality parameters of the final compost

Parameter	*Acceptable limit	Range value (Present study)	Mean ± SD	R^2	*P* value
Moisture (%)	Maximum 35%	33.5-33.7	33.6±0.67	0.9983	0.978
pH	6-8	7.5-7.9	7.8±0.26	0.8833	0.972
C/N ratio	10-15	11.9-12.1	12.0±0.1	0.9992	0.988
Organic carbon (%)	>19.4%	24.90-27.50	25.9±1.4	-	-
Organic nitrogen (%)	>0.5%	1.30-1.56	1.44±0.13	-	-
Total P_2O_5 (%)	0.22%	1.45-1.47	1.45±0.02	-	-
Total K_2O (%)	0.2-0.5%	1.61	1.61	-	-
Sulfur (%)	-	1.49-1.53	1.52±0.03	-	-
Denitrifying bacteria, MPN ($x10^3$ g^{-1})	-	2.2-2.4	2.1±0.2	0.9949	0.867

*WHO Standard, 2003. Australian Standard 4454, Australian Standard 1999. Fertilizer Association of India 2007. Alexander (1994), and Watson (2003).

Physicochemical parameters: The pH value of the compost samples ranged between 7.5 and 7.9, with a mean of 7.8 (Table 9), which met the standard value (6-8) for good quality compost (WHO Standards, 2003). The change in C/N ratio shows the achieved organic matter decomposition and stabilization during composting. The findings of the study show that the final C/N ratio average ~12.0 (Table 9) is within the WHO range (10-15). Organic carbon content in the compost samples ranged between 24.90 and 27.50%, with a mean value of 25.9% (Table 9), which met the standard value of greater than 19.4% as suggested by Australian Standard 4454 and Australian standard 1999.

Fertility parameters: Although 36 different nutrients are needed for plant growth, the macronutrient (N, P and K) contribution of compost is mostly of major interest (Tisdale et al., 1985). The total nitrogen content in the compost samples ranged between 1.30 and 1.56% (Table 9), which was well above the Indian Standards (Fertilizer Association of India, 2007) of 0.5% and the range of 1-2% total N content suggested by Alexander (1994), and Watson (2003). Total phosphorus (1.45-1.47%) as shown in Table 9 was higher than the minimum suggested standard of 0.22% (Fertilizer Association of India, 2007), whereas the values obtained for total potassium (1.61%) were higher than the range (0.2-0.5%) suggested by Alexander (1994), and Watson (2003), on dry matter basis. Hence, the results obtained for the self-aerated composting technique were in the upper range, which clearly substantiated their rich nutrient status.

Cost of prepared compost

The total cost of production based on the present market price was estimated to BDT 1,780.00 for 298 kg of compost and the details of the cost items is shown in Table 10. The unit cost of production was about BDT 6/kg and this is comparable to the cost of BDT 15~20/kg of organic fertilizer available in the local market.

Table 10. Cost analysis for the composting of poultry litter

Item of variable costs	Total amount of raw materials	*Rate	Total cost (BDT)
poultry litter	496 kg	BDT 20 /50kg	190.00
water hyacinth	130 kg	-	100.00
rice straw	57 kg	-	100.00
transportation	-	LS	200.00
labour	1 no.	BDT 600 /person	600.00
Item of fixed costs			
bamboo	1 no.	BDT 500 /piece	500.00
polythene sheet	3 m^2	BDT 30 /m^2	90.00
Total			1780.00
	Total amount of final product		Unit cost (BDT/kg)
Prepared organic fertilizer	298 kg	-	6.00

*Rates were considered based on the local market price of materials in February 2022

Conclusion

The following conclusions can be drawn from the study:

(a) Disposal of fresh poultry litters in open place (50%), roadside and drain (12%), crop field and fish pond (12%) and, sun-drying (4%) caused environmental and public health hazards.

(b) The developed composting method would be an effective option for the production of safe and good quality compost from poultry litters. The production cost of compost is only about BDT 6/kg.

(c) The minimal infrastructural requirement, speedy biodegradation of materials and cost-effectiveness of this self-aerated composting method would be an eco-friendly technology to be used by the farmers in the rural areas.

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