INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 5, No. 12, p. 105-115, 2014

RESEARCH PAPER OPEN ACCESS

Nutrients release pattern during co-composting of poultry litter and different sources of fast food wastes

M. Azeem[1,2*], A.N. Chaudhry[2], M. Faheem[3], M. Imran[4], A. Riaz[5] , A. Satti[6]

[1]*Department of Environmental Sciences, University of California, Riverside, CA, USA*

[2]*Department of Soil Science and Soil Water Conservation, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi 46300, Pakistan*

[2]*College of Agriculture, Nanjing Agricultural University, Nanjing, China*

[3]*Department of Pest Warning and Quality Control of Pesticides, Punjab, Pakistan*

[4]*Queensland Alliance for Agriculture and Food Innovation. The University of Queensland, Brisbane, QLD 4072, Australia*

[5]*National Agricultural Research Centre, Islamabad, Pakistan*

Key words: Co-composting, fast food waste, poultry litter, nutrient release.

http://dx.doi.org/10.12692/ijb/5.12.105-115 Article published on December 15, 2014

Abstract

Today our earth is experiencing various serious environmental challenges, among which one of the most critical is associated with raw poultry litter and fast food waste. These challenges could be mitigated by stabilizing its nutrients with co-composting. In the present study, co-composting of poultry litter (PL) and fast food waste (FFW) was carried out in a pile under aerobic condition to analyze the chemical changes during the composting process. The experiment was conducted with complete randomized design with five treatments, i.e., T_1= PL+FFW (100:0); T_2= PL+FFW (75:25); T_3= PL+ FFW (50:50); T_4= PL+ FFW (25:75); T_5= PL+FFW (0:100), and three replications. Samples were collected at 15 days interval for the duration of 105 days and analyzed for C: N ratio, macro-nutrients (N, P and K) and micronutrients (Cu, Fe, Zn & Mn) in each treatment. Treatment PL+FFW (75:25) attained C:N ratio up to the desired level (12:1). While N, P and K concentrations recorded at 105th day of composting for this treatment were 3.3%, 1.06% and 2.71%, respectively. The concentration of Cu, Fe, Zn and Mn of poultry litter and fast food waste (75:25) were 21.92 mg kg^{-1}, 210.25 mg kg^{-1}, 288.63 mg kg^{-1} and 172.05 mg kg^{-1} respectively, at the 105th day of composting. The study depicted that the poultry litter and fast food waste in 75:25 ratio released maximum amount of macro nutrients, i.e. N, P and K, as compared to other treatments. Hence, it can be considered as a more appropriate ratio for co-composting of poultry litter and fast food waste. This study would help in conversion of poultry litter and fast food waste to bio-fertilizer as a feasible and potential technology in the future to maintain the natural resources and to reduce the impact on environmental quality.

* **Corresponding Author:** M. Azeem ✉ cmazeem78@gmail.com

Introduction

A food waste is the second largest component of municipal wastes posing serious environmental hazards when subjected to land filling and incineration (USEPA, 2011). Composting is considered to be a more sustainable alternative to land filling and incineration for managing food waste (USEPA, 2010) and to transform into useful bio-fertilizer (Debosz *et al.*, 2002). In various studies about food being wasted, amounts 35%, based on the difference between the calories brought into the home and calories consumed (Saer *et al.*, 2013; ERS 2007). Fast food waste usually contains about 80% of water besides oil and biodegradable organic matter (Haruta *et al.*, 2005; Gonzales *et al.*, 2010). Poultry litter is in fact a mixture of poultry droppings and bedding materials (Regulation, 2002; Lynch *et al.*, 2013), which is produced in millions of tons and ultimately subjected to improper disposal. In general, farmers use this manure directly as fertilizer in their field without any preliminary treatment. Thus, this leads to serious environmental problems such as increased nutrient loss through leaching, erosion and runoff from agricultural fields along with many pathological problems (Gerba and Smith, 2005; Font-Palma, 2012). Nitrogen losses from manure are larger with possible contamination of soil (Petric *et al.*, 2009), and other environmental implications (Font-Palma, 2012). Co-composting is a biological process to decompose two or more types of organic materials (Petric *et al.*, 2012) into a stable humus like substance, and is expected to overcome the disadvantages of composting of a single material (Kumar *et al.*, 2010). Different combinations of residual matters had been tested for co-composting such as: olive mill waste water with solid organic wastes (Paredes *et al.*, 2000), rose processing waste with organic fraction of municipal solid waste (Tosun *et al.*, 2008), poultry manure and wheat straw (Petric and Selimbasic, 2008), municipal solid wastes and sewage sludge (Fourti *et al.*, 2010), physic nut de-oiled cake with rice straw and different animal dung (Das *et al.*, 2011), sewage sludge, barks and green wastes (Watteau and Villemin, 2011). It is practiced at both large and small scales (Cooperband, 2000). The soils in Pakistan are characterized by low nutrients and poor organic matter contents, can be replenished by applying compost to enhance the fertility and productivity (Khan *et al.,* 2003; Sarwar *et al.,* 2008).

In Pakistan, both poultry and fast food industry is growing with a ramping speed. The restaurants, hotels and fast food chains are producing tons of solid, fast food waste every year. In the current scenario of advanced technology and scarcity of land, to handle this huge amount of poultry and food waste at waste disposal sites in the urban surroundings, had increased the demand for development of an efficient and environmental friendly waste management system among which co-composting is the right option. Keeping this in view present study was designed to study the nutrients release pattern of co-compost from poultry litter and fast food waste incurred during the preparation process and find the best combination of poultry litter and fast food waste in terms of nutrient release.

Materials and methods

Composting feedstock

Poultry litter was collected from the sheds of Poultry Research Institute (PRI), Rawalpindi contains bedding material and poultry droppings. Likewise, fast food waste from the different fast food chains and restaurants like KFC, Pizza hut etc. containing cardboard, cooking oil, metals, food scraps and decomposable wastes (vegetables, meat). Five open pits of 1x1x1meter (LxWxD) were excavated and treatments were allotted in completely randomized design (CRD) as described by Inckel *et al.*, 2005); Khan *et al.*, 2012; Chaudhry *et al.*, 2012). The pits were lined with concrete to reduce the leaching losses (Figure 1). Two pits were filled with poultry litter and fast food waste separately, while remaining three pits were filled with mixing poultry litter and fast food waste in different ratios. The treatments used for co-composting where T_1= Poultry litter + Fast food waste (100:0); T_2= Poultry litter + Fast food waste (75:25); T_3= Poultry litter + Fast food waste (50:50); T_4= Poultry litter + Fast food waste (25:75) and T_5= poultry litter + Fast food waste (0:100).

Feedstock characterization

Temperature of compost heap was taken at 15 days interval by a thermometer at different depths of compost pile in the pit. Three compost samples were taken from each treatment at 15 days interval for analysis. A fresh sample of compost was taken and weighed it before drying in oven at 65°C for 48 hours. Then the compost sample was weighed again by electric balance (APHA 1989). Total organic carbon was determined by wet digestion in 1.0N potassium dichromate ($K_2Cr_2O_7$) solution and concentrated sulphuric (H_2SO_4) acid, and titrated against 0.5N ferrous ammonium sulphate solution ($Fe(NH_4)_2(SO_4)_2$) (Nelson and Sommers, 1982). Dried sample of compost (1.0g) was taken into micro Kjeldahl flask and total nitrogen was determined by digestion with sulphuric acid (H_2SO_4) and distillation process carried out by adding Boric acid in the presence of NaOH in distillation chamber. Nitrogen in the distillate was determined by titration against 0.01N H_2SO_4 until the color changed from green to pink (Schouwenberg and Walinge, 1973).

For the determination of total phosphorous, total potassium and micronutrients (Cu, Fe, Zn and Mn), dried compost sample (1.0g) was transferred into 100 mL Pyrex digestion tube. Ten mL of nitric perchloric di-acid mixture (2:1) was added to it and allowed to stand overnight. The mixture was heated in block digester up to 235°C until the white fumes of perchloric di-acid started appearing. After cooling down the mixture, volume was made up to 100 mL with distilled water (Issac and Johnson, 1975). Total phosphorous was analyzed on a spectrophotometer (Spectronic 21) at 420nm by adding molybdate reagent in the samples (Anderson andIngram, 1993). Total Potassium was analyzed on flame photometer by taking 1.0ml filtrate with the addition of 4ml lithium chloride ($LiCl_2$) Solution (Win kleman *et al.*, 1986). The filtrate of digested material was taken and used directly to determine micronutrient contents by atomic absorption spectrophotometer.

$$\text{Fe, Zn, Cu, Mn (ppm)} = (\text{ppm in extract} - \text{blank}) \text{x} \frac{A}{W}$$

A = Total volume of extract (mL)

W = Weight of dry compost (g)

Statistical analysis

Analysis of Variance (ANOVA) was performed to compare the variation among treatments during co-composting (Steel and Torrie, 1980). Significant differences between the mean values of the treatments were observed using LSD at $P \leq 0.05$ (Sokal and Rohlf, 1997).

Results and discussion

Physical changes during composting

The temperature and moisture content profile of five composting piles with different ratios of material were depicted in figure 2 and 3, respectively. The internal temperature of piles, recorded at very first day of composting, was not significantly different from one another. It was recorded from 33.5°C to 35.92°C in fast food and poultry wastes. A significant difference of 12.22^{as} was noticed on the 15th day of intervals. Similar results were also reported by Raj and Antil (2011). The temperature had increased with the passage of time, but not at a uniform speed. However, at 45th day of composting, an abrupt fall of temperature was recorded i.e., 6.86°C. A similar decline in temperature was observed on the 60th day. No appreciable decrease in temperature was observed at 75 days interval. A minimum decrease in temperature was observed at 90th and 105th days' time. Among all the treatments, the maximum change in temperature was observed during 15 to 30 days of composting, which suggested that during this time internal microbial activities were at peak and the decomposition (exothermic) process was carried out. The results were in line with those reported by Guang *et al.*, (2010). Similar results were also reported by Goyal *et al.*, (2005) that, initial temperatures of 28-30°C were recorded at the start of the composting process and the highest temperature was observed at thermophilic stage, up to 46°C during composting organic wastes. Similarly, results were also observed by Ogunwande *et al.* (2008) that pile temperatures during composting ranged between 28 and 71°C. Hachicha *et al.*, (2009) also revealed that composting mixtures rapidly achieved thermophilic temperatures (>45°C) and maximum temperature reached during composting was 62°C.

Fig. 1. Poultry Litter composting pile under plastic cover.

Data regarding release pattern nutrients suggested that maximum decomposition took place from 15th to 45th days of composting. The moisture contents (MC) at the start of co-composting ranged from 50.58-54.98% in fast food and poultry wastes, respectively (figure 2). Gradual increase in moisture contents was observed during the first 30 days of composting after that moisture content (MC) started to decrease throughout the composting process in all the treatments. Our findings were well in accordance with those of Patric and Selimbasic, (2008). They had reported that high MC above 69.11% could cause difficulty in the starting of the composting process as pores are completely filled, while too low MC (< 45) also leads to early drying of composting piles. On the 30th day of composting maximum moisture contents (54.98%) were recorded in fast food waste (T_5) depicting slowness of the composting process. Data revealed that most of the decomposition work by microbes was done during 60 to 105 days of composting. At the 105th day of composting minimum moisture content (38.4%) was recorded in poultry litter while the maximum in fast food waste (43.41%). Moisture contents recorded in treatment poultry litter and fast food waste (50:50) and poultry litter and fast food waste (25:75) were statistically at par but differ significantly with that of poultry litter and fast food wastes individually. Amlinger *et al.*, (2008) had reported that 65-70% as initial moisture content and maintaining moisture content of 50-60% in subsequent stages. These results was signed in agreement with the current research findings that moisture content ranges between 53-59%.

Chemical changes during composting

Comparative effect of co-composting of poultry litter and fast food wastes on concentration of micronutrients. The data of C: N ratio revealed that it was high in all the treatments at initial stage and decreased with the passage of time. At first day maximum C: N ratio (43.45).

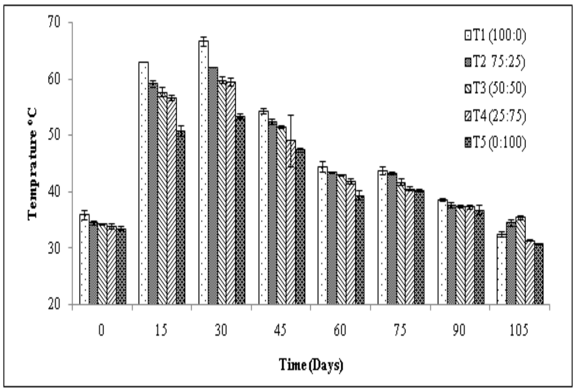

Fig. 2. Comparative effect of various ratios of poultry litter and fast food wastes (T_1 to T_5) on Temperature (C) at different time intervals (0 to 105 days) during co-composting. Vertical bars show standard error among three replicates and subjected to LSD (α > 0.05), where value is between 0.94 - 2.67.

Gradual decline in C: N ratio was observed in all the treatments during the first 45 days, which speed up from the 60th day of composting and continued up till 90th day. While the data recorded on 45th, 90th and the 105th day showed that composting was slowed down and there is decrease in C:N ratio. This trend showed that maximum composting activity was at the start of the composting process till 45th day. Lowest C:N was observed in treatment T_1 and T_5 with 100% poultry litter and fast food waste. The maximum decreasing trend for C:N was observed for poultry litter and fast food waste (75:25), which was considered to be the best combination of poultry litter and fast food waste as reported by Raj and Antil, (2011). Due to the decomposition of carbohydrates, the C:N ratio decreases. Several studies (Huang *et al.*, 2004; Benito *et al.*, 2006; Amanullah, 2007; Zhu, 2007; Kumar *et al.*, 2010) reported that composting can also be effective at C/N ratio lower than 20. Therefore, equal amount of poultry litter and fast food waste (50:50) gave the highest C:N ratio and can be regarded as the best.

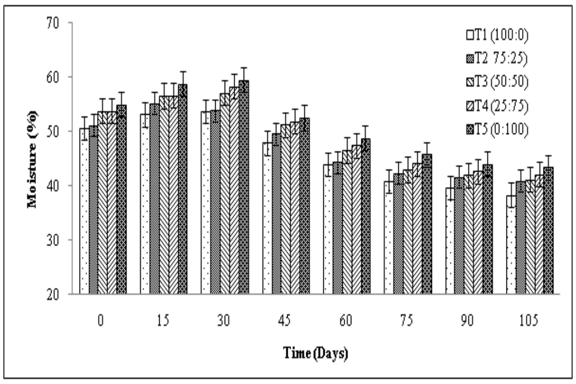

Fig. 3. Comparative effect of various ratios of poultry litter and fast food wastes (T_1 to T_5) on moisture (%) at different time intervals (0 to 105 days) during co-composting. Vertical bars show standard error among three replicates and subjected to LSD ($\alpha > 0.05$), where value is between 1.02–1.63. was observed in the treatment $T_{3,}$ while minimum (29.25) was recorded in treatment T_1 (figure 4).

Combination of materials of good quality composts.

Total Nitrogen

The observation recorded on 1st day of composting depicted that blending of fast food with poultry litter had a positive effect on nitrogen content. At 1st day, maximum nitrogen content was found in treatment containing poultry litter and fast food waste (75:25). On the other hand, the treatment T_5 had least nitrogen contents (1.98%). It was observed that nitrogen contents increased at variable rates in all the treatments with time. Maximum rate of nitrogen increase was observed between 60th and 75th day of composting in all treatments (figure 5). During the entire process of composting, maximum nitrogen content (3.3%) was recorded for poultry litter and fast food waste (75:25) at the 105th day of composting whereas, minimum nitrogen contents of 2.62% were found in poultry litter and fast food waste (0:100), reinforcing that fast food wastes is not a good source of nitrogen. On the other hand, presence of urine and poultry dropping the overall nitrogen content has increased in poultry litter. Rodriguez *et al.*, (2006) studied the co-composting of barley wastes and solid poultry with N contents (3.56%) in the solid poultry manure and found an increased trend of total nitrogen at compost maturity. The results for low nitrogen contents in 100 % fast food restaurant waste was also similar with those found by Zhang *et al.*, (2003). So, poultry litter and fast food waste (75:25) was proved to be the best among all, as it provided maximum nitrogen contents not only during the composting process but also in the final product.

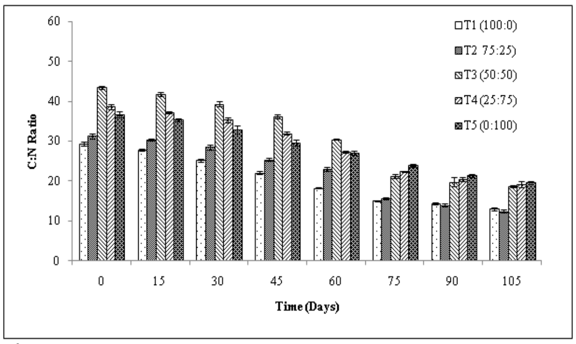

Fig. 4. Comparative effect of various ratios of poultry litter and fast food wastes (T_1 to T_5) on C:N ratio at different time intervals (0 to 105 days) during co-composting. Vertical bars show standard error among three replicates and subjected to LSD ($\alpha > 0.05$), where the value is between 1.36–2.22.

Total Phosphorus

Data recorded on the first day of composting revealed that maximum phosphorus (P) (0.46%) was present in poultry litter (T_1) while fast food waste had the minimum phosphorus contents (0.28%). However, the blending of poultry litter with food waste had no significant effect on the phosphorus content as all the blended treatments (T_2, T_3 and T_4) were statistically indifferent from one another (figure 5). The results also revealed that in all the treatments, there was an irregular trend of increasing P concentration till the end of composting. Similarly, increasing trend of P concentration was reported by Rodriguez *et al.*, (2000), Preusch *et al.*, (2004) and also been observed in Figure 5.

The vermicomposting of poultry manure by Ghosh *et al.*, (1999). During the first 60 days, P contents increased at a slower rate which speeded up during 60th to the 90th day of composting. Data indicates the highest concentration of P (1.06%) was found at the 105th day of composting in mixture of poultry litter and fast food wastes (75:25) whereas, it was minimized (0.55%) at the same time in 100% fast food waste. The poultry litter and fast food waste

(75:25) were found to be the best among all the treatments as it provides maximum phosphorus. Cooperband *et al.*, (1996) found maximum P values in the poultry litter at the end of the composting process. These findings were not similar to that obtained from co-composting of a chestnut burr and leaf litter with solid poultry manure which showed an inverse behavior. A decrease in phosphorus during co-composting (0.71 to 0.12%) was observed by Rodriguez *et al.* (2001).

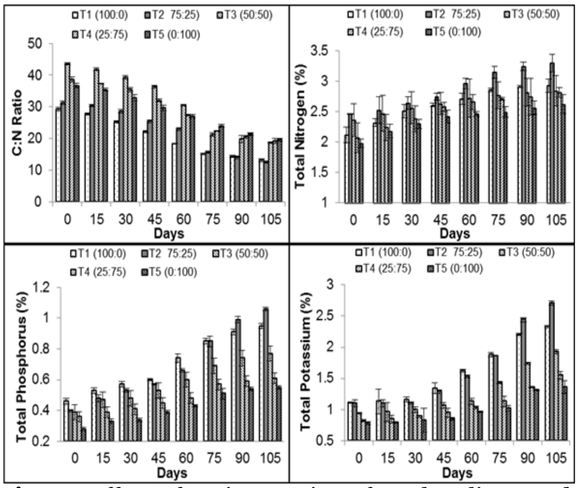

Fig. 5. Effect of various ratios of poultry litter and fast food wastes (T_1 to T_5) on C:N, total N (%), Total P (%) and Total K (%) at different time intervals (0 to 105 days) during co-composting. Vertical bars show standard error among three replicates and subjected to LSD (α > 0.05), where value is between 1.36–2.22, 2.66– 4.57, 5.41– 9.76 and 0.02– 0.06, respectively.

Total Potassium

The potassium (K) concentration ranged from 0.78-1.11% on the first day of composting (figure 5). Poultry litter had the highest concentration of K whereas fast food waste had the minimum value. Results revealed that there was a linear increase in the K contents in all the treatments during the process of decomposition. The maximum increase in potassium contents was observed for the treatment T_2 for which the total K contents increased from 1.10-2.71% in 105 days, While a minimum value of 1.36% was recorded for fast food waste (100%). The increase of the K in the co-compost could be explained by the mineralization process and decrease in the K concentration was due to the fixation process. It is inferred from the present results that treatment T_2 is best for co-composting and can provide maximum K nutrients to the plants when applied. Rodriguez *et al.*, (2001) and Clark, (2000) had reported an increase in the K concentration (2.82-3.26%) during co-composting which is in accordance with the findings of the present study.

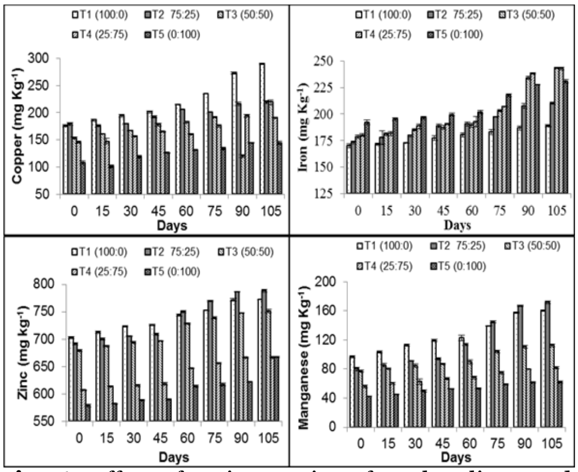

Fig. 6. Effect of various ratios of poultry litter and fast food wastes (T_1 to T_5) on micronutrients (Cu, Fe, Zn, Mn at different time intervals (0 to 105 days) during co-composting. Vertical bars show standard error among three replicates and subjected to LSD (α > 0.05), where value is between 1 3.98–4.92, 0.03–0.06, 0.01– 0.04 and 3.25– 6.49, respectively.

Comparative effect of co-composting of poultry litter and fast food wastes on concentration of four micronutrients

Copper

The result revealed that the initial concentration of (Cu) recorded at first day of composting was much higher in poultry litter than that of fast food wastes (178.56 mg kg^{-1}) was recorded in poultry litter, whereas it was 106.76 mg kg^{-1} for fast food waste while the concentration of all other mixtures lay within this range (figure 6). The gradual increase in the concentration of Cu remained till the 75th day. After that maximum Cu was released between the 75th and 90th day of composting for all the treatments due to increased microbial activity. Overall maximum concentration of Cu was recorded at 105th day in poultry litter and fast food waste (75:25), while the minimum was observed in fast food waste. The overall concentration of Cu remains low in fast food waste during the composting which depicts that low quantity of copper in fast food wastes. Hseu, 2004) obtained the similar findings and concluded that the Cu concentrations were lower (10.5 mg kg^{-1}) in the wood residues while higher values (112- 511 mg kg^{-1}) was found in manure. Zhou *et al.*, (2005) found values of 152 mg kg^{-1} in poultry manure. Whereas low concentration of Cu (23 mg kg^{-1}) was obtained from the composting of cow manure (Walker *et al.*, 2004). Low concentrations of Cu were also detected by Hachicha *et al.,* (2009), in the range of 27.71-31.83 mg kg^{-1} in composted organic waste especially of plant origin. Bustamante *et al.*, (2008) reported that the Cu concentration averaged at 45 mg kg^{-1} in composted animal waste especially of poultry manure.

Iron

Data at initial stage maximum concentrations of iron (192.6 mg kg^{-1}) was recorded in fast food waste, whereas in poultry litter it was169.85 mg kg^{-1}. Results showed that T_3 and T_4, and T_1 and T_2 were not significantly different from one another (figure 6). The concentration of iron increased to a uniform rate during the whole course of composting and among all treatments. The maximum concentration of iron was observed at 105th day of composting. The maximum increase in iron concentration was recorded in T_3 and T_4 for which value increased from 178.68 mg kg^{-1} to 243.26 mg kg^{-1} and 179.94 mg kg^{-1} to 243.04 mg kg^{-1} in 105 days respectively. Minimum iron concentration (188.98mgkg^{-1}) was observed in poultry litter at the final stage of composting. From the results, it was concluded that either poultry litter and fast food waste at (50:50) or (25:75) could be the appropriate mixture of co-composting as both of these treatments release maximum amount of iron. Kulcu *et al.*, (2008) found some higher concentrations of Fe within chicken litter and spent mushroom compost (i.e., 566 mg kg^{-1}).

Zinc

Zinc contents in poultry litter and fast food wasted recorded on the first day of co-composting represented the two extremes (figure 6). Fast food wastes (79.03 mg kg^{-1}) had much lower concentrations of zinc as compared to the poultry litter (203.13 mg kg^{-1}). Data revealed that there was a gradual increase in the concentration of zinc in all the treatments as the composting process progressed. The concentration of zinc increased more rapidly after 60 days and continued till 90 days of composting, which showed that microbial activity remained high during this time span. Moreover, the increase in zinc content between 90th and 105th days of composting was not significantly increased which was the indication that composting process had almost completed. The maximum increase in zinc contents (191.76 mg kg^{-1} to 288.63 mg kg^{-1}) was recorded for poultry litter and fast food waste (75:25). At the end of composting process the minimum contents of zinc were recorded in fast food wastes (122.86 mg kg^{-1}). It is finally concluded that poultry litter and fast food waste (75:25) is the best combination to get higher contents of zinc. Rodriguez *et al.*, (2006) that the co-compost obtained from solid poultry manure with chestnut burr/leaf litter and with barley wastes two values were under the legal local limits, i.e. (813 to 883 mg kg^{-1}) respectively. Zinati *et al.*, (2001) studied the characteristics of poultry litter and found relatively increased contents of Zn at the final stages of composting. The results of the present study were compared with the findings of Bao *et al.*, (2008), that intensive mineralization of poultry litter Zn concentration ranged between 154.6-237.2 mg kg^{-1}.

Manganese

During the composting process, poultry litter concentration ranged from 96.94 mg kg^{-1} of manganese contents whereas fast food had the minimum contents (42.50 mg kg^{-1}) at first day of composting (figure 6). Moreover, treatments T_2 and T_3 were statistically at par with regard to manganese contents at first day of composting. The maximum increase in manganese concentration (80.22 mg kg^{-1} to 172.05 mg kg^{-1}) was observed in treatment T_2 while in fast food the minimum (42.5 mg kg^{-1} to 62.24 mg kg^{-1}) increasing trend was observed during 105 days of composting. During the composting process, Mn is released slowly in all composting treatments from initial stage (100-360 mg kg^{-1}) to the final stage (120-

388.36 mg kg^{-1}) of finished compost. This is due to climatic effects, especially due to moisture availability and temperature build up in composting piles. The maximum and minimum values of Mn might be due to reason that after 75 days of composting process, slight decomposition of the material took place which increased gradually after 90 days of composting process. Similar results were also observed by Adediran *et al.*, (2003). Bustamante *et al.*, (2008) had reported that Mn concentrations were averaged at 150 mg kg^{-1} in composted agricultural waste especially of animal compost.

Conclusion

The present study depicted that the overall temperature during composting ranged from 30.75 to 66.6 ^{o}C. It is observed that temperature increases as the time of composting progressed up to 45th day after that is declining in all treatments. The highest temperature increase was found in poultry litter as compared to the fast food waste. Therefore, it can be concluded that the increase in temperature releases more nutrients. Moisture contents during composting showed a unique trend as compared to temperature or release of other nutrients. In almost all the treatments it increased from first day to 30th day of composting after which it decreased till the end of composting. Poultry litter and fast food waste (75:25) released maximum amount of macro nutrients, i.e. N, P and K (3.3 mg kg^{-1}, 1.06 mg $kg^{-1}$and 2.71 mg kg^{-1} respectively), at the 105th day of composting. On the other hand, concentrations of Cu, Fe, Zn and Mn of poultry litter and fast food waste (75:25) were 21.92 (mg kg^{-1}), 210.25 (mg kg^{-1}), 288.63 (mg kg^{-1}) and 172.05 (mg kg^{-1}) respectively, at the 105th day of composting. For co-composting, combination of three parts of poultry litter with one part of fast food waste is best to get the highest quantity of micro and macro nutrients. Beside the efficient nutrients release, there is a need to investigate the toxicological and microbial studies of the effective combination in order to be applicable for better plant growth.

References

Adediran J, Baets AN, Mnkeni PNS, Kiekens L, Muyiama NYO, Thys A. 2003. Organic Waste Materials for Soil Fertility Improvement in the Border Region of the Eastern Cape, South Africa. Biological Agriculture and Horticulture **20,** 283-200. http://dx.doi.org/0.1080/01448765.2003.9754974

Amanullah MM. 2007. Nutrient Release Pattern during Composting Poultry Manure. Research Journal of Agriculture and Biological Sciences **3(4),** 306-308.

Anderson JM, Ingram JSI. 1993. Colorimetric Determination of Nitrogen And Phosphorus. In: Anderson JM, Ingram JSI, eds. Tropical soil Biology and fertility. A handbook of methods, 2nd ed. C.A.B. International, Wallingford, UK. 73-74.

APHA AWWA, WPCF. 1989. Standard Methods for the Examination of Water and Wastewater, 17th Ed. American public health association. Washington D.C, USA.

Bao Y, Zhou Q, Guan L. 2008. Allantion-N Concentration Changes and Analysis of Influencing Factors on Its Changes during Different Manure Composting. Bioresource Technology **99,** 8759-8764. http://dx.doi.org/10.1016/j.biortech.2008.04.037

Benito MA, Masaguer, Moliner A, Antonio R. 2006. Chemical and Physical Properties of Pruning Waste Compost and Their Seasonal Variability. Bioresource Technology **97,** 2071- 2076. http://dx.doi.org/10.1016/j.biortech.2005.09.011

Bustamante MA, Paredes C, Marhuenda-Egea FC, Pérez-Espinosa A, Bernal MP, Moral R. 2008. Co-Composting Of Distillery Wastes with Animal Manures Carbon And Nitrogen Transformations In The Evaluation Of Compost Stability. Bioresource Technology **72,** 551-557. http://dx.doi.org/10.1016/j.chemosphere.2008.03.030

Chaudhry AN, Naeem, Jilani MA, Razzaq G, Zhang A, Azeem DM, Ahmed M. 2013. Influence of Composting and Poultry Litter Storage Methods on Mineralization and Nutrient Dynamics. Journal of Animal and Plant Sciences **23(2),** 500-506.

Chang JI, Hsu T. 2008. Effects of Compositions on Food Waste Composting. Bioresource Technology **99,** 8068–8074. http://dx.doi.org/10.1016/j.biortech.2008.03.043

Clark S. 2000. Development of a Biologically Integrated Food Waste Composting System. Berea College, Kentucky, USA.

Cooperband L, Middleton R, June H. 1996. Changes in Chemical, Physical and Biological Properties of Passively Aerated Co-Composted Poultry Litter and Municipal Solid Waste Compost. Compost Science and Utilization **4,** 24-34. http://dx.doi.org/10.1080/1065657X.1996.10701849

Cooperband LR. 2000. Composting: Art and Science of Organic Waste Conversion to a Valuable Soil Resource. University Wisconsin. Compost **31,** 283-290.

Debosz K, Petersen SO, Kube LK, Ambus P. 2002. Evaluating Effects of Sewage Sludge and Household Compost on Soil Physical, Chemical and Microbiological Properties. Applied Soil Ecology **19,** 237–48. http://dx.doi.org/10.1016/S0929-1393(01)00191-3

Inckel M, Smet P, Tersmette P, Veldkamp T. 2005. The preparation and use of compost. 7th ed. Agromisa Foundation. Digigrafi, Wageningen, The Netherlands.

Ghosh M, Chattopadhyay GN, Baral K. 1999. Transformation of Phosphorus during Vermicomposting. Bioresource Technology **69,** 149-154. http://dx.doi.org/10.1016/S0960-8524(99)80001-7

Goyal S, Dhull SK, Kapoor KK. 2005. Chemical And Biological Changes During Composting of Different Organic Wastes and Assessment of Compost Maturity. Bioresource Technology **96(14),** 1584-159. http://dx.doi.org/10.1016/j.biortech.2004.12.012

Guang KC, Ya LL, Shang Y. 2010. Inoculation of Food Waste with the Thermo-Tolerant Lipolytic Actinomycete Thermoactinomyces Vulgaris A31 and Maturity Evaluation of the Compost. Bioresource Technology **101,** 7424-7431. http://dx.doi.org/10.1016/j.biortech.2010.04.051

Hachicha R, Hachicha S, Trabelsi I, Woodward S, Mechichi T. 2009. Evolution of The Fatty Fraction During Co-Composting of Olive Industry Wastes With Animal Manure: Maturity Assessment Of The End Product. Chemosphere **75,** 1382-1386. http://dx.doi.org/10.1016/j.Chemosphere.2009.02.064

Hseu ZY. 2004. Evaluating Heavy Metal Contents in Nine Composts Using Four Digestion Methods. Bioresource Technology **95,** 53-59. http://dx.doi.org/10.1016/j.biortech.2004.02.008

Hogarh JN, Fobil JN, Budu GK, Carbo D, Ankrah NA, Nyarko A. 2008. Assessment of Heavy Metal Contamination and Macro-nutrient Content of Composts for Environmental Pollution Control in Ghana. Global Journal of Environmental Research **2,** 133-139.

Jadia CD, Fulekar MH. 2008. Vermicomposting of vegetable waste: A Bio-Physicochemical Process Based on Hydro-Operating Bioreactor. African journal of Biotechnology **7,** 3723-3730.

Khan M, Sharif M. 2012. Solubility enhancement of phosphorus from rock phosphate through composting with poultry litter. Sarhad Journal of Agriculture **28(3),** 415-420.

Khan MA, Rahim M, Ali S. 2003. Sewage Sludge Effect on Soil Fertility of Maize As Compared to Poultry Litter, Farmyard Manure, And Chemical

Fertilizer. Pakistan Journal of Agriculture **6,** 69-77.

Kulcu R, Sonmez I, Yaldiz O, Kaolan M. 2008. Composting of Spent Mushroom Compost, Carnation Wastes, Chicken and Cattle Manure. Bioresource Technology **9,** 8259-8264.
http://dx.doi.org/10.1016/j.biortech.2008.03.074

Kumar M, Ou YL, Lin JG. 2010. Co-Composting of Green Waste and Food Waste at Low C/N ratio. Waste Management **30,**602–609.
http://dx.doi.org/10.1016/j.wasman.2009.11.023

Larney FJ, Blackshaw RE. 2003. Weed Seed Viability during Composting of Beef Cattle Feedlot Manure. Journal of Environmental Quality **32,** 1105-1113.

Leconte MC, Mazzarino MJ, Satti P, Iglesias MC, Laos F. 2009. Co-Composting Rice Hulls and/or Sawdust with Poultry Manure in NE Argentina. Waste Management **29,** 2446-2453.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.wasman.2009.04.006

Mohee R, Ackmez M. 2005. Analysis of the Physical Properties of an In-Vessel Composting Matrix. Powder Technology **155,** 92-99.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.powtec.2005.05.051

Nelson DW, Sommers LE. 1982. Total Carbon, Organic Carbon and Organic Matter. In: Page AL, Miller RH, Keeney DR, eds. Methods of Soil Analysis, Part 2 Chemical and Microbiological properties. Agronomy monograph 9, Am. Society of Agronomy and Soil Science Society of America, Madison, Wisconsin, USA. p. 539-594.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.2134/agronmonogr9.2.2ed.frontmatter

Ogunwande GA, Osunade JA, Adekalu KO, Ogunjimi LAO. 2008. Nitrogen Loss in Chicken Litter Compost as Affected By Carbon to Nitrogen Ratio and Turning Frequency. Bioresource Technology **99,** 7495-7503.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.biortech.2008.02.020

Patric I, Selimbasic V. 2008. Composting of Poultry Manure and Wheat Straw in a Closed Reactor: Optimum Mixture Ratio and Evolution of Parameters. Biodegradation **19 (1),** 53-63.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1007/s10532-007-9114-x

Petric I, Sestan A, Sestan I. 2009. Influence of Wheat Straw Addition on Composting Of Poultry Manure. Process safety and Environmental Protection **87,** 206-212.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.psep.2009.02.002

Preusch PL, Takeda F, Tworkoski TJ. 2004. N and P Uptake by Strawberry Plants Grown with Composted Poultry Litter. Scientia Horticulturae **102 (1),** 91-103.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.scienta.2003.12.005

Raj D, Antil RS. 2011. Evaluation of Maturity and Stability Parameters of Composts Prepared From Agro-Industrial Wastes. Bioresource Technology **102,** 2868–2873.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.biotech.2010.10.077

Rashid A. 1986. Mapping Zinc Fertility of Soil Using Indicator Plants and Soils Analysis. Ph. D. Dissertation, University of Hawaii. HI, USA.

Rodrıguez EG, Alonso J, Melgar MJ, Vazquez M. 2006. Evaluation of Heavy Metal Contents in Co-Composts of Poultry Manure with Barley Wastes or Chestnut Burr/Leaf Litter. Chemosphere **65,** 1801–1805.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.chemosphere.2006.04.023

Rodriguez GE, Vazquezand M, Ravina MD.

2000. Co-composting of Barley Wastes and Solid Poultry Manure. Bioresource Technology **75,** 223-225.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/S0960-8524(00)00069-9

Rodriguez GE, Vazquezand MV, Ravina MD. 2001. Co-composting of Chestnut Burr and Leaf Litter With Solid Poultry Manure. Bioresource Technology **78,** 107-109.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/S0960-8524(00)00159-0

Sarwar G, Hussain N, Schmeisky H, Muhammad S. 2007. Use of Compost an Environment Friendly Technology for Enhancing Rice-Wheat Production in Pakistan. Pakistan Journal of Botany **39(5),** 1553-1558.

Steel RGD, Torrie JH. 1980. Principles and Procedures of Statistics: A Biometrical Approach. McGraw-Hill Publishing Co. Inc. New York. 633 P.

Schouwenberg JCHV, Walinge I. 1973. Methods of Analysis of Plant Material. Agric. Univ. Wageningen, The Netherlands.

Walker R, Clecente, Bermal MP. 2004. Contrasting Effects of Manure and Compost on Soil pH, Heavy Metals Availability and Growth Of *Chenopodium Album* L. In A Soil Contaminated By Pyretic Mine Waste. Chemosphere **57,** 215- 224.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.Chemosphere.2004.05.020

Wijewardena JDH, Gunarathna SP. 2004. The Heavy Metal Content in Commonly Used Animal Manure. Journal of Soil Science Society of Sri Lanka. **6,** 245-253.

Yun YS, Park JI, Suh MS, Park JM. 2000. Treatment of Food Wastes Using Slurry Phase Decomposition. Bioresourse technology **73,** 21–27.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/S0960-8524(99)00131-5

Zhang XW, Nie HY, Qiu X. 2003. Co-composting of High Moisture Vegetable Waste, Flower Waste and Chicken Litter In Pilot Scale. Huan Jing Ke Xue **24(2),** 147-151.

Zhou XZ, Wang YJ, Dong YH, Cang L. 2005. Copper and Zinc Uptake by Radish and Pakchoi As Affected By Application of Livestock and Poultry Manures. Chemosphere **59,** 167-175.
http://dx.doi.org/10.1016/j.wasman.2009.11.02310.1016/j.Chemosphere.2004.11.008

Zinati GM, Herbert YL, Bryan H. 2001. Accumulation and Fractionation of Copper, Iron, Manganese, and Zinc in Calcareous Soils Amended with Composts. Journal of Environmental Science and Health **90,** 155-166.
http://dx.doi.org/10.1081/PFC-100103746