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Composting of Poultry Carcass with Farm Yard Manure in Summer

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Abstract: Aerobic composting experiment was carried out to study the feasibility of composting dead birds with farm yard manure (FYM) co-composted with paddy straw or sorghum hay as carbonaceous material. Two treatment mixtures were formulated viz., T_1 (dead birds+ FYM + straw) and T_2 (dead birds +FYM+ sorghum hay) and T_3 (FYM alone) as control in ratio to adjust C:N as 20:1 and moisture level as 60 per cent. Composting work was carried out during summer with one replicate. The dead birds were sequentially layered as per recipe and physical, chemical and microbial changes during composting were recorded. T_1 and T_2 reached the peak temperature by second week, peak temperature of 66.69°C (T_1) and 69.10°C (T_2) was significantly ($P<0.01$) higher than control (51.82°C). The thermophilic temperature persistency was more in treatment mixture 54 days and 65 days respectively for T_1 and T_2. The total composting period was significantly high for T_2 (127.5 days) followed by T_1 (166.5 days) and least for control (107 days). Weight and volume reduction was significantly higher in treatment group than control. pH and EC was within acceptable range. Total nitrogen content was significantly higher in T_1 (13.771 g/kg) and T_2 (12.75 g/kg) than control group (9.967 g/kg). C:N ratio in the finished compost was below 20:1 and the K level of treatment group was significantly higher than control group. The compost mixtures ensure biosafety by way of reduction in the indicator organisms viz., coliform and salmonella.

Key words: Dead bird compost, waste disposal, carcass compost, dead bird disposal, aerobic composting

INTRODUCTION

Poultry is one of the fastest growing segments of the agricultural sector in India. While the production of agricultural crops has been growing at a rate of 1.5 to 2 per cent per annum, eggs and chicken meat production has been growing at a rate of 8 to 10 per cent per annum[1]. Reason behind this tremendous growth is mainly industrialization of poultry rearing.

Presently commercial poultry rearing is concentrated mainly to certain pockets results in more number of birds housed relatively in smaller area. Death of commercial poultry due to natural cause and due to bacterial or vial diseases is not uncommon. Nearly 7 to 11 per cent stock die due to various reasons before they complete their laying cycle[1]. Safe disposal of these dead birds is a major problem to the poultry growers. Various methods like incineration, burial and anaerobic digestion, rendering are employed in disposal of dead birds but they are costlier and labour intensive. An alternative to this method is disposal of dead birds by aerobic composting.

Composting is a controlled natural process in which beneficial microorganisms (bacterial and fungi) reduce and transform organic waste into a useful end product called compost[2]. Composting of livestock and poultry manure[3-4] and municipal solid waste[5] is recommended as an eco-friendly process with less cost and labour. Hence an attempt was made to compost the dead birds along with farm yard manure (FYM).

MATERIALS AND METHODS

The composting experiment was carried out Veterinary College and Research Institute, Namakkal, Tamil Nadu, India located at 11° 09'42.1" N latitude and 78°09'39.7" E longitude at an altitude of 192 meters above mean sea level (MSL). The soil type is non-calcareous red and brown soil and calcareous black soil.The climate ranges from semi arid to sub-humid with frequent occurrence of drought. The meteorological variables recorded during the composting period were given in the table1.

Aerobic composting was done in mini composter specially designed with a specification of 1.2 m length x 1.2m width x 1.2m height[6]. The floor of the compost bin was made up of concrete slabs and the side walls of the

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Table 1: Mean ± SE of meteorological variable during the composting period.

Weather parameter	March 2005	April 2005	May 2005	June 2005
Maximum temperature (ºC)	35.97± 0.19	35.23±0.28	35.71±0.28	34.50±0.22
Minimum temperature (ºC)	23.35±0.25	24.97±0.23	25.29±0.17	25.30±0.17
Relative humidity at 8.00 hrs (per cent)	77.42	77.97	77.74	80.03
Relative humidity at 2.00 hrs (per cent	40.00	52.17	49.65	54.73
Wind speed (Km/hr)	4.87	4.38	4.15	8.67
Total rainfall (mm)	18.0	160.2	232.0	0.0
Rainfall days	3	3	5	0

Table 2: Mean ± SE of physical properties and chemical composition of different ingredients used in formulation of compost recipe

	Physical properties				Chemical composition						
Type of ingredients	pH	Moisture (%)	Electrical conductivity (mS/cm)	Total dissolved salts (ppt)	Total nitrogen (g/kg)	Total phosphorus (g/kg)	Total Calcium (g/kg)	Ash (%)	Total organic matter (%)	Total carbon (%)	C:N ratio
Straw	7.275±0.301	10.185±1.177	4.931±0.443	2.719±0.171	1.69±0.35	1.99±0.012	4.86±0.027	18.805±0.471	81.195±0.471	47.206±0.274	279.33:1
Hay	6.654±0.088	10.357±0.298	2.800±0.233	1.675±0.277	3.55± 0.75	1.055±0.024	7.045± 0.210	6.872±0.333	93.128±0.333	54.144±0.194	152.52:1
FYM	8.088±0.068	48.803±4.606	2.871±0.228	1.501±0.100	9.21± 1.04	8.268±0.559	27.396± 2.673	36.058±3.560	63.942±3.560	37.176±2.070	40.36:1
Poultry Carcass	6.559±0.085	62.480±0.871	2.898±0.209	1.449±0.099	87.44± 8.24	14.441±1.024	35.045± 1.130	15.370±2.011	84.630±2.011	49.203±1.169	5.63:1

compost bins were made up of wooden planks of 10 cm wide and 2.5 cm thick. An air space (2.5cm) was provided between wooden planks for the purpose of aeration to compost piles. These bins were arranged under roofed shed to protect the bins from entry of rainwater.

Farm Yard manure available from the Livestock Farm of Veterinary College and Research Institute, was utilized as manure substrate. Dead birds were collected from the commercial farms. Paddy straw (*Oryza sativa*) and sorghum hay (*Sorghum bicolor*) were used as added carbon source. After analyzing the chemical composition of ingredients the C: N ratio of the compost recipe was adjusted to 20:1 by addition of carbonaceous materials. The moisture content of was kept as 60 per cent by sprinkling sufficient water over the compost materials. The chemical composition of different ingredients used was presented in the table 2. The treatment recipes used are as follows

T_1 – Carcass + FYM + straw + water :1:3:0.65: 0.57
T_2 - Carcass + FYM + hay + water :1:3:0.65: 0.57
T_3 – FYM :As such

Composting was carried out during the period between March and June 2005. The compost bins were filled as per recommendation of Donald *et al.*[6] and USDA-NRCS[7] by sequential layering of carcass, manure substrate and carbon source with addition of moisture. The compost bins were opened when the bin temperature was below 40ºC (primary stage) and the content was mixed thoroughly, remoistened and aerated and filled again for secondary stage heating. When the second heating cycle was completed, the compost materials were moved to a storage yard.

The temperature of the compost bins were recorded with the help of compost thermometer (WIKA make model name TREND), Moisture content of composting samples was determined by drying at 105ºC in the hot air oven for 24 hours[7-8]. pH, electrical conductivity (EC) and total dissolved salts (TDS) were measured[8] using digital pH meter (Water proof pH, EC/TDS and Temperature meter, HANNA Instruments, 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 430º 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[9-11].

Compost samples were analysed for total Kjeldahl nitrogen, phosphorus and calcium as per the procedure outlined by AOAC[12]. The concentration of potassium was analyzed using Flame photometer as described by Jackson[13]. The data thus collected were statistically analyzed as per the methods suggested by Snedecor and Cochran[14].

RESULTS AND DISCUSSIONS

Physical Changes: During summer the temperature profile reached the peak by 2nd week and started declining steadily (Fig. 1) and reached the level below 35 to 40ºC, which is the recommended level for maximum microbial diversity[15,16]. The second heating

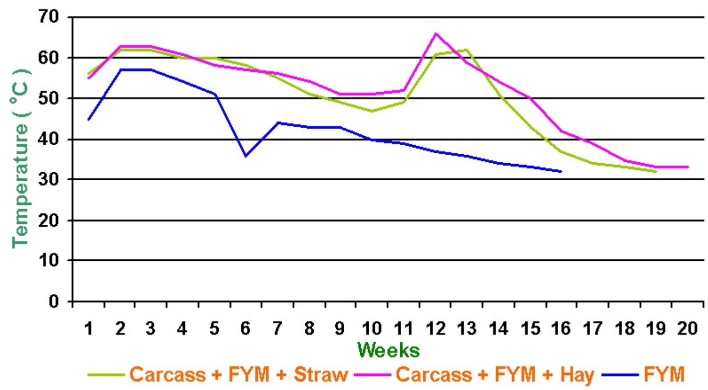

Fig. 1: Temperature profile during deed bird composting.

Table 3: Mean ± SE of physical changes during composting of dead birds

Treatment	Peak temperature (°C)	Persistency of thermophilic temperature (days)	Composting period (days)	Moisture (%)	Weight reduction (%)	Volume reduction (%)
T_1	66.69^{a}±1.41	54.0^{a}±4.0	116.5^{b}±1.5	30.544^{b}± 2.122	46.05^{a}± 2.67	59.32^{a}± 3.39
T_2	69.10^{a}±2.06	65.0^{a}±23.0	127.5^{a}±4.5	28.740^{b}± 2.519	41.14^{b}± 9.43	50.00^{b}± 1.69
T_3	51.82^{b}±4.30	17.5^{b}±4.5	107.0^{c}± 0.0	39.847^{a}± 2.175	31.80^{c}± 6.35	39.41^{c}± 5.51

Figures with different lowercase column wise differ significantly (P< 0.01)

Table 4: Mean ± Physiochemical properties of dead bird compost

Treatment	pH	EC in mS/cm	Total organic carbon (%)	Total nitrogen (g/kg)	C:N	Calcium (g/kg)	Phosphorus (g/kg)	Potassium (g/kg)
T_1	7.809^{b}±0.019	3.590^{a}±0.074	23.637^{b}±0.792	13.771^{b}±0.552	17.563^{b}±1.133	33.820±1.189	11.564±0.401	22.400^{a}±0.321
T_2	8.011^{a}±0.167	2.984^{b}±0.242	24.058^{b}±0.748	12.750^{b}±0.629	19.277^{b}±0.926	29.007±0.680	11.033±0.250	23.375^{a}±0.685
T_3	8.099^{a}±0.036	3.213^{b}±0.176	21.212^{Ca}±0.712	9.967^{a}±0.723	22.045^{a}±1.058	28.603±0.921	11.854±0.754	20.267^{b}±0.299

Figures with different lowercase column wise differ significantly (P< 0.01)

Table 5: Mean ± of microbial quality of dead bird compost (as $\log_{10}$ cfu/g) during different stages of composting

	Total bacterial count			Coliform count			Salmonella count		
Treatment	Initial	End of primary stage	End of secondary stage	Initial	End of primary stage	End of secondary stage	Initial	End of primary stage	End of secondary stage
T_1	9.52±0.14	7.16^{c}±0.27	7.50^{b}±0.21	7.89^{a}±0.20	3.68±0.10	3.05^{b}±0.15	4.18^{a}	0.79	ND
T_2	9.20±0.09	7.78^{b}±0.12	7.74^{a}±0.09	7.98^{a}±0.16	3.54±0.16	2.87^{b}±0.04	3.99^{a}	0.83	ND
T_3	9.48±0.20	8.30^{a}±0.23	7.63^{a}±0.16	6.84^{b}±0.22	3.42±0.13	3.73^{a}±0.08	3.28^{b}	0.96	ND

Figures with different lowercase column wise differ significantly (P< 0.01)

cycle also able to reach the temperature above 60ºC except T_3. T_1 and T_2 group perform better in heating up process than T_3 throughout the experimental period indicated that optimum moisture and C:N ratio facilitates better microbial degradation of dead birds.

The treatment recipes with dead bird recorded significantly (P<0.01) higher peak temperature (Table 3) than control group and it is beneficial in terms of more effective elimination of pathogens. Extremely higher peak temperature of 74°C was reported by Murphy[17] while composting dead bird with broiler manure co-composted with straw. But the main disadvantage of high temperature above 60°C is decline in microbial activity due to thermal inactivation of favourable microorganisms[18].

Compost temperature above 55°C for three consecutive days is recommended for effective elimination of pathogenic microorganisms[19-20]. In this work also the persistency of thermophillic temperature was significantly (P<0.01) higher in T_1 (54 days) and T_2 (65 days) than the control bin (17.5 days), which ensures maximum pathogen elimination.

Dead bird compost took significantly (P<0.01)longer period (table 3) to complete decomposition process (116.5 to 127.5 days) than the compost bin without dead birds (107 days). Relatively shorter duration (14 to 20 days) was reported for dead bird compost with poultry manure by Murphy[17], Murphy and Carr[21]. But Cummins *et al.*[22] reported 43 days and more to finish composting of dead birds. The reported periods were for temperate and subtropical climate and from the results it could be inferred for tropical summer climate prolonged the composting process beyond 100 days.

Moisture content (table 3) of finished compost ranged between 28.74 and 39.847 and treatment mixture T_1 (30.54%) and T_2 (28.74%) showed significantly (P<0.01)lower moisture than control bin T_3 (39.847%) indicated that straw and hay had poor moisture holding capacity. Weight reduction was higher in T_1 (46.05%) followed by T_2 (41.14%) than control (31.80%). Similarly volume reduction was also significantly (P<0.01)higher in dead bird compost mixture than control mixture (table 2) which is higher than the reported values of 25 to 30 per cent by Murphy[17] and McCaskey[23] for dead bird compost with poultry manure as substrate and comparable with the values of 50 to 60 per cent for hog compost reported by Fonstad *et al*[24].

In this study no obnoxious odour or fly menace was noticed during the study period. The paddy straw and sorghum hay are effective in controlling the odour and they acted as biofilter. The high temperature generated during composting process create an unfavourable environment for fly breeding also

Physicochemical Changes: 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 dead bird compost with FYM as manure substrate are with the acceptable range. The quantity of calcium, magnesium, sulphate, sodium, chloride and other ions are responsible for EC and the EC was significantly higher in T_1 followed by T_2 and T_3.

The treatment mixture with FYM (T_1 and T_2) group showed uniformity in TOC indicated that both the carbon sources (straw and hay) are effective and equally degradable. Similarly the total nitrogen content (table 4) was significantly(P<0.01) higher in dead bird compost mixture than control compost, 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.*[24] that addition of hog carcass in the compost mixture increased the level of N by 108 per cent in the finished product. The C:N ratio was significantly lower (Table 3) in compost mixtures with dead birds than control. The C:N ratio below 20 can be considered satisfactory for compost maturity, when the initial C:N ratio is between 25 and 30[25] and it could not be an absolute indicator for compost maturation[26]. Most of the compost recipes in the present study had a C:N ratio below 20 hence are considered matured. Vuorinen and Saharinen[27] reported the C:N ratio decreased from 22.6-28.5:1 to 21.8-26.9:1 while composting cattle manure and further reduction was noticed during curing (12.7-13.6). Similar drastic reduction was also noticed by Inbar *et al*[28] in liquid cattle manure from 27.1:1 to 8.1:1 during composting process. Similarly in this study also, heavy reduction in C:N ratio was noticed in FYM compost indicating higher decomposition in cattle manure compost. The calcium and phosphorus content of dead bird compost was also most uniform as that of control mixture and dead birds did not showed any significant effect on Ca and P content of finished compost. On the other hand potassium content was significantly higher in treatment mixture than compost mixture without dead birds.

Microbial Changes: The total bacterial count (TBC) was reduced from the initial compost to the end of primary stage and there after the microbial stabilization was noticed indicating that the mesophilic organisms decreased significantly (table 5) due to higher pile temperature during the first heating cycle but they are reestablished again at the end of second phase of heating cycle. Similar fluctuation was noticed by Tiquia and Tam[8] and Hassen *et al*[16].

The presence of coliform bacteria is often used as an indicator of overall sanitary quality of soil and water environment. Use of an indicator such as coliform, against actual disease causing organisms is advantageous as the indicators generally occur at higher frequencies than the pathogens and are simple and safer to detect[16]. In this experiment also, an attempt was made to enumerate total coliforms as an indicator of pathogenic microorganisms. The coliform count was higher at the time of loading composting bins mainly due to additions of dead birds and good reduction in coliform count was noticed at the end of primary heating cycle and the trend was continued up to end of composting cycle (Table 5). In the finished compost the coliform count was significantly (P<0.01) lower in T_1 and T_2 than control group. Similar reduction was also reported by Tiquia *et al.*[29] while composting spent pig litter and Ramos *et al*[30] while composting cow manure with tannery effluent and wheat straw. The reduction was due to unfavorable condition (65 to 70ºC) established during the thermophilic phase[16].

The treatment mixtures with dead birds showed significantly higher levels of *Salmonella* count (Table 5). The addition of dead bird might be attributed to the increase in *Salmonella* level. At the end of first phase of composting the *Salmonella* count showed similar decreasing trend as that of coliform count. There was a drastic reduction in the count to non detectible level at the end of composting process, indicating the mixing of compost mixture eliminated maximum number of organisms. The destruction of *Salmonella* by the composting process was reported by Murphy[31]; Cummins *et al.*[22] ; Donald *et al*[6]; Tiquia *et al*[29]and Das *et al.*[32].

In the present study, parasitic egg determination was only carried out and the results showed that parasitic eggs could not be detected at the completion of both first and second heating cycles, indicating that the parasitic eggs were destroyed by the increase in bin temperature. Haug[33]stated that the average temperature of 55 to 60 ºC for a day was sufficient to eliminate protozoa (including cyst) and helminthes ova to a acceptably low level. Even at a temperature of 40 ºC

Fig. 2: Layering of dead birds for composting.

Fig. 3: Mini compost bins used for composting dead birds.

the *Ascaris* egg and other helminthes eggs were reduced to a non detectible level Ramos[30].

Conclusions: This experiment revealed that the dead birds from the commercial poultry farms can be effectively composted with FYM and the resulted end product is richer in N content. The temperature profile of the compost piles favours the elimination of pathogenic microbes and parasitic eggs, which ensures biosecurity of the poultry farms. Higher weight and volume reduction and the favourable pH of the finished compost ensure the safety to land application.

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