Chemical Changes During Composting of Dead Birds with Caged Layer Manure

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Abstract: An aerobic composting experiment was conducted at Veterinary College and Research Institute, Namakkal, India to study the feasibility of disposing dead birds from commercial layer farms. Dead birds were sequentially layered with caged layer manure and paddy straw or sorghum hay waste in a 4’ x 4’ x 4’ mini composter. The C:N ratio and moisture was adjusted to 20:1 and 60 percent, respectively. Composting was carried out during summer, monsoon and winter. The pH of the finished compost ranged between 8.20 and 9.34. Dead bird compost recorded higher N content (16.19 to 17.92 g/kg) than control (13.80 to 16.52 g/kg). The composting methods facilitated quick and effective decomposition of dead birds and improved the nutrient contents of the poultry farm waste. The study also revealed that the dead birds can be effectively composted throughout the year.

Key words: Carcass, dead bird, disposal, compost, manure compost, nutrient content

INTRODUCTION

Dead birds constitute an appreciable proportion of the wastes generated in commercial poultry farms and the proper disposal of the same represents a considerable practical problem for producers. Burial, incineration and anaerobic digestion in closed pits are the common methods employed at present for the disposal of dead birds. All these methods (except anaerobic septic tanks) are not practically feasible in large farms due to dependency on labour and cost involvement. Anaerobic digestion pits creates problem of obnoxious odour if not maintained properly and it will not ensure biosafety also[1]. An alternative to all the above methods of disposal of dead bird is composting with caged layer manure.

Composting is a controlled natural process in which beneficial microorganisms (bacteria and fungi) reduce and transform organic waste into a useful end product called compost[2]. Composting of livestock and poultry manure[3] and municipal solid waste[4] is recommended as an eco-friendly process with less cost and labour.

The end product of compost resembles humus and can be used as soil amendment. Composting reduces the volume of the organic waste and pathogens are destroyed if the process is controlled properly[1]. Hence, with these ideas in view, this experiment was designed to study the feasibility of composting dead birds with caged layer manure in tropical climate.

MATERIALS AND METHODS

A composting experiment was conducted in 2006 at Veterinary College and Research Institute, Namakkal, Tamil Nadu, India to study the feasibility of composting dead birds with caged layer manure in tropical climate. Mini compost bins[6] with a dimension of 4 feet length x 4 feet width x 4 feet height were designed. The floor of the compost bin was made up of concrete slabs to prevent seepage of leachates and subsequent moisture and nutrient loss. The sidewalls of the compost bins were made up of country wooden planks of 4” to 5” wide and 1” thick. One inch air space was provided between wooden planks to provide sufficient aeration to compost piles. A total of 6 such bins were utilized under a tile roofed shed to protect the bins from rain.

Dead birds were collected from commercial farms in and around Namakkal and Caged Layer Manure (CLM) were collected from commercial high-rise layer farms. Paddy straw (Oryza sativa) and sorghum hay
waste (Sorghum bicolor) were used as carbon source. Chemical composition of ingredients used is presented in Table 1.

The compost recipe was calculated and prepared based on the C: N ratio of the ingredient used. In this experiment the criteria for C:N and moisture content was fixed as 20-25: 1 and 50-60 per cent, respectively. Based on this the compost recipes were formulated[9]. The total carbon and total nitrogen content of each ingredient viz., dead bird, caged layer manure (CLM), paddy straw (PS) and sorghum hay (SH) waste were analyzed individually and quantity of ingredient required for each layer was calculated and finalized. The moisture content of each ingredient was determined and the total ingredient mixture moisture content was stabilized to 50-60 per cent by addition of water while filling.

Compost Recipe Formulation: The C:N ratio (20-25: 1) and moisture (50-60 per cent) were kept constant by changing the quantity of manure substrate and carbonaceous source. Two compost recipes were formulated along with one control compost recipe without dead birds for comparison purpose. Different treatment combinations were as follows:

- T₁ – Dead birds + CLM + paddy straw + water : 1: 3: 1.75:1.7
- T₂ – Dead birds + CLM + sorghum hay water + water: 1: 3: 1.75: 1.6
- T₃ – CLM + sorghum hay + water (control): 3: 0.5: 0.92

Composting Procedure: The compost bins were filled as per the recommendations of Donald et al.,[6] and USDA-NRCS[7] by sequential layering of manure substrate, dead bird and added carbon source and water was sprinkled over the carbon source to stabilize the moisture. After filling the compost bin a final cover or cap layer was laid with manure over the top for a thickness of 6 inches. The temperature of the compost pile was recorded at different heights daily at 0800 hrs. Composting was done at two stages. The primary stage was completed when the temperature of the compost bin dropped below 40° C. After this the bins were opened, mixed and refilled after addition of sufficient water. After completion of thermophilic phase (secondary stage) the compost materials were moved to storage yard. To ascertain the year round feasibility the composting work was carried out during summer, monsoon and winter season with one replicate.

Physicochemical Analysis: Compost samples were collected at the end of secondary stage. Samples were gathered from different locations to get a representative sample. Sample (250 g) was collected from six different locations and stored in an air tight polythene bag and transferred immediately for moisture estimation. Moisture content of composting samples was determined by drying at 105°C in the hot air oven for 24 hours[5, 8]. Electrical conductivity (EC) and pH were measured[8] using digital pH meter (Water proof pH, EC/TDS and Temperature meter, HANNA Instruments, USA, model No. HI 98130) by preparing 1: 10 w/v compost – water extract.

Total organic matter (TOM) was calculated by gravimetric loss on ignition produced by ashing the samples in a muffle furnace for 24 hours at 430° C[9]. The total organic carbon content was calculated from the ash content using the formula Total organic carbon = [1-ash content x (1000)]. The total carbon was calculated from total organic matter value using the conventional “Van Bemelem Factor” of 1.724. The weight loss on ignition was divided by 1.724 to give the percentage of total carbon[9, 10]. Compost samples were analysed for total Kjeldahl nitrogen, phosphorus and calcium[11]. The concentration of potassium was analyzed using Flame photometer as described by Jackson[12]. The data thus collected were statistically analyzed by two way analysis with replicate as per the methods suggested by Snedecor and Cochran[13].

RESULTS AND DISCUSSIONS

Physicochemical Properties: Moisture content was significantly higher in the finished compost during winter followed by monsoon and least during summer (except T₁). Different treatment mixtures showed variability during summer and monsoon. High environmental temperature and high internal temperature built-up might be the reason for heavy loss of moisture. Further it indicated that frequent addition of moisture is essential to hasten the composting process[14].

At the end of composting the CLM based mixture recorded (Table 2) higher pH (8.20 to 9.34) which indicated high rate of ammonium salt formation from CLM. The final pH of dead bird compost as reported by McCaskey[15] and Lawson and Keeling[16] ranged between 7.4 and 8.9. The acceptable range of pH at the end of composting is 7.5 to 8.0 regardless of beginning pH[7]. In this experiment the CLM mixture had comparable pH during summer and winter but during monsoon the pH was above 9, which required adjustment by way of addition of super phosphate[17]. Similarly Rodriguez et al. [17] observed a higher pH range of 8.6 to 9.3 at the end of composting liquid poultry manure with barley waste. They recommended that higher pH can be mitigated by using the compost as a liming agent on acidic soil.

Winter season in CLM group recorded (table 2) higher EC (6.840±0.31 to 7.429±0.18 mS/cm) followed by summer (3.956±0.113 to 4.793±0.151 mS/cm) and
monsoon (3.047±0.084 and 3.898±0.137 mS/cm). Loss of TOM due to microbial degradation and concentration of salts might be the reason for this increase in EC. Different treatment mixtures showed significant difference in EC, but a clear trend could not be established. The observed EC values are comparable with the values (3.31 to 4.34 dS/m) reported by Abdelhamid et al.[7] and Tiquia and Tam[8] in poultry manure compost.

Season had highly significant (P<0.01) effect on organic carbon content (Table 2). Carbon content was lower during monsoon than summer and winter. The treatment mixture with dead birds (T1 and T3) uniformity in TOC indicated that both the carbon sources (straw and hay) are effective and equally degradable. A cumulative reduction in TOC accounted for 29.02 to 31.02 per cent. The loss of organic carbon showed that addition of optimum moisture, aeration and optimum C:N ratio improved the microbial degradation. The results are comparable with the reports of Cummins et al.[9] and Lawson and Keeling[10].

Nitrogen Profile: The treatment bins with CLM as manure substrate (T1 to T3) showed uniformity (except T3 in summer) in N content ranged between 14.71 and 17.92 g/kg (Table 2). Seasons had little influence on N conservation. Highly unstable N content of CLM and high porosity and aeration by addition of carbon source might be the reason for heavy loss of N in the form of gaseous NH3[11]. The reported N value for finished dead bird compost ranged between 25.7 to 40.8 g/kg[12,13], which are much higher than the observed value. The compost mix with dead bird recorded higher N content (16.19 to 17.92 g/kg) than control bins (13.80 to 16.52 g/kg), which indicated that carcass compost increased the fertilizer value of compost. In agronomical point of view, it is helpful to the farmers in efficient disposal of dead birds. This fact was supported by Fonstad et al.[20] who reported that addition of hog carcass in the compost mixture increased the level of N by 108 per cent in the finished product.

The estimated total nitrogen at the time of loading (20.44, 20.92 and 19.47 g/kg) was reduced to 16.75, 16.92 and 15.01 g/kg which accounted for 18.05, 19.12
and 22.91 per cent N loss in CLM compost mixture viz., T₁, T₂ and T₃, respectively and this fact was comparable with the reports (11.19 to 14.54 per cent loss) of Mahimairaja et al.,[15] in poultry manure compost. Still higher reduction was reported (55.2 to 63.2 per cent N loss) by Das et al.,[22] while composting hatchery waste.

**Carbon: Nitrogen Ratio:** A general trend of reduction in C:N ratio was noticed from initial C:N ratio. The treatment mixtures with dead birds (T₁ and T₂), had uniform C:N ratio in any particular season than control indicating that the carbon source is good in all the seasons (Table 2). In the finished compost the C:N ratio was high in summer (18.00 to 23.09 g/kg) followed by winter (17.44 to 18.09 g/kg) and monsoon (15.94 to 17.09 g/kg). Heavy loss of N during summer might be the reason for this increase in C:N ratio. This result was contrary to the reports of Cekmekceoglou[4] who stated that the rate of reduction was high during summer than winter in food waste compost.

**Major Plant Nutrients:** The Ca content of CLM used (74.0) (Table 1) was comparable with the reported value ranged between 68.5 and 109.8 g/kg by Rubananthini[23]. This higher Ca content of manure substrate was reflected in the compost mixture also (Table 3). Still higher value (155.6 g/kg) was reported by Das et al.[22] in hatchery waste compost, which might be due to presence of egg shells in the hatchery waste. Season had a highly significant effect on Ca content which might be due to variation in the feeding schedule of the birds.

P level was significantly higher (P<0.01) during summer and winter than monsoon (Table 3). The loss of P through leaching from manure stacks might be the reason for this reduction in P content. The observed P contents are comparable with the reported values of 18 to 38 g/kg in dead bird compost[15,18,19] Higher K content was noticed in T₁ group. The observed values are comparable with the reported values 17 to 40.7 g/kg in various compost recipes with CLM as manure substrate[8,10,15,18,19,24].

**Conclusion:** Based on the results it can be concluded that dead birds can be effectively composted throughout the year along with caged layer manure and either paddy straw or sorghum hay. The composting methods facilitated quick and effective decomposition and improved the nutrient contents of the poultry farm waste.

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