Research Article

Assessment of Quality of Compost Prepared From Paddy Straw and Distillery Effluent

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Abstract

During the present investigation the paddy straw and distillery effluent were mixed in different ratios along with cattle dung and microbial consortium and allowed to decompose under pit house conditions up to 90 days. The changes in C/N ratio were monitored at different days of composting and C/N ratio dropped down from 49.09 to 16.25 after 90 days in the treatment T5 having Paddy straw + 30% Distillery Effluent + 10% Cattle dung + microbial consortia (1 g) in comparison to control treatment T1 having Paddy straw + 10% Cattle dung. The quality of compost was assessed by measuring different parameters such as C/N ratio, humic substances, carbon dioxide evolution, water soluble carbon and % germination index of wheat. The compost prepared with paddy straw, 30% distillery effluent, 10% Cattle dung and microbial consortia (compost 2) was having 16.25 C/N ratio after 90 days, 109.66 mg/g humic acid, 27.79 mg/g fulvic acid and CO_2 evolution was 249.80 mg CO_2/100g compost and having 1.80% water soluble carbon, thus found best in quality.

Keywords: Co-composting, Paddy straw, Distillery effluent, compost and Compost quality

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Introduction

Due to everlasting large growing population and rapid rate of industrialization, there is enormous increase in Industrial and agricultural waste. It is necessary to pretreat these wastes before their disposal into soil to avoid any kind of environmental problems. Distillery effluent and paddy straw are the industrial and agricultural wastes respectively. Distillery effluent (DE) is dark brown complex, organic industrial material having extremely high chemical oxygen demand (COD), biological oxygen demand (BOD), inorganic solids and low in pH [1-4]. It contains reduced sugars, carbohydrates, waxes, proteins, alcohol, sulfurous compounds, minerals, melanoidins etc. It is reported as one of the major pollution problems of countries, which are producing alcohol from the fermentation and subsequent distillation process of sugar cane molasses [5]. It doesn't having any toxic substances but has high oxygen demand so it is harmful to apply as it is into the soils.

Huge amount of paddy straw (PS) is generated throughout India every year after crop harvest [6] which is not degraded easily. India is the world's largest producer of paddy after China [7]. In 2014, Indian paddy production was 152 MMT along with huge amount of paddy straw. To manage this straw, the most common practice in India is to burn this in the fields itself to make the fields ready for the next crop just because of short window time between two crops [8]. Paddy residue management through its direct incorporation into soil is associated with certain problems such as immobilization of important plant nutrients, impedes bed preparation and reduced germination of subsequent crops. Paddy straw is having high C:N ratio and lignin, therefore decomposes slowly [9]. So keeping in view the above facts, the present study was carried out with this idea of co-composting of an agricultural waste (paddy straw) along with industrial waste (distillery effluent) and evaluated for different quality parameters.

Experimental

Composting Material and Treatments

The composting of paddy straw and distillery effluent was carried out under pit house conditions in different ratios in various treatments given below and the experiment was conducted in 1.5×1.5×1.5 ft. size pits. The initial C:N ratio of material was adjusted to 50:1 by dipping in 0.1% solution of urea. Fungal consortium of three different fungi (*Aspergillus awamorii, Paecilomyces fusisporus* and *Trichoderma viride*) was used for composting.

Different Concentration of Composting Material in Various Treatments

Sr. No.	Treatments
T1.	Paddy straw + 10% Cattle dung
T2.	Paddy straw + 10% Cattle dung + microbial consortia (1 g)
T3.	Paddy straw + 10% Distillery Effluent + 10% Cattle dung + microbial consortia (1 g)
T4.	Paddy straw + 20% Distillery Effluent + 10% Cattle dung + microbial consortia (1 g)
T5.	Paddy straw + 30% Distillery Effluent + 10% Cattle dung + microbial consortia (1 g)
T6.	Paddy straw + 40% Distillery Effluent + 10% Cattle dung + microbial consortia (1 g)
T7.	Paddy straw + 50% Distillery Effluent + 10% Cattle dung + microbial consortia (1 g)

Compost Quality Determination

The compost quality was determined by measuring final C/N ratio, humic substances, CO_2 evolution, water soluble carbon and % germination index of wheat.

Carbon/Nitrogen ratio (C/N)

Total carbon was estimated by dry Combustion [10] method and total nitrogen was determined by [11] as C:N ratio is one of the most important parameters that determines the extent of composting and degree of compost maturity.

Humic substances

The humic substances in compost were estimated according to method outlined by [12].

Carbon dioxide evolution (CO_2)

The amount of Carbon dioxide was measured in the compost by capturing the CO_2 evolved in 0.5 N NaOH solution and then titrated it with 0.5 N HCl after adding saturated barium chloride [13].

Water Soluble Carbon

Total Water soluble carbon was evaluated by the titrimetric method of Kalembasa and Jenkinson [14].

Germination index

Forty seeds of wheat were taken for determining the germination index in a sterile petri plate having sterilized ordinary filter paper disc in it and to each petri plate 8 ml of compost water extract was added, which was prepared with the addition of 10 g of final matured compost in 90 ml of distilled water. Then it was shaken for half hour and filtered through Whatman no.1 filter paper for each treatment and incubated in a BOD incubator at 30^0C. The seeds germination was calculated by taking the number of seeds germinated in sterilized distilled water taken as control.

- All observations were taken out in triplicate and statistical analysis was done by using OPSTAT software tool [15].

Results and Discussion

Compost Quality Determination

Carbon/Nitrogen ratio

The changes in C/N ratio at different time intervals of composting are presented in **Table 1**. As the decomposition progressed the carbon content of the compostable material decreased with time due to evolution of CO_2 and N content increased which resulted in decrease in C/N ratio. When a waste is composted, there is decrease in C/N ratio with time which stabilizes in the range of 15 to 20.

The C/N ratio dropped down from 49.88 to 26.97 in control T1 (paddy straw + 10% cattle dung) after 90 days of composting. With the amendment of distillery effluent and microbial consortia the decline in C/N ratio was more as compared to control. The treatment T5 was having minimum C/N ratio (16.25) than other treatments. There was no decrease in C/N ratio after 75 days of decomposition in all the treatments and was almost same on 75th and 90th day. These results were according to Hussain and co-workers [16], where total organic carbon values and C/N ratio were lower in the vermicompost and different enriched composts than that of conventional compost [17]. Analysed physical and chemical characteristics such as pH, K^+, PO_4-^{3}, NH_4^+, NO_3^- of wheat straw by using a microbial consortium. The composting process resulted into a quality compost with C:N ratio 17:1 and contained 1.5% NO_3^-, 0.3% NH_4^+ ion, 44% K^+, 15.46 mg/Kg PO_4^{-3} along with pH 7 after 60 days of incubation. Viji and Neelanarayanan [18] have also reported that mixed culture of three fungal strains (R. oryzae, A. oryzae and A. fumigatus) reduced C:N ratio to 10:1 in paddy straw compared to 70:1 in paddy straw mixed with soil.

Table 1 Changes in C/N ratio at different days of composting

Treatments	C:N ratio						
	Days of composting						
	0	15	30	45	60	75	90
T1.(Control)	49.88	46.83	39.36	30.71	28.64	26.84	26.97
T2.	49.64	45.82	36.62	25.98	22.41	21.64	20.94
T3.	49.10	44.37	35.13	23.72	21.68	20.84	19.59
T4.	50.05	45.43	36.55	21.24	19.78	18.34	18.29
T5.	49.09	46.71	38.71	22.42	18.82	17.04	16.25
T6.	48.79	45.15	37.12	27.86	19.06	17.31	17.07
T7.	49.11	45.94	39.55	28.09	20.32	18.96	18.65

Humic substances

The composting process results in the production of humic substances, which are slowly degradable and act as permanent source of energy for growth of microorganisms and regulate the carbon cycle in soil [19]. The different composts were analyzed for humic substances. The composting process results in the production of humic substances. Humic and fulvic acid contents of different composts are shown in **Table 2**.

Table 2 Amount of humic substances (mg/g) in compost after 90 days

Sr. No.	Humic substances		
	Humic acid (mg/g)	Fulvic acid (mg/g)	Humic+ Fulvic acid (mg/g)
T1.	92.12	19.20	111.32
T2.	104.40	20.90	125.30
T3.	106.12	26.68	132.80
T4.	109.40	27.15	136.55
T5.	106.26	28.06	134.32
T6.	109.66	27.79	137.45
T7.	110.11	27.06	137.17
C. D. at 5% level of significance	4.02	3.05	--

Humic acid in different treatments varied from 92.12 to 110.11 mg/g and fulvic acid from 19.20 to 28.06 mg/g after 90 days of composting. The maximum amount of humic substances (Humic + Fulvic acid) were observed in treatment T6 (Paddy straw + 40% distillery Effluent + 10% cattle dung + microbial consortia) and T5 (Paddy straw + 30% Distillery Effluent + 10% Cattle dung + 1g microbial consortia) while the minimum was in treatment T1 (Paddy straw + 10% cattle dung). By analysing C.D for both it can be seen that there is no significance difference among the two. In an another study, they [20] found that the total humic substances amount produced by lignocellulosic fungi and cattle dung was more than using biogas slurry alone as inoculum in comparison to the control, which was without any inoculum. The inoculation of fungal consortium with paddy straw and cattle dung resulted in 21.4 and 25.1% more humic substances total amount respectively, in comparison to that untreated control.

Carbon dioxide evolution

Carbon dioxide evolution in finished compost at different intervals is shown in **Table 3**. The amount of carbon dioxide evolution was higher in all the treatments during first week of incubation and it decreased with further incubation with least amount of carbon dioxide evolved in fourth week of incubation. The total carbon dioxide evolution in the treatment T1 having PS alone was higher than the treatment T5 with PS and DE both.

The product formed by composting materials without microbial consortia was still evolving more CO_2. The explanation for it may be the continuous decomposition of organic waste even after 90 days of composting. Garcia and co-workers [13] suggested that in mature municipal compost, the total amount of CO_2 evolved should be less than 500 mg CO_2/100g compost. In present experiment, the CO_2 evolution after 90 days of composting was less than above limit, indicating that these composts were properly stabilized and was matured after 90 days of decomposition.

Table 3 Amount of CO_2 evolution (mg CO_2/100g compost) in compost:

Treatments	**Incubation time (weeks)**				
	1	**2**	**3**	**4**	**Total**
T1.	126.60	108.00	92.80	70.40	406.80
T2.	106.60	91.60	50.90	31.70	280.80
T3.	104.70	91.20	50.20	32.30	278.40
T4.	103.90	88.00	43.20	33.10	268.20
T5.	102.30	81.50	45.10	20.90	249.80
T6.	103.60	89.00	42.90	37.40	272.90
T7.	112.80	83.00	44.80	34.10	274.70

Changes in Water Soluble Carbon

The water soluble carbon in composts prepared from different levels of distillery effluent and microbial consortia varied from 1.80 to 2.99% after 90 days of composting in different treatments (Table 4). The compost prepared from paddy straw + 30% distillery effluent + 10% cattle dung and microbial consortia were showing lowest amount of water soluble carbon as compared to control (paddy straw + cattle dung). Castaldi and co-workers [21] also found that the water soluble organic carbon concentration vigorously increased at maximum level after 18th day and after that decreased during 122th days of composting.

Table 4 Changes in carbon (%) in compost water extract during the period of composting

Treatments	**Carbon (%) in compost water extract**						
	Days of composting						
	0	**15**	**30**	**45**	**60**	**75**	**90**
T1.(Control)	7.03	8.14	7.12	5.82	4.60	3.23	2.89
T2.	7.22	8.48	7.24	5.43	4.18	3.11	2.30
T3.	7.09	8.67	7.11	5.98	4.16	2.04	1.94
T4.	7.23	8.70	6.98	6.04	3.92	2.34	1.90
T5.	7.22	8.86	6.85	5.67	3.32	2.09	1.80
T6.	8.20	8.92	7.04	5.74	3.84	2.16	1.87
T7.	8.08	8.92	6.96	5.70	3.87	2.19	1.82
C. D. at 5% level of significance	0.22	0.84	0.20	0.61	0.41	0.41	0.60

Seed germination

The germination index of wheat seeds were analysed in compost water extract and was compared with seeds germinating in water after 4 days of incubation (**Figure 1**).

The percentage of wheat germination varied from 90 to 95 percent. The evaluation of phytotoxicity of mature compost before land application is essential and its germination index should be above 80%. During the present investigation, seed germination above 90% shows that compost prepared from different levels of distillery effluent + paddy straw and microbial consortium, do not have any phytotoxic effect on seed germination. Gaind and co-workers [22] evaluated the maturity of compost, which was prepared from neem cake, poultry droppings, castor cake, grass clippings and jatropha cake by inoculating different fungal mixture showing that the mixture of poultry dropping, wheat straw and jatropha cake was having the minimum C/N ratio (10:1) and also showed that germination index exceeded upto 80 after 60 days of decomposition.

Batham and co-workers [23] have also reported that seed germination up to 20% (w/w) concentration of vermicomposting had no inhibitory effect on seed germination. While at higher (>40%) concentration, there was decrease in seed germination.

As the main criteria for quality testing of compost are its nutrient content, humified and stabilized organic matter, the maturity degree, the cleanliness and the availability of certain toxic compounds [24]. Quality of compost is also closely related to its maturity and stability. Different parameters which define the quality and maturity of composts are water soluble carbon, the C: N ratio of the final product, humic acid content, and the CO_2 evolution from the finished compost [25].

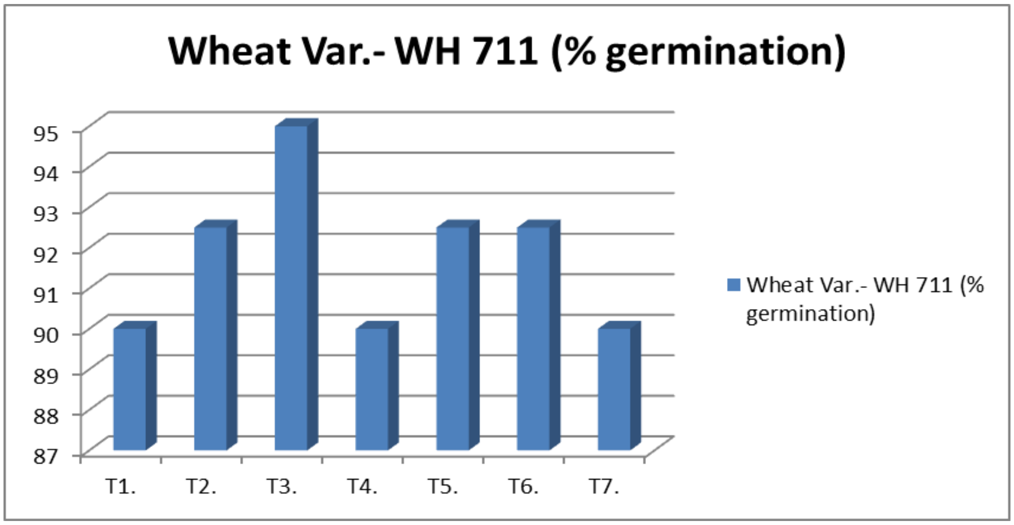

Figure 1 Wheat germination index in compost water extract after 4 days of incubation

Co-composting of paddy straw along with 30% distillery effluent resulted into a compost with neutral pH, dark brown colour, C:N ratio (16.25) and was having lowest CO_2 evolution (249.80 mg/ 100 g). Germination index of wheat was above 90% for each compost water extract which thereby shows that all of these composts do not have any phytotoxic effect on seed germination.

There is no use of any research if we do not apply it for the benefit of environment and mankind. Compost can have many beneficial aspects if we apply it in soil for growth of crop as improvement of soil health and crop quality. As we know most of the cultivated soils in tropical climates are deficient in organic matter content due to fast decomposition and repeated cultivation so we have to apply extra nutrients to meet crop needs. The continuous decrement in the crop yield could be because of inefficient use of chemical fertilizers especially that of nitrogen [26]. Soil reserves are not able to meet the large amounts of nutrients required year after year to harvest the quantum of crop produce needed for increasing human population. The organic manures are slowly degraded, hence will improve the soil organic matter status and also provide organically bound form of nutrients to plant through mineralization.

Conclusion

During the present investigation it was found that paddy straw co-compost along with 30 and 40% distillery effluent and microbial consortium can be done and resulting into a quality compost.

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