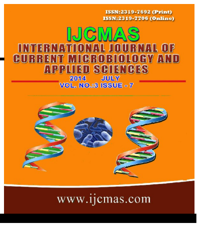

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Original Research Article

Effect of inoculating lignocellulolytic fungus on nutrient changes during different phases of composting of poultry droppings amended with bagasse

D.Prabhakaran and S.Manivannan*

Department of Zoology, Annamalai University, Annamalai Nagar – 608 002,
Tamil Nadu, India
**Corresponding author*

ABSTRACT

Keywords

Composting,
Poultry droppings,
Bagasse,
Microbial inoculation,
Nutrients

Composting is a widely used method for disposal of organic wastes. Application of undecomposed wastes or non-stabilized compost to soil may leads to immobilization of plant nutrients and cause phytotoxicity. The environmental problems associated with raw poultry droppings application, such as release of gas pollutants or dissemination of pathogens could be mitigated by stabilizing its nutrient and organic matter contents by composting before application to agricultural soils. The objectives of this study was to evaluate the changes in physico- chemical parameters of poultry droppings amended with bagasse in different ratios using different lignocellulolytic fungal inoculations during composting over a period of 90 days in order to produce organic fertilizer. Four fungal species *A. niger*, *A. flavus*, *P. chrysosporium* and *T. viride* and consortium of these species were tested under in vivo conditions for composting. The composts were sampled at 0, 30, 60 and 90 days for the assessment of temporal changes in physico- chemical properties. Results revealed that nutrient contents during composting showed a significant variation in all the treatments ($p<0.05$) for all the sampling days. Among the different treatments inoculation of lignocellulolytic fungal consortium in poultry droppings and bagasse mixed at equal proportion (1:1) produced a superior quality compost with desirable C:N ratio and higher macro and micro nutritional status than uninoculated natural composting. The combination of fungal species reduced the overall time required for composting days and accelerated the degradation process of waste by- products of poultry farming and sugar processing industry, thereby producing a nutrient-enriched compost product useful for sustaining high crop yield, minimizing soil depletion and value added disposal of waste materials.

Introduction

Over the last few years, the problem of efficient disposal and management of organic wastes has become more rigorous intensive agriculture. Most of the organic wastes are disposed in ecologically unsustainable manner by open dumping or burning. These environmentally unhealthy waste disposal methods may leads to loss of plant nutrients present in the waste (Edwards and Batter, 1992). Therefore, conversion of a waste into beneficial materials through biological methods is an important component of resource recovery and recycling principles (Yadav and Garg, 2011).

The poultry and livestock industries are growing rapidly along with the human population and production of animal waste are potential sources of many major environmental problems. India is one of the largest producers of poultry in the world and the poultry manure availability is estimated to be 12.1 million tons (The week end leader, 2014). In the poultry farm large amount of droppings that accumulated in the litter turns it into importance sources of contamination i.e. odorous gases including amines, amides, mercaptans, sulphides and disulphides.

These noxious gases can cause respiratory disease in animals and humans (Schiffamn and Williams, 2005). However, poultry droppings along with litter has useful nutrients, and is therefore used as organic fertilizer (Moore *et al.,* 1995) but uncontrolled decomposition and excess applications to soil can cause environmental problems due to their extremely high levels of nitrogen as ammonia, low pH, and heat generation. Therefore, there is an urgent need to recycle the poultry droppings without environmental impact.

Many alternatives for the disposal and management of organic wastes have been proposed, composting being one of the natural bio process and most attractive on account of its low environmental impact and cost (Bustamante *et al.,* 2008; Canet *et al.,* 2008; Lu *et al.,* 2008), as well as its capacity for generating a valuable product used for increasing soil fertility (Weber *et al.,* 2007). Several reports indicate that composting is used as a major process of stabilizing organic wastes through the degradation of biodegradable components by microbial communities under controlled conditions (Dominguez *et al.,* 2002; Zaved *et al.,* 2008). Numerous studies have been reported that specific bacteria and fungi species play a significant role in the decomposition and mineralization of organic wastes (Eiland *et al.,* 2001; Cahyani *et al.,* 2003; Liang *et al.,* 2003; Tang *et al.,* 2007). Further decomposition by the microbes naturally present in the wastes can be slow inoculation with suitable micro-organism can accelerate the composting process (Singh and Sharma, 2002; Kumar *et al.,* 2010).

Hence, to improve the biological degradation of poultry droppings, selection of effective microorganisms enhancing the activities of lignin degrading enzymes is essential. According to the previous studies, the lignocellulotic fungi were the most efficient microorganisms for biomass deconstruction and delignification (Elisashvili *et al.,* 2008; Dinis *et al.,* 2009). However, the low C:N ratio of poultry droppings results in the loss of nitrogen as ammonia. It is presumed that mixing of poultry droppings with some bulking agent will not only lower the high C:N ratio of latter but also help to restrict the nitrogen loss.

In poultry forming various types of litter materials are used and the common types of litter in poultry houses are saw dust, rice husk, sugar cane pulp, sugar cane bagaase, chopped straw, paper mill by products, sand, wood shavings, corn cobs, coir pith, coffee husk, oat hulls and dried leaves. Among these litter materials, sugar cane bagasse is the best on account of its softness and quick absorbing moisture, and it does not fall into feeder and waterier. It should be preferred to others, wherever available at reasonable prices than other material (Rao, 1986). Hence, in the present study poultry droppings amended with sugar industry waste bagasse as bulking agent.

According to our knowledge, there is no information is available about the bioconversion and nutrient changes of poultry droppings with bagasse using different degrading fungal species. Therefore, the purpose of this study was to investigate the role of different inoculating fungal species on rapid biodegradation and the physico-chemical parameters during laboratory scale composting of poultry droppings with bagasse in order to produce quality end products for organic forming.

Materials and Methods

Collection of poultry droppings and sugar industry waste bagasse

Poultry droppings (PD) 10 days old were collected from Indian feeds farm, Perumal kovilmedu, Namakkal district, Tamil Nadu, India. Sugar cane bagasse (BG) was obtained from E.I.D parry sugar mill located at Nelikkuppam, Taminadu, India.

The poultry droppings were transported to the laboratory using sterile plastic bags. PD and BG were sundried separately for 15 days to remove the odor and noxious gases. The bagasse was chopped into small pieces (3–5cm) using chopping machine. The important physico- chemical properties of the PD and BG are given in Table 1.

Microbial source and inoculums preparation

Four lignocelluloses degrading fungal species *Aspergillus flavus, Aspergillus niger, Trichoderma viride,* and *Phanerochaete chrysosporium* were purchased from the Gowri biotech research laboratory, Thanjavur, Tamil Nadu, India. Selection of the strains for this work was prepared on the basis of enzymatic activity at a wide range of temperature, pH, and substrate specific organic waste degradation. The fungal species and consortium of these fungal species were used as the inoculums for different treatments. Equal quantities of each fungal inoculums were mixed together to make a consortium.

Experimental set-up

The experiments were performed in six treatments with three replicates using cement tanks (50cm×180cm×30cm) with a hole at the bottom. Each composting tank (treatments) contains 10 kg of PD mixed with BG in 1:1 ratio (w/w dry weight basis). Pure cultures of *Aspergillus flavus, Aspergillus niger, Trichoderma viride,* and *Phanerochaete chrysosporium* and consortium of fungal species (50 ml/kg substrate having 10^6 cells per ml) were inoculated after 3days of pre-decomposition.

The different fungal inoculums was added a layer wise in each treatments. The composting process of PD and BG were arranged in the following combinations: T1: PD + BG, Control (without microorganism) T2: PD + BG + *Aspergillus niger*, T3: PD+BG + *Aspergillus flavus*, T4: PD + BG + *Phanerochaete chrysosporium*, T5: PD + BG + *Trichoderma viride*, T6: PD + BG + Consortium.

The moisture content in each treatment was adjusted to about 60–70% at the beginning of composting and then periodically water was added during the turning of composting up to 90 days.

All treatments were manually turned for twice a week to revolve the treatment and provide aeration. Temperatures were monitored manually using thermometers. Temperature readings were taken towards the central part of the top, middle, and bottom locations of the cement tank.

Analysis of compost samples

Samples were collected periodically from each treatment on days 0, 30, 60 and 90 days for physico-chemical analysis. The pH and electrical conductivity (EC dSm^{-1}) were determined using a double distilled water suspension in the ratio of 1:10 (W/V) using a digital pH and conductivity meter.

Total organic carbon (TOC) content in the sample was determined by chromic oxidation method (Walkely and Black, 1934). Furthermore total Kjeldhal nitrogen (TKN) was measured by micro Kjeldhal method (Tiquia, 2000). Total phosphorus (TP) was estimated by vanadomolybdo phosphoric acid yellow colour method using a colorimeter (Model 115, Systronics, India) (Jackson, 1967).

While Total potassium (TK) was detected by the method of Jackson (1967) using flame photometer (Model 128, Systronics, India). C: N was considered from the measured value of C and N. Exchangeable elements (Na, Ca, and Mg) were determined after extracting the sample using ammonium acetate extraction method. (Simard, 1993).

Data analysis

Results are the means of the three replicates. Two way analysis of variance (ANOVA) was performed by using the SPSS 10.5 software. The objectives of statistical analysis to determine any significant differences among the parameters analyzed in different treatments during the composting process.

Results and Discussion

pH

An increase in pH was recorded in all the treatments during initial period of composting of poultry droppings with bagasse. Initially increase in pH was observed up to 30 days but later decreased to almost neutral pH after 60 and 90 days of composting, respectively. The pH in all the treatments after 60 days decreased gradually during microbial composting of this study due to the fermentative metabolism of inoculated microorganisms that result in the production of organic acids in higher amounts (Khalil *et al.,* 2001; Abdel-Aziz and Barakah, 2005).

In the present study decrease / neutral pH in the treatments also due to better aeration might have resulted in some loss of nitrogen as ammonia thereby reducing the pH. Neklyudov *et al.*, (2006) also reported that the decomposition of organic matter and production of organic and inorganic acids by the microorganism would also be responsible for the pH reduction. The increase in pH at initial stage of this study was attributed to the production of ammonia associated with protein degradation in the raw materials and to the decomposition of organic acids (Warman and Tremmeer, 2005).

EC

In the present study, an increase in electrical conductivity (EC) was recorded in all the treatments during microbial composting. The relatively low EC values were recorded in all treatments (T1–T6) on 0 days. During the 30 and 60 days of composting, the EC values of all treatments were increased to attain the maximum peaks (3.05±0.04 dSm^{-1} to 3.98±0.09 dSm^{-1}), then gradually declined to reach the lowest values at the end of 90 days. However, the EC value was significantly different from treatment 1 and 6. In the present study, maximum increase in EC during composting might have been due to effective composting by inoculated microorganisms and release of different mineral ions, such as phosphate, ammonium, potassium etc, (Yadav and Garg 2011). On the contrary, in the present study the decrease in EC after 60 days due to the reduction of water- soluble substances and the volatilization of ammonia as well as precipitation of mineral salts during the bioprocess (Tang *et al.*, 2004; Niwagaba *et al.*, 2009). However, in the present study the ultimate EC values of the final composts were less than 1.5 dSm^{-1} which made the produced from composts acceptable as soil amendments (Watson, 2003).

Total organic carbon

A decrease in total organic carbon (TOC) was recorded in all the treatments during composting. The TOC ranged between 47.60±0.19 to 14.02±0.12 in composted materials after 60 days of composting which was lower than initial levels. However, TOC loss was greater in treatment 6 then other treatments. Decrease in TOC in treatments no. 2, 5 and 6 was insignificant with each other and significant with treatments no 1, 3 and 4 as compared to the initial level. TOC of the final compost was remarkably reduced at the end of the experiment suggest that a higher carbon loss patent in treatments 2, 5 and 6 could be an attributed to the rapid decomposition rate than other treatments.

Earlier studies reported that microbial consortium can mineralize poultry droppings more easily than other organic wastes because it contains an ammonical nitrogen (Eklind and Kirchmann, 2000; Moldes *et al.*, 2007). Moreover the inoculation of microorganisms to the treatments mainly responsible for production of extra cellular enzymes during composting (Suthar, 2009). The results observed in this study are consistent with previous work of Molla *et al.*, (2001) and they reported that significant reduction in total organic carbon content after microbial inoculation during composting. Moreover in this study there was a significant difference among the treatments for TOC possibly due to different rate of enzyme activity related to carbon mineralization. Hence, the activities of enzyme related to the organic matter decomposition in the treatments directly related to the substrate quality used for microbial composting.

Total nitrogen

The initial TKN content (%) of the treatments was in the range of 1.38±0.06 to 1.41±0.07, and TKN content increased in the range of 1.88±0.14 to 2.69±0.10 in different treatments after composting. The difference in the TKN content of the compost obtained from treatment 6 was statistically significant. This confirms that if inoculations of microbial consortium into PD and BG mixture would have antagonistic impact on the TKN content of the compost on 60 and 90 days. The increase in TKN concentration of microbial inoculated treatments can be attributed as a consequence of strong degradation of substrates material by the inoculated microorganisms. In the present study, the maximum increase in TKN content was observed with the addition of microbial consortium (treatment 6). The decreased TKN content after 60 days in all treatments may be due to loss of nitrogen in the form of NH_3 with progressive composting.

According to Benitez *et al.*, (1999) the hydrolytic enzyme production, which plays an important role in C and N cycle in waste decomposition system, is drastically influenced by the availability of easily degradable organic compounds in the substrate. Nakasaki *et al.,* (2005) reported that the increase in the TKN content at the period of composting process was mainly due to the concentration effect of the substrate material.

C:N ratio

During composting the C:N ratio is used as an index for maturity of organic waste decomposition. In the present study, C:N ratio of the substrate material indicated a drastic change during composting process (Figure 2). However, the maximum reduced C:N ratio was recorded in the treatment 6 during 30 and 60 days of composting, which was significantly superior over other treatments.

In the previous studies suggested that, higher C:N ratio would cause nitrogen to volatize thus reducing the nitrogen content, whereas lower C:N ratios would release a large quantity of soluble basic salts thus assembly the soil to affect the plant growth (Raut *et al.,* 2008). Similar observations have been reported by Bernal *et al.,* (1998) and they concluded that a decrease in C:N ratio implies an increase in the degree of humification of organic matter.

Total phosphorus

The initial TP content of the different treatments was in the range of 0.93±0.04 to 0.98±0.08 (Table 3) and composting resulted in significantly increase in the TP in different treatments. The difference in the TP content of the compost obtained from treatment 6 (2.69±0.37) and 5 (2.43±0.44) not significant.

The increase in TP during microbial composting is may be due to mineralization and mobilization of phosphorus by bacterial and phosphate activity of microorganisms as reported by other researchers (Edwards and Lofty, 1972). On the other hand TP in all treatments after 60 days was probably due to the mineralization of organic P and consumption by the microbes (Huang *et al.,* 2004).

Total potassium

The TK content of the initial substrate mixtures was in the range of 1.08±0.11 to 1.13±0.06 (Table 4). Final TK was higher than initial was in the range of 1.41±0.24 to 1.92±0.15. The maximum TK content was significantly higher in treatment 6 than other treatments. The differences in the TK content of the compost obtained from treatments 5 (1.76±0.23) and 6 (1.92±0.15) was not significant ($p<0.05$).

The TK of all the treatments increased gradually up to 60 days and then decreased until the end of composting period. The previous studies suggested that microorganism processed waste material contains higher concentration of exchangeable K due to enhanced microbial activity during the microbial composting process, which consequently enhances the rate of mineralization (Suthar, 2007).

In the present study, at the end of composting, the TK content was higher in treatment 6. The TK content of compost showed that the better nutrient levels of higher concentration compared to control. This is probably due to higher mineralization rate as result of enhanced microbial and enzyme activities leading to decrease in volume of the material (Nagarajan *et al.,* 1985; Anandavalli *et al.,* 1998; Imam and Sharanappa 2002).

Table.1 Physico-chemical characterization of poultry droppings and bagasse before microbial composting

Parameters	pH	EC (dSm^{-1})	TOC	TKN	TP	TK	Na	Ca	Mg	C:N ratio
			(%)				(mg /kg^{-1})			
Poultry droppings	7.3±0.5	2.80±0.6	28.21±0.24	1.65±0.12	1.25±0.09	1.35±0.03	216±0.18	262±0.06	160±0.13	17.10±0.22
Bagasse	6.3±0.7	0.63±0.08	67.17±0.44	1.31±0.05	0.63±0.12	0.81±0.02	198±0.10	318±0.18	195±0.21	51.22±0.88

EC- electrical conductivity; TOC-total organic carbon; TKN-total Kjeldhal nitrogen; TP- total phosphorous; TK- total potassium; Na- sodium; Ca- calcium; Mg- magnesium; C:N ratio-carbon nitrogen ratio; All values are mean and standard deviation of three replicates.

Table.2 Changes of pH and EC during microbial decomposition of poultry droppings with bagasse in different treatments

Treatments	pH				EC (dsm^{-1})			
	Days				Days			
	0	30	60	90	0	30	60	90
T$_1$	6.8 ± 0.04^{ab}	8.2 ± 0.02^{ab}	7.5 ± 0.03^{c}	7.5 ± 0.05^{bc}	1.70 ± 0.02^{a}	3.05 ± 0.04^{a}	3.73 ± 0.07^{a}	3.62 ± 0.06^{a}
T$_2$	6.8 ± 0.02^{ab}	8.6 ± 0.04^{c}	7.1 ± 0.05^{a}	7.2 ± 0.02^{b}	2.32 ± 0.06^{bc}	3.05 ± 0.04^{a}	3.94 ± 0.08^{b}	3.90 ± 0.09^{b}
T$_3$	6.7 ± 0.03^{a}	8.0 ± 0.03^{a}	7.3 ± 0.02^{b}	7.2 ± 0.03^{b}	2.20 ± 0.03^{b}	3.15 ± 0.05^{ab}	3.86 ± 0.06^{ab}	3.87 ± 0.06^{ab}
T$_4$	6.8 ± 0.02^{ab}	8.0 ± 0.03^{a}	7.5 ± 0.05^{c}	7.2 ± 0.02^{b}	2.17 ± 0.04^{b}	3.13 ± 0.03^{ab}	3.84 ± 0.09^{ab}	3.82 ± 0.07^{ab}
T$_5$	6.7 ± 0.02^{a}	8.2 ± 0.04^{ab}	7.0 ± 0.02^{a}	7.0 ± 0.04^{a}	2.30 ± 0.05^{bc}	3.25 ± 0.02^{b}	3.91 ± 0.06^{b}	3.90 ± 0.07^{b}
T$_6$	6.7 ± 0.03^{a}	8.4 ± 0.05^{b}	7.3 ± 0.02^{b}	7.2 ± 0.03^{b}	2.33 ± 0.05^{bc}	3.30 ± 0.03^{bc}	3.98 ± 0.09^{bc}	3.92 ± 0.07^{b}

All values are mean and standard deviation of three replicates; means in a column followed by the same letter(s) are not significantly different ($P<0.05$).

Table.3 Changes of TKN and TP during microbial decomposition of poultry droppings with bagasse in different treatments

Treatments	TKN (%)				TP (%)			
	Days				Days			
	0	30	60	90	0	30	60	90
T_1	1.38 ± 0.06^{a}	1.65 ± 0.08^{a}	1.88 ± 0.14^{a}	1.76 ± 0.14^{a}	0.93 ± 0.04^{a}	1.17 ± 0.13^{a}	1.58 ± 0.25^{a}	1.43 ± 0.33^{a}
T_2	1.41 ± 0.07^{a}	2.01 ± 0.05^{b}	2.32 ± 0.09^{c}	2.29 ± 0.12^{c}	0.98 ± 0.14^{a}	1.55 ± 0.23^{c}	2.46 ± 0.46^{c}	2.38 ± 0.27^{c}
T_3	1.38 ± 0.03^{a}	1.82 ± 0.04^{ab}	2.17 ± 0.15^{b}	2.05 ± 0.06^{b}	0.96 ± 0.02^{a}	1.38 ± 0.18^{b}	1.81 ± 0.27^{b}	1.69 ± 0.28^{ab}
T_4	1.38 ± 0.06^{a}	1.86 ± 0.08^{ab}	2.09 ± 0.06^{b}	2.01 ± 0.12^{b}	0.95 ± 0.13^{a}	1.32 ± 0.14^{b}	1.85 ± 0.23^{b}	1.77 ± 0.31^{bc}
T_5	1.40 ± 0.02^{a}	2.05 ± 0.09^{b}	2.41 ± 0.12^{cd}	2.37 ± 0.10^{cd}	0.97 ± 0.11^{a}	1.57 ± 0.19^{c}	2.43 ± 0.49^{c}	2.37 ± 0.46^{c}
T_6	1.40 ± 0.05^{a}	2.20 ± 0.06^{c}	2.69 ± 0.10^{d}	2.46 ± 0.14^{d}	0.98 ± 0.08^{a}	1.72 ± 0.15^{d}	2.69 ± 0.37^{d}	2.53 ± 0.41^{d}

All values are mean and standard deviation of three replicates; means in a column followed by the same letter(s) are not significantly different ($P<0.05$).

Table.4 Changes of TK and Ca during microbial decomposition of poultry droppings with bagasse in different treatments

Treatments	TK (%)				Ca (mg/kg^{-1})			
	Days				Days			
	0	30	60	90	0	30	60	90
T_1	1.10 ± 0.15^{a}	1.23 ± 0.28^{a}	1.41 ± 0.24^{a}	1.36 ± 0.12^{a}	291.32 ± 0.29^{a}	312.45 ± 0.35^{a}	328.65 ± 0.56^{a}	319.82 ± 0.32^{a}
T_2	1.09 ± 0.17^{a}	1.51 ± 0.28^{b}	1.72 ± 0.19^{bc}	1.68 ± 0.15^{b}	292.41 ± 0.31^{a}	345.62 ± 0.41^{bc}	364.76 ± 0.61^{bc}	353.35 ± 0.46^{b}
T_3	1.09 ± 0.09^{a}	1.38 ± 0.18^{ab}	1.53 ± 0.20^{ab}	1.43 ± 0.16^{a}	291.45 ± 0.31^{a}	330.57 ± 0.51^{b}	339.83 ± 0.51^{ab}	328.61 ± 0.41^{a}
T_4	1.13 ± 0.06^{a}	1.35 ± 0.17^{ab}	1.61 ± 0.11^{b}	1.57 ± 0.20^{ab}	292.37 ± 0.27^{a}	332.49 ± 0.39^{b}	348.83 ± 0.57^{b}	332.64 ± 0.28^{ab}
T_5	1.08 ± 0.11^{a}	1.47 ± 0.12^{ab}	1.76 ± 0.23^{bc}	1.70 ± 0.09^{b}	290.51 ± 0.25^{a}	343.72 ± 0.38^{bc}	376.13 ± 0.63^{c}	367.23 ± 0.18^{bc}
T_6	1.12 ± 0.18^{a}	1.62 ± 0.22^{bc}	1.92 ± 0.15^{d}	1.88 ± 0.06^{bc}	290.58 ± 0.34^{a}	365.51 ± 0.47^{c}	395.83 ± 0.65^{d}	382.72 ± 0.51^{c}

All values are mean and standard deviation of three replicates; means in a column followed by the same letter(s) are not significantly different ($P<0.05$).

Table.5 Changes of Na and Mg during microbial decomposition of poultry droppings with bagasse in different treatments

Treatments	Na (mg/kg^{-1})				Mg (mg/kg^{-1})			
	Days				Days			
	0	30	60	90	0	30	60	90
T_1	207.20 ± 0.18^{a}	220.39 ± 0.24^{a}	281.12 ± 0.31^{a}	279.41 ± 0.26^{a}	177.50 ± 0.61^{a}	188.79 ± 0.71^{a}	231.97 ± 0.41^{a}	226.34 ± 0.31^{a}
T_2	208.54 ± 0.25^{a}	263.59 ± 0.34^{c}	326.54 ± 0.28^{bc}	311.37 ± 0.15^{b}	177.47 ± 0.67^{a}	225.64 ± 0.69^{bc}	298.71 ± 0.56^{c}	283.86 ± 0.42^{b}
T_3	206.59 ± 0.34^{a}	241.54 ± 0.38^{b}	301.33 ± 0.42^{b}	287.68 ± 0.21^{a}	178.37 ± 0.55^{a}	211.68 ± 0.65^{b}	252.62 ± 0.47^{b}	241.51 ± 0.27^{ab}
T_4	206.65 ± 0.13^{a}	237.42 ± 0.40^{b}	314.29 ± 0.51^{b}	295.35 ± 0.37^{ab}	177.45 ± 0.62^{a}	212.36 ± 0.53^{b}	245.28 ± 0.31^{ab}	238.22 ± 0.16^{ab}
T_5	206.62 ± 0.31^{a}	261.60 ± 0.47^{c}	322.64 ± 0.35^{bc}	315.55 ± 0.28^{b}	177.42 ± 0.58^{a}	223.78 ± 0.62^{bc}	293.87 ± 0.43^{c}	285.38 ± 0.51^{b}
T_6	206.80 ± 0.22^{a}	270.65 ± 0.52^{cd}	340.67 ± 0.46^{c}	336.41 ± 0.53^{c}	178.62 ± 0.61^{a}	248.81 ± 0.55^{c}	311.96 ± 0.64^{d}	299.28 ± 0.47^{bc}

All values are mean and standard deviation of three replicates; means in a column followed by the same letter(s) are not significantly different (P<0.05).

Figure.1 Changes in TOC (%) during microbial decomposition of different treatments

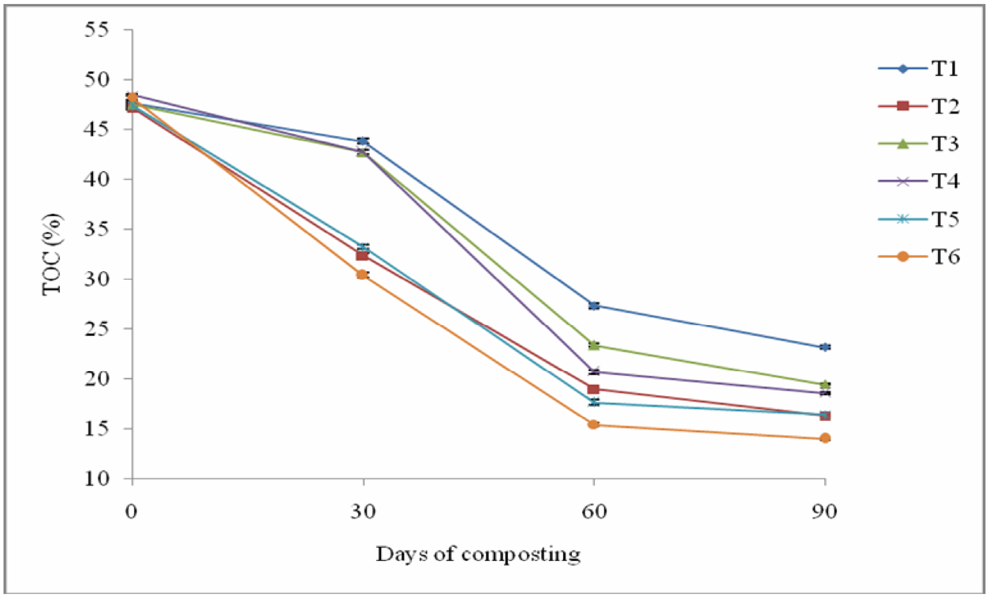
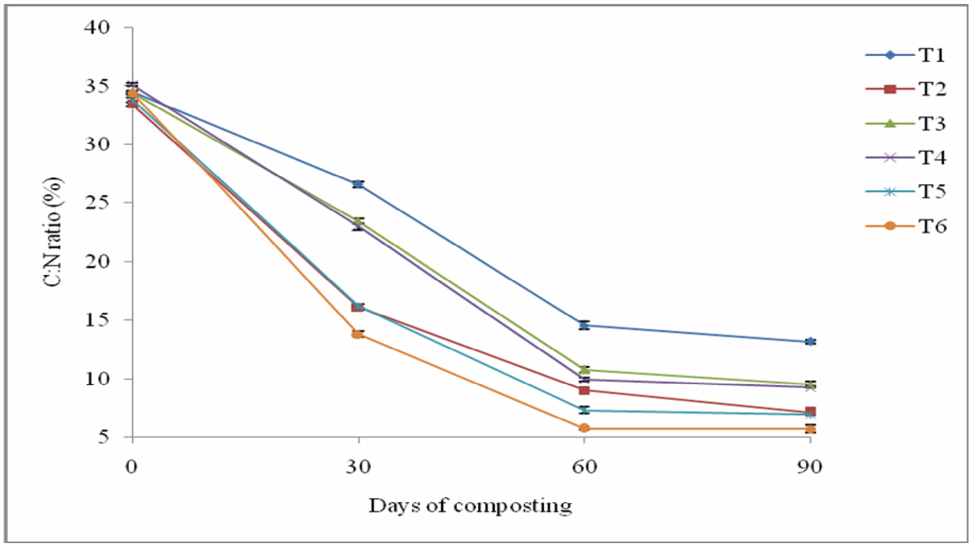


Figure.2 Changes in C:N ratio during microbial decomposition of different treatments



The present study decreased TK content after 60 days in all the treatments may be due to leaching of soluble potassium by excess water (Gupta *et al.*, 2007).

Ca, Na and Mg

A significant difference in Ca, Na and Mg was observed during the microbial composting of PD with BG in all the treatments. The enhancement of Ca, Na and Mg was higher than initial substrate material and recorded between the ranges of 328.65±0.56 to 395.83 ± 0.65, 281.12 ±0.31 to 340.67 ±0.46 and 231.97 ±0.41 to 311.96 ± 0.64, respectively.

The microbial inoculated treatments showed more concentration of available forms of Ca, Na and Mg than experimental control. The maximum increase in Ca, Na and Mg was observed on 60th day and slightly decline on 90th day of composting. However, the microbial composting plays an important role in microbial- mediated nutrient mineralization in wastes. In general, microorganism plays an important role in transformation of plant metabolites into more available forms of Ca, Na, and Mg content, which can be further metabolized by microbial communities associated with compost (Dominuguez, 2004).

In conclusion the feasibility of PD amended with BG waste decomposition by microbial inoculation has been evaluated in order to rapid composting and to produce quality compost with higher agronomic value.

This study suggests that microbial inoculation effectively degraded these waste in all the treatments, however, the highest degradation was recorded when inoculation of microbial consortium in to the treatment followed by inoculation of *T. viride* and *A. niger*. According to the experimental results, the highest values of nutrients were obtained in T6, T5 and T2, treatments. Therefore, the mixture ratio of PD to BG in 1:1 (dry weight) with inoculation of *T. viride, A. niger* and consortium was better for composting process and production of nutrient rich organic materials.

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