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AEROBIC COMPOSTING AS A SUITABLE ALTERNATIVE FOR EFFICIENT MANAGEMENT OF POULTRY FARM WASTE

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ABSTRACT

Poultry being fastest growing segment, estimated to have around 4500 thousand metric tons annual poultry waste production in India. Handling and disposal of this huge waste is a great task for the poultry producers. The experiment was conducted for 90 days during July to September month to investigate the processes taking place during composting with regards to biodegradability of the mixture for efficient waste disposal. Two treatments with 3 replicates using enclosed compost bins (1.2m length × 1.2m width × 1.2m height), T_1 was prepared by mixing poultry litter, dead carcass or offals of slaughtered birds and paddy straw (*Oryza sativa*) as a source of carbon. Sequential layering of dead carcass or offals of slaughtered birds, poultry litter and addition of water was same except the carbon source *i.e.* paddy straw was replaced by saw dust thus forming second treatment (T_2) and were compared with the control group consisting of conventional waste material (T_0) which was composed of poultry litter and debris. Physical changes, chemical composition and microbial load of initial ingredients and finished product were recorded during composting. Mature compost weight reduction was higher in treatment mixture T_1 (31.6 %) followed closely in T_2 (30.1%) than the T_0 (10.5%). Volume reduction indicated significant difference between both T_1 (41.8 %) and T_2 (15.5 %) groups. On day 7 of composting, theT_1 and T_2 had pH of 8.82 and 8.67 respectively, while approaching to maturity the compost mixture had pH of 8.3 and 8.1 in treatment T_1 and T_2 respectively. Electrical Conductivity and Total Dissolved Solids had decreasing trend from primary stage to secondary stage. The total organic matter content was reduced at the end of secondary stage and ranged between 19.6 and 21.2 per cent. There was a reduction in total organic carbon content at the end of secondary stage in both the treatments T_1 and T_2 which was found to be 20.32 and 21.4 per cent respectively. This might be due to loss of organic matter through microbial degradation. At end of composting, the total Nitrogen content of different treatment mixtures ranged between 2.71-3.81 per cent. C: N ratio of different treatment mixtures did not differ significantly at maturity and it ranged between 14.1:1 and 14.5:1. The Ca and P levels of the composted product were increased by 49.8 and 48.2 per cent in treatment containing paddy straw and saw dust respectively. The Total Bacterial Count was numerically higher at the time of loading, reduced at end of primary stage and maintained thereafter. Reduction in lactose fermenter and non-lactose fermenting bacteria was also found till maturity of compost. In conclusion, use of aerobic composting as method of waste disposal is efficient management of poultry farm waste.

Key words: Aerobic composting, Chemical Composition, Microbial load, Physical composition, Poultry waste

Poultry is one of the fastest growing segment (growing at the rate of 8-10 per cent per annum) of the agriculture sector in India, ranked third in world egg production with an estimated population of 158 million layers (FAO, 2003). However, this sector is accompanied by production of huge quantities of organic waste materials viz. faeces, urine, bedding

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material, feather, broken eggs and dead birds etc. Handling and disposal of this huge waste is a great challenge for the poultry producers. The problem of waste disposal may further be aggravated by disposal of dead birds to the tune of 7-11% annually (Mehta et al., 2003). Large-scale accumulation of these wastes may pose disposal and pollution problems unless environmentally and economically sustainable management technologies are evolved (Kelleher et al., 2002; Sharpley et al., 2007). Various methods like incineration, burial, anaerobic digestion and rendering etc. employed in disposal of dead birds are costlier and labour intensive. However, pollution and nuisance problems can occur when manure is applied under environmental conditions that do not favour agronomic utilisation of the manure-borne nutrients. The continued productivity, profitability, and sustainability of the poultry industry will likely to be dependent on the formulation of best management practices to mitigate environmental consequences associated with air and water quality parameters that are impacted by land application, and the development of cost-effective innovative technologies that provide alternative to land application of poultry wastes (Kelleher et al., 2002). All these issues related to farm waste disposal have rekindled the global interest in organic recycling practice like composting. It is a controlled natural process in which beneficial micro-organisms (bacteria and fungi) reduce and transforms organic waste into a useful end product with lesser cost and labour called compost. (Abdelhamid et al.,2004). Co-composting of litter and dead carcasses may further improve the value of resulting product and may be used as pathogen free livestock feed ingredient.

Composting of poultry manure reduces the odour and pathogens and improves its quality as a soil amendment. Addition of organic material, e.g., sawdust, increases the C: N ratio to achieve optimum degradation of organic carbon and retention of nitrogen through biomass formation. However the relative biodegradability of the organic material in poultry litter and the amendment are usually not known. It is assumed that as microorganisms metabolize organic compounds and produce CO_2, they increase biomass and retain nitrogen (Atkinson et al., 2005).Composting of livestock and poultry manure and municipal solid waste is recommended as an eco-friendly process with the less cost and labour. Hence an attempt was made to compost the dead birds along with conventional poultry farm waste. Co-composting of litter and dead carcasses may further improve the value of resulting product and may be used as pathogen free livestock feed ingredient. Therefore, in the light of above said facts the present study has been planned to investigate the processes taking place during composting with reference to biodegradability of the mixture and the suitability of the final product as livestock feed ingredient.

MATERIALS AND METHODS

The dead birds composting experiment was carried out at the Poultry Farm, Department of Livestock Production Management, College of Veterinary Science GADVASU, Ludhiana, Punjab, India.

Study Area and Climate

Ludhiana is located at the latitude of 30°54’ north, longitude of 75°48’ east and at the height 246 meters above mean sea level (MSL). The maximum temperature ranges from 40 to 47°C and minimum temperature ranges from 1.6 to 24°C with a mean annual rainfall of 730.5 ± 6.19 mm.

Mini composter

The specially designed compost bins were fabricated of size 1.2m length x 1.2m width x 1.2m height (Donald et al., 1996; Anon., 2000 and Sivakumar et al., 2008).The floor of each compost bin was made up of concrete slab and the side walls of compost bin were made of wooden planks of suitable width and thickness. An air space of two inches was created between two consecutive wooden planks for better aeration.

Ingredients

Dead birds were obtained from commercial poultry farms of GADVASU, post mortem section of Department of Veterinary Pathology and stored in the deep freezer at -20˚C till sufficient carcasses were available for uniform filling. Poultry litter was made available from different poultry farms of GADVASU and was utilized as manure substrate. The low cost carbon sources like ‘paddy straw’ and ‘saw dust’ were collected from the farm of Agriculture University and local market respectively. Dried paddy straw was chaffed to a length of 2 to 3 inches for ease of filling the compost bin, whereas the saw dust powder was used as such.

Compost treatments

First treatment (T_1) composed of dead birds, cage layer manure, paddy straw mainly. Water was added to maintain the moisture percentage to optimum.

Second treatment (T_2) composed of dead birds, cage layer manure and saw dust. water was also added in this group to maintain the moisture percentage to optimum.

Control group (T_0) was having conventional poultry farm waste i.e. poultry litter material, debris, dead birds and broken egg shells etc.

T_1 - Dead birds + Cage layer manure +Paddy straw + Water

T_2 - Dead birds + Cage layer manure + Saw dust + Water

T_0 - Conventional poultry waste

Table 1. Ratio of the initial ingredients added to the compost bins

PARAMETER		INGREDIENTS			
		Paddy straw	Poultry litter	Saw dust	Poultry carcass
Density (Kg/L)		**0.08**	**0.32**	**0.416**	**0.1001**
Volume (L)	T_1	1240	230	-	200
	T_2	-	740	495	400
Mass (Kg)	T_1	99.2	73.6	-	20.2
	T_2	-	236.8	206.4	40.05
Carbon (Kg)	T_1	48.57	31.34	-	10.03
	T_2	-	100.85	114.93	20.07
Nitrogen (Kg)	T_1	0.177	2.42	-	1.88
	T_2	-	7.81	0.203	3.76
Final C: N ratio of T_1 and T_2 = 20: 1					

The ingredients added to T_1 and T_2 were added in such a way to balance th carbon and nitrogen ratio to 20:1

Physical and chemical parameters

The compost bins were filled as per recommendation of Donald et al., and USDA-NRCS 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 TREND), Moisture content of composting samples was determined by drying at 105ºC in the hot air oven for 24 hours(Tiquia and Tam, 2002).

pH, electrical conductivity (EC) and total dissolved salts (TDS) were measured using digital pH meter (Waterproof pH, EC/TDS and Temperature meter, HANNA Instruments, model No. HI 98130) by preparing 1: 10w/v compost – water extract (Tiquia and Tam, 2002).

Total organic matter (TOM) was calculated by gravimetric loss on ignition produced by ashing the samples in a muffle furnace for 5 hours at 550º C. 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” of1.724. The weight loss on ignition was divided by1.724 to give the percentage of total carbon. Compost samples were analysed for total Kjeldahl nitrogen, crude fibre, ether extract, phosphorus and calcium as per the procedure outlined by AOAC. Microbial load was estimated as per Miles and Misra method.

Statistical analysis

The collected data from the experiment was subjected to statistical analysis using Software Package for Social Sciences (SPSS, version 16.0) and analysed by ANOVA (Snedecor and Cochran, 1989) to test the difference between various treatments. The treatment means were compared by Duncan’s Multiple Range Test (Duncan, 1955) at 5% level of significance ($P \leq 0.05$).

Results and Discussion

The results of present study with respect to total ash, total organic matter , total organic carbon, Nitrogen, C:N ratio ether extract ; crude fiber (%), Calcium, Phosphorous (%); Total bacterial count (TBC), lactose fermenting, non-lactose fermenting bacteria; pH, electrical conductivity (mS/cm) and total dissolved salts (ppt) of compost samples under different treatment groups have been presented in Table 2, 3,4 and 5 respectively.

Weight and volume reduction

The weight reduction was significantly higher ($P<0.05$) in treatment mixture T_1 (31.6 %) followed closely in T_2 (30.1%) than T_0 (10.5%). The data for volume reduction indicated significant difference between both T_1 (41.8 %) and T_2 (15.5 %) groups. Whereas, 7.5% reduction ($P<0.05$) in volume of litter material of control group (T_0) was noticed. Hence there is noticeable reduction in mass and volume by doing the aerobic composting. This depicts reduction in the waste and improving the quality of that simultaneously.

pH

Treatment mixture with conventional poultry waste (T_0) had significantly ($P<0.05$) higher pH values during primary and secondary stages except on 7th day of composting than both the treatment groups where comparatively low pH(8.19) was noticed. The highest value (9.4) was recorded on 75th day in the control. In contrast to these findings, treatment compost mixtures (T_1 and T_2) had significantly lower ($P<0.05$) level, which was near neutral (7.2; 7.1) and (7.3; 7.5) pH at the end of primary and secondary stages, respectively. The pH in T_1 and T_2matches the pH of the soil hence this can be said that the final product obtained from both the treatments could be a good fertilizer for fields in comparison to T_0 .

Electrical Conductivity (EC) and Total Dissolved Solids (TDS)

The data for EC showed a decreasing trend from primary stage to secondary stage. EC was significantly lower ($P<0.05$) in T_1 (5.0 mS/cm)and T_2 (4.8 mS/cm) than the T_0(6.84 mS/cm). The EC in the finished compost was reduced to 2.4 mS/cm in both T_1 and T_2 groups. The data for total dissolved salts followed similar trend to EC from primary to secondary stage in all the compost groups. The TDS at the end of primary stage was significantly lower ($P<0.05$) in dead bird compost mixtures (2.75 and 2.65 ppt), respectively in T_1 and T_2 than T_0 which had 3.76 ppt of TDS. But in the finished compost, the TDS values in both the treatments further declined to 1.3 ppt which differed significantly from the control with 2.4 ppt of total dissolved salts. Hence this is clear that T_1 and T_2 are better fertizers than T_0 .

Proximate analysis

The average ash content pertaining to the compost and control groups is furnished in Table 2. The results of analysis of variance showed that there was no significant difference between different treatment mixtures (T_1 and T_2) after the end of primary stage of composting. However, this difference was found statistically significant ($P<0.05$) when compared with the control group. The finished compost of both the treatment groups had significantly increased ash content (about 16%) than at the end of primary stage. However, data of conventionally disposed poultry waste indicated consistent ash percentage up to 60 days of period and thereafter 13 % increased ash content in the control group.

The data for TOM content of the treatment and the control decomposed litter samples are presented in Table 2. The total organic matter content was reduced at the end of composting process in both the treatment and the control groups. The results revealed that the TOM content ranged between 84.2- 84.8 per cent and had statistically similar values in both treatment mixtures (T_1 and T_2 respectively) at the end of primary stage. Similarly, finished compost had 68.3 and 67.8 per cent of TOM content, respectively in T_1 and T_2 groups as compared to the slightly lower value of 63.1 per cent in the control. However, this numerical difference in the TOM content of all the groups was statistically non-significant.

The mean values of TOC content of all the groups are presented in Table 2. The mean carbon content did not differ significantly among treatment mixtures T_1 and T_2 throughout the composting process except during 31 days period in which TOC value of T_1 compost was statistically similar value as that of the control.The total organic carbon content ranged between 48.8 - 49.2 per cent at the end of primary stage of composting in both the treatment mixtures and were significantly higher ($P<0.05$) than the control group. At the terminal stage of composting, there was a reduction in TOC (39.6 and 39.3 per cent) values, respectively in both the treatments as well as in control group. Overall, TOC values in both the treatments differed significantly from control (T_0) in primary as well as till end of composting process at 5 per cent level of significance.

Total N content of compost recipes of T_1, T_2 and the control are shown in Table 3. The results revealed significant ($P<0.05$) difference in the total nitrogen content of litter compost material of all the groups at the end of 7th day of composting process. The N content of all the groups ranged between 3.3 and 3.5 per cent with numerically similar values at the end of primary stage. At end of composting, the total N content of different treatment mixtures had significant ($P<0.05$) difference and it ranged between 2.71- 3.81 per cent. There was a reduction of 19.48 and 28.50 per cent, respectively, in T_1 and T_2 groups during the whole process of composting. However, conventionally disposed poultry litter (T_0) maintained the consistent range of 3.15- 3.81 per cent of the nitrogen content.

The C: N ratio at the end of primary stage was numerically higher in both the treatment mixtures with a range from 13.8:1 -14.6:1. The C:N ratio followed increasing trend up to 60 days of composting in both the treatment groups than the control where reverse trend was noticed. At the end of composting process, the C: N ratio of different treatment mixtures did not differ significantly, it ranged between 14.1:1- 14.5:1. From the results, it is evident that the C: N ratio showed a reducing trend from initial to end of primary stage and from primary to secondary stage in both the treatment groups (Table 2).

The average values for ether extract and crude fibre are presented in Table 3. The results revealed that there was a gradual increase in ether extract (EE) value from the beginning of primary stage till maturity of compost in both the treatment (T_1 and T_2) groups. In both the treatments, the values of ether extract were statistically similar except at the end of 31 days of composting where both the groups differed significantly from each other and the control group.

Whereas there was a gradual decline in CF values in both the treatments from the beginning till the maturity of compost as indicated in Table 3. Reduction in CF value in T_1 was from 25.7- 5.5 per cent from the start to end of the composting process. In T_2 the similar trend was observed and the reduction in the CF value was from 19.5- 5.01 per cent. The control group followed a very slight reduction in CF values as compared to both the treatments.

The results revealed that at the end of primary stage of composting, Ca content was significantly lower ($P<0.05$) 1.9 and 2.1per cent in both the treatments (T_1 and T_2) respectively than the T_0. However, there was no significant difference among both the treatment groups. Increase in Calcium levels in both the treatment composts was observed

Table 2. Effect of different treatments on total ash, total organic matter, total organic carbon, Nitrogen and C:N ratio of compost

Days	Total ash (%)			Total organic matter (%)			Total organic carbon (%)			Nitrogen (%)			C: N ratio		
	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2
7	$20.8^{b}\pm0.09$	$14.1^{a}\pm0.3$	$13.7^{a}\pm0.7$	$79^{a}\pm0.09$	$85^{b}\pm0.3$	$86^{b}\pm0.7$	$45.9^{a}\pm0.05$	$49.7^{b}\pm0.2$	$50^{b}\pm0.4$	$3.15^{a}\pm0.05$	$3.49^{b}\pm0.09$	$3.79^{c}\pm0.03$	14.5±0.2	14.3±0.47	13.1±0.19
21	$22.2^{b}\pm0.1$	$15.7^{a}\pm0.4$	$15.1^{a}\pm0.4$	$77.7^{a}\pm0.1$	$84.2^{b}\pm0.4$	$84.8^{b}\pm0.4$	$45.1^{a}\pm0.09$	$48.8^{b}\pm0.2$	$49.2^{b}\pm0.2$	3.3±0.01	3.3±0.07	3.5±0.05	13.5±0.03	14.6±0.4	13.8±0.2
31	$20.5^{b}\pm0.2$	$21.5^{b}\pm0.4$	$17.8^{a}\pm0.8$	$79.4^{a}\pm0.2$	$78.4^{a}\pm0.4$	$82.1^{b}\pm0.8$	$46^{a}\pm0.1$	$45.4^{a}\pm0.2$	$47.6^{b}\pm0.5$	$3.4^{c}\pm0.04$	$3^{a}\pm0.01$	$3.17^{b}\pm0.03$	$13.1^{a}\pm0.2$	$15.1^{b}\pm0.13$	$15^{b}\pm0.21$
45	22.5±0.01	23.3±0.3	21.3±0.9	77±0.01	76±0.3	78±0.9	44.9±0.005	44.4±0.17	45.5±0.5	$3.4^{b}\pm0.03$	$2.9^{a}\pm0.02$	$2.9^{a}\pm0.04$	$12.8^{a}\pm0.11$	$15.3^{b}\pm0.09$	$15.4^{b}\pm0.04$
60	23.2±0.06	25.4±0.38	23.6±0.7	76.7±0.06	74.5±0.3	76.3±0.7	44.5±00	43.2±0.2	44.2±0.4	$3.5^{c}\pm0.01$	$2.7^{a}\pm0.017$	$2.8^{b}\pm0.04$	$12.5^{a}\pm0.03$	$15.8^{b}\pm0.17$	$15.4^{b}\pm0.27$
75	$31.07^{b}\pm2.8$	$26.6^{a}\pm0.2$	$25.6^{a}\pm0.6$	$68.9^{a}\pm2.85$	$73.3^{b}\pm0.2$	$74.3^{b}\pm0.66$	$39.9^{a}\pm1.6$	$42.5^{b}\pm0.1$	$43^{b}\pm0.39$	$3.6^{b}\pm0.05$	$2.7^{a}\pm0.028$	$2.7^{a}\pm0.014$	$10.9^{a}\pm0.28$	$15.3^{b}\pm0.19$	$15.4^{b}\pm0.2$
90	$36.8^{b}\pm0.02$	$31.6^{a}\pm0.3$	$32.1^{a}\pm0.5$	$63.1^{a}\pm0.02$	$68.3^{b}\pm0.35$	$67.8^{b}\pm0.56$	$36.5^{a}\pm0.05$	$39.6^{b}\pm0.2$	$39.3^{b}\pm0.3$	$3.81^{b}\pm0.01$	$2.81^{a}\pm0.09$	$2.71^{a}\pm0.05$	$9.59^{a}\pm0.01$	$14.1^{b}\pm0.55$	$14.5^{b}\pm0.21$

Mean values bearing different superscripts in a row differ significantly ($p\leq0.05$)
Primary stage = Heating phase up to 21 days; Secondary stage = Heating phase up to 45 days + cooling phase 45 days onwards

Table 3. Changes in ether extract, crude fiber (%), Calcium and Phosphorous (%) of compost samples under different treatments

Days	EE (%)			CF (%)			Calcium (%)			Phosphorus (%)		
	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2
7	$1.6^{a}\pm0.01$	$2.9^{b}\pm0.1$	$3.2^{b}\pm0.16$	$11.2^{a}\pm0.02$	$25.7^{c}\pm0.8$	$19.5^{b}\pm1.19$	$3.83^{b}\pm0.035$	$1.70^{a}\pm0.04$	$1.81^{a}\pm0.09$	$1.75^{b}\pm0.07$	$0.37^{a}\pm0.15$	$0.375^{a}\pm0.035$
21	$1.7^{a}\pm0.03$	$7.06^{b}\pm0.13$	$7.5^{b}\pm0.36$	$10.8^{a}\pm0.01$	$16.6^{c}\pm0.5$	$15.1^{b}\pm0.2$	$4.3^{b}\pm0.03$	$1.9^{a}\pm0.01$	$2.1^{a}\pm0.1$	$2.6^{c}\pm0.01$	$0.75^{b}\pm0.02$	$0.59^{a}\pm0.03$
31	$1.68^{a}\pm0.02$	$8.4^{b}\pm0.25$	$9.8^{c}\pm0.17$	$9.85^{a}\pm0.03$	$13.1^{b}\pm0.17$	$13.2^{b}\pm0.63$	$4^{b}\pm0.1$	$2.1^{a}\pm0.04$	$2^{a}\pm0.05$	$2.04^{b}\pm0.02$	$1.03^{a}\pm0.03$	$1.02^{a}\pm0.06$
45	$1.76^{a}\pm0.025$	$10.9^{b}\pm0.1$	$11.5^{b}\pm0.33$	9.64±0.02	9.9±0.09	10.2±0.58	$3.4^{b}\pm0.03$	$2.6^{a}\pm0.06$	$2.5^{a}\pm0.025$	$2.4^{b}\pm0.055$	$1.22^{a}\pm0.03$	$1.26^{a}\pm1.15$
60	$2.09^{a}\pm0.01$	$13.5^{b}\pm0.32$	$14.9^{b}\pm0.56$	8.89±00	8.83±0.18	8.58±0.39	$3.6^{b}\pm0.12$	$3.0^{a}\pm0.05$	$2.81^{a}\pm0.07$	$2.28^{b}\pm0.06$	$1.37^{a}\pm0.04$	$1.49^{a}\pm0.046$
75	$2.2^{a}\pm00$	$15.9^{b}\pm0.43$	$17.4^{b}\pm0.48$	$8.7^{b}\pm0.005$	$7.19^{a}\pm0.3$	$6.4^{a}\pm0.09$	$3.6^{b}\pm0.1$	$3.1^{a}\pm0.05$	$3.0^{a}\pm0.08$	$1.2^{a}\pm0.005$	$1.4^{b}\pm0.04$	$1.7^{c}\pm0.02$
90	$2.2^{a}\pm0.015$	$18.4^{b}\pm0.3$	$19.8^{b}\pm0.73$	$8.5^{b}\pm0.07$	$5.5^{a}\pm0.65$	$5.01^{a}\pm0.16$	$3.8^{b}\pm0.04$	$3.39^{a}\pm0.06$	$3.5^{a}\pm0.06$	$2.12^{c}\pm0.015$	$1.83^{a}\pm0.02$	$1.96^{b}\pm0.019$

Mean values bearing different superscripts in a row differ significantly ($p\leq0.05$)

Table 4. Total bacterial count (TBC), lactose fermenting and non-lactose fermenting bacteria (6th dilution as log_{10} cfu/g) of compost samples under different treatment groups

Days	TBC			E. coli MLA			Salmonella and Salmonella like bacteria MLA			E. coli HC			Salmonella and Salmonella like bacteria HC		
	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2
7	2.00±00	3733±1809.5	1400±378.5	-	-	-	-	-	-	-	-	-	-	-	-
21	1±00	2.33±1.2	0.33±0.33	-	-	-	-	-	-	-	-	-	-	-	-
31	1±00	2±0.5	0.67±0.66	-	-	-	-	-	-	-	-	-	-	-	-
45	6±00	4.3±0.66	5.3±2.9	-	-	-	-	-	-	-	-	-	-	-	-
60	291.67^{b}±0.66	116.33^{a}±14.6	102.6^{a}±7.2	-	-	-	134^{ab}±1.15	163.6^{b}±20.08	72.6^{a}±27.7	-	-	-	178^{b}±1.7	178.3^{b}±13.7	123.6^{a}±13.6
75	1080±00	572.6±262.5	1020±472.5	-	-	-	780±0	410±69.69	450.04±250.4	-	-	-	311^{c}±00	244.6^{ab}±88	97.3^{a}±33.3
90	208^{b}±1.1	94.3^{a}±8.0	98.3^{a}±3.3	12.0^{b}±1.1	00^{a}	00^{a}	283.3^{b}±1.4	26.3^{a}±0.33	29.6^{a}±3.1	12.33^{b}±1.4	00^{a}	00^{a}	259.3^{b}±9.2	21^{a}±3	28^{a}±4.9

Mean values bearing different superscripts in a row differ significantly (p≤0.05)

Table 5. pH, electrical conductivity (mS/cm) and total dissolved salts (ppt) of compost samplesunder different treatment groups

DAYS	pH			EC			TDS		
	T_0	T_1	T_2	T_0	T_1	T_2	T_0	T_1	T_2
7	8.19±0.10	8.82±0.40	8.67±0.13	7.20^{b}±0.12	5.7^{a}±0.18	5.5^{a}±0.03	3.9^{b}±0.06	3.15^{a}±0.10	3.04^{a}±0.01
21	8.90^{b}±0.05	7.10^{a}±0.05	7.10^{a}±0.08	6.84^{b}±0.02	5.0^{a}±0.05	4.8^{a}±0.08	3.7^{b}±0.01	2.75^{a}±0.03	2.65^{a}±0.04
31	9.18^{b}±0.04	7.15^{a}±0.08	7.12a±0.05	6.60^{b}±0.03	4.1^{a}±0.08	4.0^{a}±0.20	3.6^{b}±0.01	2.20^{a}±0.04	2.20^{a}±0.10
45	9.30^{b}±0.06	7.30^{a}±0.04	7.50^{a}±0.08	6.20^{c}±0.04	3.4^{b}±0.03	3.2^{a}±0.06	3.4^{c}±0.02	1.90^{b}±0.01	1.76^{a}±0.03
60	9.03^{c}±0.03	8.30^{b}±0.05	8.10^{a}±0.06	5.10^{b}±0.02	3.1^{a}±0.05	3.0^{a}±0.03	3.0^{b}±0.01	1.70^{a}±0.03	1.60^{a}±0.01
75	9.40^{b}±0.12	8.70^{a}±0.12	8.60^{a}±0.20	5.00^{b}±0.03	2.9^{a}±0.05	2.8^{a}±0.08	2.7^{b}±0.01	1.50^{a}±0.03	1.50^{a}±0.04
90	9.20^{c}±0.05	8.30^{b}±0.05	8.10^{a}±0.06	4.40^{b}±0.03	2.4^{a}±0.05	2.4^{a}±0.08	2.4^{b}±0.01	1.30^{a}±0.03	1.30^{a}±0.04

Mean values bearing different superscripts in a row differ significantly (p≤0.05) approaching the end of composting, while fluctuation persisted in the calcium content of T_0 during the process.

The analysis of variance of data indicated that the mean P content among the treatment groups (T_1 and T_2) did not differ significantly during primary stage. But in the finished compost, the difference was highly significant (P<0.05). At the end of primary stage of composting, the total P content ranged between 0.75 and 0.59 per cent in both the compost groups. The calcium content of $T_{0,}$ T_1 and T_2 mixtures differed significantly (P<0.05) at the end of 21st and 75th day of composting. In the finished compost, the total P content ranged between 1.83 and 1.96 per cent in both the treatment mixtures with added carbon source and it was significantly (P<0.05) higher (2.12 per cent) in T_0.

As there is decline in the organic matter in both the treatments and there is rise in Ca and P levels reaching the end of composting. This can be said that the compost mass obtained from T_1 and T_2 is a better fertilizer than obtained from T_0.

Microbial load

The mean total bacterial count (TBC) is presented in Table 3 and the results revealed a highly significant difference (P<0.05) at various stages of composting. The TBC was numerically higher in $T_{1,}$ T_2 than T_0 on day 7 of composting. These values were non-significant among the compost and the control mixture. After that there was a sharp decline in TBC levels up to day 31 in $T_{0,}$ T_1 and T_2 groups. Overall, the TBC levels were increased by the end of maturity in all the groups.

The mean (± SE) coliform count during different stages of composting is presented in Table 4. The analysis of variance revealed that in the 6th dilution, the E. *coli* were declined to zero level in primary as well as secondary stages of composting. While in the terminal stage of composting, 12 log_{10}cfu/g of E. *coli* count was recorded in control group only.

The mean (± SE) non-lactose fermenting bacteria viz., *Salmonella* and *Salmonella* like bacteria in the poultry litter waste samples during different stages of composting is presented in Table 4. The analysis of variance revealed that in the 6th dilution, the non-lactose fermenting bacteria were declined to zero level in primary as well as secondary stages of composting. While in the cooling stage of composting, non-lactose fermenting bacteria were evaluated as 163.6, 72.6 and 134 log_{10} cfu/g in T_1, T_2 and $T_{0,}$ respectively. The bacterial count in these groups was significantly different except the control which had statistically similar values of bacterial count as those in T_1 and T_2 groups. On 75th day, an increase in non-lactose fermenting bacteria (410, 450.04 and 780 log_{10} cfu/g respectively) in all the treatments (T_1, T_2 and T_0) was recorded without any significant difference. While in the end of composting process on day 90, there was again a decrease in the count in T_1 and T_2 (26.3 and 29.6 log_{10}cfu/g, respectively) while a significantly higher value (283.3 log_{10}cfu/g) was observed in case of T_0 group.

CONCLUSION

As we are getting better manure than the conventional waste of the poultry (T_0) in T_1 and T_2, hence from the above results this can be concluded that the aerobic composting is better alternative for poultry farm waste management.

REFERENCES

1. AOAC. 1990. Official method of analysis: 16th ed. Association of official analytical chemists Washington D C, USA.
2. Atkinson C F, Jones D D, Gauthier J J. 2005. Biodegradability and microbial activities during composting of poultry litter. *Bioresource Technology,* **96**:1584-91
3. Abdelhamid M T, Horiuchi T and Oba S. 2004. Composting of rice straw with oil seed rape cake and poultry manure and its effect on faba bean (*Vicia faba* L.) growth and soil properties. *Bioresource Technology,* **91**: 183-89
4. Donald J, Blake J P, Tucker K and Harkins D. 1996. Mini-composters in poultry production. Alabama Cooperative Extension System, ANR-804. www.aces.edu.
5. Duncan D B. 1955. Multiple range and multiple “F” tests. *Biometrics* **11**: 1-42

6. FAO. 2003. Cited in: *Poultry Int.,* 2005. **44** (1): 28
7. Kelleher B P, Leahy J J, Henihan A M, O'Dwyer, Sutton D and Leahy M J. 2002. Advances in poultry litter disposal technology-a review. *Bioresource Technology,* **83**: 27-36
8. Mehta R, Nambiar R G, Delgado C L and Subramanyam S. 2003. Livestock Industrialization Project: Phase (II) – Policy, technical and environmental determinants and implications of the scaling-up of broiler and egg production in India. Final research report of project on livestock industrialization, trade and social-health-environment impact in developing countries, International Food policy Research Institute, Washington, D C.
9. http://www.virtualcentre.org/en/res/awi/reports/x6170e/x6170e2j.htm
10. Sharpley A N, Herron S and Daniel T. 2007. Overcoming the challenges of phosphorus-based management challenges in poultry farming. *Journal of Soil and Water Conservation* **58**: 30-38
11. Sivakumar K, Kumar R S V , Richard Jagatheesan P N, Viswanathan K and Chandrasekaran D. 2008a. Seasonal variations in composting process of dead poultry birds. *Bioresource technology,* **99**: 3708-13.
12. Snedecor, G.W. and Cochran W.G. 1989. Statistical Methods. 8th Edition, Iowa State Press, Ames, Iowa, USA.
13. Tiquia S M and Tam N F Y. 2002. Characterization and composting of poultry litter in forced-aeration piles. *Process Biochem.,* **37**: 869-80
14. USDA-NRCS. 2000. United States Department of Agriculture - Natural Resources Conservation Service. Composting: Environmental Engineering National Engineering Handbook.637. www.info.usda.gov/CED/ftp/CED/neh637-ch02.pdf.