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Isolation and Screening of Cellulose Degrading Fungi and its Potential for degrading Organic wastes

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Abstract

The present investigation entitled Isolation and Screening of Cellulose Degrading Fungi and its Potential for degrading Organic Waste was conducted at Department of Plant Pathology and Microbiology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri. Were carried out with an object to know the potential of cellulolytic consortium to degrade organic waste. It was concluded from the experiment that, among all the treatments, treatment of chopped sugarcane trash @ 5 Kg pot^{-1} + Consortium of cellulose degrading fungus @ 5g pot^{-1}, took 85 days to degrade all organic waste. At maturity of decomposition, pH of all the treatments was stabilized in between 7.11 to 8.13 during decomposition process. C:N ratio of all the treatments were in the range of 15.59 to 25.44. While the results of organic carbon content was in the range of 18.18-21.30 per cent. Total nitrogen, phosphorous and potassium content at maturity was ranged from 0.79 to 1.20 per cent, 0.21 to 0.65 per cent and 1.25 to 2.54 per cent respectively. The results in general concluded that compost made from sugarcane trash contained 48.4 per cent moisture, 32.1 °C temperature and 18.71 per cent organic carbon content. The ready compost had highest nutrient content like total nitrogen, total phosphorous and total potassium i.e. 1.20%, 0.34% and 2.54% respectively, as compared to uninoculated compost. It indicated that cellulose degrading fungi had played role for degrading sugarcane trash effectively in minimum days.

Key words : Cellulose, Compost, Degrade, Fungi etc.

The composting is one of the eco-friendly and cheap methods of recycling solid wastes. The continuous use of large quantities of chemical fertilizers in intensive cropping systems results in various adversities and unfavorable soil conditions (Parr *et al*., 1986). So, the usage of sustainable sources of nutrients becomes necessary. Composting is a process in which the complex organic substances are converted into carbon dioxide, water, mineral constituents and biostable organic compound known as humus. Composting leads to the conservation of nutrients, destruction of pathogens and enrichment of soil fertility. Generally, it takes six to seven months to obtain good, finished compost from agricultural wastes and one of the important research is to reduce the period of composting of agricultural residues through rapid composting.

Biological decomposition is a widely recognized and effective method for waste breakdown, utilizing bacterial and fungal spores to accelerate the process under both aerobic and anaerobic conditions. Sustainable and environmentally friendly agricultural waste management strategies are essential for effective agro-waste disposal. Numerous studies and research initiatives have aimed to develop bio-fertilizers from agro-waste. These bio-fertilizers are derived from agricultural residues like straw and maize stalks, which are broken down by decomposers and are considered recycled materials. Residues from green vegetables, fruits, and cereal crops provide essential nutrients such as nitrogen, phosphorus, and potassium, along with secondary and micronutrients like calcium, boron, magnesium, and manganese. Microbial decomposition enhances the nutritional value through processes like nitrogen fixation, phosphorus solubilization, and cellulose degradation (Manna *et al*., 1997). Many microbes utilize cellulose and hemicellulose as sources of carbon and energy, and fungi have been particularly studied for their ability to produce a diverse array of cellulases.

Composting can occur through either aerobic or anaerobic processes. In anaerobic composting, organic materials are placed in pits and left for several months without exposure to fresh air. This method is marked by the generation of unpleasant-smelling gases and proceeds more slowly due to the action of anaerobic microorganisms. For rapid aerobic decomposition, optimal conditions include a moisture content of 45 per cent to 60 per cent by weight, an oxygen concentration greater than 5 per cent, feedstock particle sizes no larger than 1 inch, and a pH level between 5.5 and 8.5.

Material and Method

Field experiment : Field work was conducted at research farm, at Department of Plant Pathology and Microbiology M.P.K.V. Rahuri (M.S), India to study the potential of cellulolytic consortium to degrade organic waste.

Organic Wastes : Sugarcane trash, Wheat straw, Sorghum straw, Pearl millet straw and Cotton straw.

Assessment of Maturity of Compost

Physio-chemical analysis of substrates was carried out by following methods,

i. Temperature of the substrates was measured by hand thermometer weekly at fixed time.

ii. pH - Pass fresh sample of compost through a 2-4 mm sieve. Take 20 g of the sample and add 100 mL of distilled water of a ratio of 1:5. Stir for about an hour at regular intervals. Calibrate the pH meter by using 4.0 and 7.0 buffer solution. Measure the pH of the suspension on pH meter

iii. Organic carbon content of substrates was determined by ignition method (Bremner *et al*. 1970).

iv. Total nitrogen content of the substrates was determined by Micro-Kjeldahl method (Digestion-Distillation) (Piper, 1966)

v. Total phosphorus content was estimated by Vanado-molybdate colorimetric method (Jackson, 1973).

vi. Total potassium content in an aliquot of Diacid Digestion mixture with suitable dilution was estimated using flame photometer (Jackson, 1973).

Experimental Details

Location : Department of Plant Pathology and Microbiology, MPKV., Rahuri

Experimental design : CRD

No. of treatments : 07

No. of replications : 03

Treatment Details : T_1 - Chopped sugarcane trash @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus@ 5 g pot^{-1}, T_2 - Chopped wheat straw @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1}, T_3 - Chopped sorghum straw @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1}, T_4 - Chopped pearl millet straw @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1}, T_5 - Chopped cotton straw @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1}, T_6 - Combination of all organic waste (i.e. Sugarcane trash, Wheat straw, Sorghum straw, Pearl millet straw and Cotton straw) @ 5 kg pot^{-1} + Consortium of cellulose degrading Fungus @ 5 g pot^{-1}, T_7 - Absolute control (Combination of all organic waste without consortium).

(Note : Each treatment contains equal dose of cow dung slurry @ 5 lit pot^{-1} + Urea @ 40 g pot^{-1} + SSP @ 50 g pot^{-1})

Observations : The observation recorded during this study included Temperature, Moisture content, Number of days required for complete degradation, initial and final C:N ratio, Initial and final pH, total N, total P, total K, organic carbon content at maturity.

Result and Discussion

An experiment was conducted with seven treatment and three replication with completely randomized design. There were significant differences were observed between various treatments due to the applications of consortium of cellulolytic degrading fungi.

The results in general revealed that the temperature was found more in the fifth week for the treatment T_1 (Chopped sugarcane trash @ 5 kg pot^{-1} + Consortium of cellulose degrading fungi @ 5 g pot^{-1}) recorded maximum 62.7 °C at end of fifth week of decomposition followed by T_6 (Combination of all organic waste @5 kg pot^{-1}+Consortium of cellulose degrading fungi @ 5 g pot^{-1}) 62.4°C. The present results are in line with Gazi *et al*. (2007) reported that the temperature variation showed typical trend during green waste composting. The thermophilic phase, with temperatures above 45°C lasted for a bit over 3 weeks, during this period highest temperature 63°C had been recorded.

The moisture content during decomposition was maintained 44 to 55 during decomposition of all treatments. Similar findings were demonstrated by Bazrafshan *et al*. (2016) found that during the active phase of composting process the moisture content decreased from 58.3 to 38.8 per cent with most of the reduction occurring during the first 30 days. Zakarya *et al*. (2018) obtained moisture content value in range of 40 to 59 per cent.

Assessment of maturity of compost

Days required for compost Maturity : Average number of days required for compost maturity were varied from 85 to 160 days for different treatments. Among all the treatments, the treatment chopped sugarcane trash @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1} (T_1) degraded in 85 days. Patil *et al*. (2021) found that average number of days required for maturity were varied from 105-171 days for all substrates. It was found that cotton straw decomposed after 148 days and combination of substrates without consortium took 171 days for decomposition.

pH : pH of all the treatments stabilized in

Table 1. C:N ratio and pH of compost at initial and final stage of composting.

Tr. No.	C: N ratio		pH	
	Initial	Initial	Initial	Final
T_1	72:1	72:1	7.91	7.70
T_2	77:1	77:1	7.69	7.20
T_3	94:1	94:1	6.70	7.30
T_4	80:1	80:1	7.88	7.14
T_5	120:1	120:1	5.91	7.80
T_6	140:1	140:1	7.90	7.61
T_7	145:1	29.55:1	8.10	7.92
SE(m) ±		0.31		0.06
C.D at 5%		0.94		0.17

Table 2. Nutrient content of compost at maturity

Tr. No.	Total N (%)	Total P (%)	Total K (%)	Organic carbon (%)
T_1	1.20	0.34	2.54	18.71
T_2	1.12	0.21	1.25	20.40
T_3	0.97	0.35	2.34	19.85
T_4	0.94	0.20	2.20	18.18
T_5	0.84	0.65	1.36	19.47
T_6	0.87	0.45	1.81	21.30
T_7	0.79	0.32	1.500	20.10
SE(m) ±	0.023	0.006	0.016	0.314
C.D at 5%	0.068	0.019	0.047	0.95

between 7.11 to 8.13 at the end of decomposition process. Jagadabhi *et al*. (2018) studied that at the end, pH ranged 7.5 to 8 indicating the completion of the decomposition process of readily degradable compounds and indicating the progress of maturity of the composted materials. De Oliveira *et al*. (2002) reported that in the initial 15 days of composting the pH value was low (pH 4), whereas it increased in the following days until reaching the final value of 7.0

C:N ratio : C:N ratio of all the treatments were found in the range of 15.59 to 25.44. The lowest C: N ratio was found in Chopped sugarcane trash @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1} (T_1). Goyal *et al*. (2005) studied that the initial C:N ratio of the wastes used for composting ranged from 13.9 to 51.1. As decomposition advanced, the C:N ratio decreased. After 90 days of composting, the C: N ratio of the final product ranged from 11.7 to 28.3.

Organic carbon : While the results of organic carbon content was in the range of 18.18- 21.30 per cent. The results obtained were similar to Patil (1994) who prepared compost from wheat straw and found that organic carbon per cent was 17.0. Ayed *et al*. (2021) observed that the values for total organic carbon decreased than initial and stabilized at 23.33- 25.23 per cent at the end of maturation phase.

Nutrient content at maturity : Total nitrogen content at maturity was ranged from 0.79 to 1.20 per cent. It was found maximum in T_1 (Chopped sugarcane trash @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1}). Total Phosphorous content at maturity was ranged from 0.21 to 0.65 per cent. It was recorded maximum in T_5 (Chopped cotton straw @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1}). Total Potassium content at maturity was ranged from 1.25 to 2.54 per cent. It was recorded maximum in T_v (Chopped sugarcane trash @ 5 kg pot^{-1} + Consortium of cellulose degrading fungus @ 5 g pot^{-1}). The present results are thus in conformity with the work done by earlier research workers. Shinde *et al*. (2024) prepared compost from sugarcane trash by using a fungal consortium and found that total nitrogen, phosphorous and potassium were in the range of 0.88, 0.24 and 2.89 per cent, respectively.

Conclusion

The results in general concluded that chopped sugarcane trash @ 5 kg pot^{-1} + Consortium of cellulose degrading fungi @ 5 g/pot showed minimum days for maturity (85 days) with minimum C:N ratio (21.03:1) and physiological weight loss 40 per cent, which indicated high degradation of substrate. At the time of maturity, pH of compost became 7.70 which was stabilized at neutral range. Compost made from sugarcane trash contained 48.4 per cent moisture, 32.1°C temperature and 18.71 per cent organic carbon content. The ready compost had highest nutrient content like total nitrogen, total phosphorous and total potassium which was 1.20%, 0.34% and 2.54% respectively, as compared to uninoculated compost.

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