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ECOTECHNOLOGY OF DISTILLERY SPENT WASH INTO BIOCOMPOST AND ITS APPLICATION IN SUSTAINABLE AGRICULTURE

Ali Khan M.A. and Preeti R. Sharma*
Environmental Science Lab, Department of Botany, Kisan (P.G.) College, Simbhaoli- 245207
Email: preetisharma911

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Abstract: Molasses based distilleries (319+) generate ethyl alcohol and spend wash (@15 Ltr/Ltr) which imbalancing the ecosystem and threatened biodiversity and human life. The Distillery spend wash has high BOD (52-56 kg/m^3) with acidic pH (4.0-4.3). Dispose of distillery spend wash has become an acute problem for Dolphin in Majestic river Ganga in sub continent that is creating pollution in atmosphere, hydrosphere and lithosphere. But ecotechnologically can be recycled for early composting of PMC for organic farming. Compost was formed from Agro Biowaste Wiz- PMC (Press Mud Cake), distillery spend wash and sugarcane trash by bioinoculate *Trichoderma Viride* and was mixed in 3 treatment over control. Variation in temperature based phases (Psychorophilic. Mesophilic, thermophilic, stabilization and poikilothermic). pH and C:N ratio were investigated. The morphological effect of T1, T2 and T3biocomposte were studied on *Triticum aestivum* in polybag culture. T2 treatment (Press mud cake+sugarcane+trash+DSW+*Trichoderma)* revealed significantly statistical higher germination. Relative index (GRI), root and shoot length, chlorophyll content and net primary productivity than control. Composts treated soil revealed higher NPK and S and soil moisture content in comparison to control and increased soil health with earth worm. Ecofriendly management of distillery spend wash into biocompost not only eliminate pollution problem but will also improve soil fertility for sustainable agriculture, environment and provide road nap for developed Indiain 21st Cemtuary.

Key words: PMC, Sugarcane trash, Distillery spend wash, C/N ratio, *Trichoderma viride*, Sustainable agriculture

INTRODUCTION

Waste management is a global issue, worsens by population &economic growth. It is increasingly serious problem in developing countries like India. Globally 140 billion tones of agricultural biomass waste is produced annually, most of it either left to rot in field or burnt. During past years pesticides, herbicides & chemical fertilizers have become the foundation of highly productive form of agriculture. However, accompanying their indiscrimate use cirrus risk of population serious changes in ecological symmetry & poisoning (Daniele & Rai, 2006) Compost is the partially decomposed remains of plants. In its final state of decomposition humus is ready. Press mud cake (PMC) - a solid waste, is a good source of organic matter, NPK and important micronutrients and also improves fertility productivity and other physical properties of soil.Distillery is known to dispose enormous quantity of spent wash which is hazardous and causing "CHEMICAL TIME BOMB" but contains many plant nutrients (Ali Khan & Dhaka 1996). Distillery effluent can be advantageously used for composting press mud cake to produce enriched quality of compost (Rajanan *et al.*, 1996a)- Som and Ram baan (Simbhaoli organic manure) are being manufactered by Simbhaoli Sugar Mill, Simbhaoli since 1996 and JOL, Gajraula after Chaudhary Charan Singh (C.C.S.) compost (Ali Khan, 1999)

The organic manure made out of Press mud maintains soil health sustains Sugarcane and Sugar production, improves soil physical properties, retains soil moisture and reduces the erosion hazards. Distillery releases spent wash that is usually considered a highly polluting waste as it is produced in a very large amount during a short season.

Sugarcane Trash are the dried leaves of sugarcane. Sugarcane produces about 10 – 12 tonnes of dry leaves per hectare per crop. The trash contains 28.6% organic carbon 0.35 to 0.42 % nitrogen, 0.04 to 0.15% Phosphorus, 0.50 to 0.42% Potassium. The direct incorporation of chopped trash increases the aviaibility of nutrients leading to soil fertility. Sugarcane trash can be easily composted by using the cellulolyticfungi – *Trichodermaviride*. It is a green coloured free living fungus multiplies very fast & spreads in the soil. It can be used as prophylatic agent against several diseases to plant or bio organic agents (Anandraj and Sharma, 1997). Compost is the product of an aerobic process during which microorganisms decompose organic matter into a stable amendment for improving soil quality and fertility. During composting, micro organisms use the organic matter as a food source, producing heat, CO_2, water vapour and humus as a result of their furious growth and activity.

Joshi *et al.* (1996, 1994) reported that destruction of aquatic life in water bodies likemajestic rivers Ganga &Gomti due to disposal of spent wash in India. Ali and Ahmed (1998) observed that "ECOLOGICAL TIME BOMB" explosion due to distillery lagoon percolation.

Subba Rao *et al.* (1990) showed that spent wash and press mud cake produce good quality of organic manure 7:1 against 2:1 that is rich in nutrient like N,P,K and trace element.

MATERIALS AND METHODS

Fresh PMC, Sugarcane trash (dried leaves) with distillery effluent (DE.) collected from Simbhaoli Sugar Mill Ltd. (SSM.) Simbhaoli (Hapur) and distillery division respectively were analyzed for physicochemical properties by standard procedure (Table 1) Sugarcane trash from agricultural farm of Kisan (P.G.) College, Simbhaoli.&decomposing agent *Trichoderma viride* in powder form were added for composting technique by heap method in plastic trays during 2008, 2009, 2010 & 2011.

The organic substrates viz. PMC. (Press mud cake) – 4.5 kg., Sugarcane trash – 500 gram, distillery effluent (DE.) – 6 liters and *Trichoderma viride* – 100 gram as a source of culture and homogenized in following treatments:

Control - PMC. + Trash + DE. + Water

T_1 - PMC. + Trash + DE.

T_2 - PMC.+Trash+ DE. + *Trichoderma*

T_3 - PMC.+Trash+DE.(1/2) + Water (1/2)+ *Tricho.*

After mixing the materials in trays was covered with the black sheet to maintain temperature, humidity & to avoid oxidation. During the complete process of decomposition pH, EC, moisture content, organic carbon and N.P.K. were recorded separately.

Temprature was observed up to 32nd day in degree centigrade unit (oc) by inserting thethermo meterin middle of heap. The pH and EC of the compost were determined by glass electrode method (1: 2) soil : water ratio (Jackson, 1967) organic carbon of the compost sample was determined by chronic acid titration wet digestion method outlined by Walkey and Black (1934). The N.P.K % was also observed. For N determination modified Kjeldahl microanalysis was adopted (Piper, 1966), P was analyzed of soil, plant and fertilizers method and obtained by Bhargwas and Raghupati (1993), P was estimated with the help of flame photometer (Jackson, 1967). The changes in C/N ratio during composting was monitored at each sampling intervals.

Plants Bioassay test was done through seed germination index (G.I.= Germination % x root length) test by using Triticumaestivum. Biocompost extracts were prepared by shaking compost samples with at a solid : water - 1:2 (W/V)upto 180 rpm. for 1 hour followed by centrifugation at 300 rpm for 20 minutes and then filtered through a 0.5 µ membrane filter. Ten seeds were placed in a petridish of 100 x 15 mm. containing 4.0ml compost extracts of T1, T2, T3 and deionized water was used as the control treatment. The numbers of germinated seeds were counted after 6, 12, 18, 24 and 48 hours on 32nd days of composting at 25°C. to 27°C. in the dark. (Lau and Wong, 2001) The data were analyzed statistically CD at 5% level.

RESULTS AND DISCUSSION

Immature and mature compost samples were analyzed for pH, EC, moisture content, N.P.K., total organic carbon and decomposer communities (Fungi, bacteria, and actinomycetes) change the temperature that represent five temperature phases. The initial phase (Psycrophilic) , moderate temperature phase (Mesophillic), high temperature phase (Thermophillic), cooling down phase (Stablization) and the curing or maturation phase (Poikilothermic) were recorded (Fig. 1)

Initially macro organisms (Grinders), they are shredders and taxis of the composting communities (mites, centipedes, millipedes, springtails etc.) starts multiplying and colonizing in the composting material. The organism breakdown the organic material into small particles& transport micro organisms throughout the compost heap.Microorganisms (fungi and bacteria) in biocompost digest or oxidize carbon as energy source and ingest nitrogen, the digestive enzyme.

Initial decomposition is carried out by psycrophillic and mesophillic ammonifying bacteria and cellulolytic micro organisms (decomposers). Most effective actinomycetes such as *Sporotrichum pulverulentum* rapidly breakdown the soluble, readily degradable compounds. Mesophillic terperature <40°C. of soluble substrate, several days rapid CO_2 loss, decrease in C/N ratio and immobilization of soluble N,P,K and S. In the compost, the thermophiles take over now. Temperature risesupto 60°C in winter (Fig. 1).

Immature compost gets hotter than 55°C, seed of weeds of most plants and pathogens are killed (a good thing). However, If it gets hotter 65°C, most of the 'good' microbes are also killed (a bad thing). Since these 'good' are needed to accelerate the decomposition process along the ideal temperature during this phase in between 55°C. and 65°C. These high temperature also speed up the breakdown of protein, fats and complex carbohydrates like cellulose and hemicellulose. This is the phase, which if not handled properly, can cause bad odour. For proper &odour free composting it is necessary to aerate the compost so as to maintain adequate supply of oxygen, lack of which encourages the growth of anaerobic microbes that produce disagreeable odours. (Masood, 2006). As the

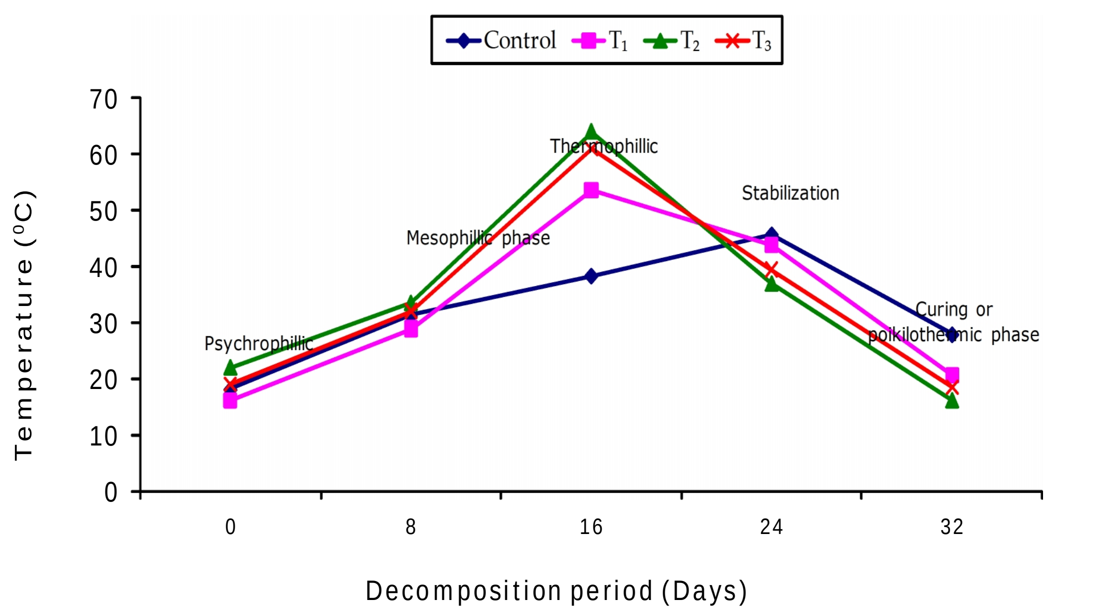

Fig. 1. Changes in Temp (°C) during biocomposting period of different substrates (treatments) in winter season
Abbreviation: PMC : Press Mud Cake; DE : Distillery effluent, Tricho.: Trichoderma Viride

Table 1. Physicochemical characteristics of immature and matured Biocompost (Fresh weight basis)

SI.	Properties	Days to Composting	Control (PMC+Trash+DE.+water)	Treatments T_1 (PMC.+Trash+DE.)	T_2 (PMC.+Trash+DE.+ *Tricho.*)	T_3 (PMC.+Trash+DE. (1/2)+Water (1/2)+*Tricho.*)	Max. and min. limits of good quality compost (Kadalli,2004)
1	Odour	0	Offensive	Foul Smell	Obnoxious	Foul Smell	Disagreeable Odour
		8 th	Punjent Smell	Foul Smell	Disagreeable	Obnoxious	
		16 th	Foul Smell	Foul Smell	Disagreeable	Obnoxious	
		24 th	Foul Smell	Foul Smell	Unpleasant	Disagreeable	
		32 nd	Foul Smell	Disagreeable	Earthly Smell	Disagreeable	
2	Appearance	0	Brown	Brownish	Brownish	Brownish	Dark Brown or Almost Black
		8 th	Brown	Brownish	Brownish	Brown	
		16 th	Brownish	Brownish	Dark Brown	Brown	
		24 th	Brownish	Brownish	Dark Brown	Brown	
		32 nd	Brownish	Brownish	Almost Black	Dark Brown	
3	pH Values	0	7.2	6.9	6.8	7.0	Between 6.5 to 7.5
		8 th	8.2	8.2	8.1**	8.3	
		16 th	8.2	7.9	8.00	8.0	
		24 th	7.9	7.5	7.6	7.3*	
		32 nd	7.8	7.0**	6.6**	6.8**	
4	EC (ds/m^{-1})	0	4.02	4.00*	3.05**	3.10**	Max. 1 dsm^{-1}
		8 th	4.16	4.05	3.09**	3.16**	
		16 th	4.18	3.56**	2.56**	3.07**	
		24 th	3.52	2.45**	1.42**	2.00**	
		32 nd	2.42	1.85**	1.10	1.38**	
5	Organic Carbon (OC) %	0	36.20	35.95	30.38**	33.00	20.00%
		8 th	36.10	32.79*	25.75**	27.48**	
		16 th	35.70	28.55**	23.84	25.82**	
		24 th	33.68	24.88**	20.49**	21.90**	
		32 nd	32.10	16.50*	12.35**	14.04**	
6	Moisture Content (%)	0	32.80	30.10	38.20**	35.40*	20-25%
		8 th	38.90	39.80**	43.70**	43.50**	
		16 th	35.40	33.40	35.00	32.50*	
		24 th	33.70	30.20*	32.60	26.70**	
		32 nd	30.20	26.30	26.20	23.00**	
	Major Nutrients						
7	Nitrogen (N)%	0	0.94	1.09*	1.02	1.05	1-2%
		8 th	0.96	1.25**	1.06	1.25**	
		16 th	0.97	1.43**	1.09	1.55**	
		24 th	1.00	1.80**	1.82**	1.78**	
		32 nd	1.05	1.95**	2.07	1.98**	
8	Phosphorus (P)%	0	0.90	0.99	1.22**	1.01**	0.75 to 1.9%
		8 th	0.95	1.12**	1.25**	1.15**	
		16 th	1.02	1.18**	1.34**	1.23**	
		24 th	1.08	1.33**	1.79**	1.58	
		32 nd	1.10	1.67**	2.02**	1.75**	
9	**Postassium (K)%**	**0**	**0.63**	**0.90****	**1.00****	**0.98****	**1 to 3%**
		8 th	0.79	0.99**	1.19**	1.08**	
		16 th	0.82	1.05**	1.23**	1.16**	
		24 th	0.93	1.12**	1.62**	1.39**	
		32 nd	0.95	1.15**	1.95**	1.50**	

C.D. (Critical difference) * - Significant at 5% level; ** - Significant at 1% level.
Abbreviation: PMC : Press Mud Cake; DE : Distillery effluent; Tricho.: Trichoderma Viride

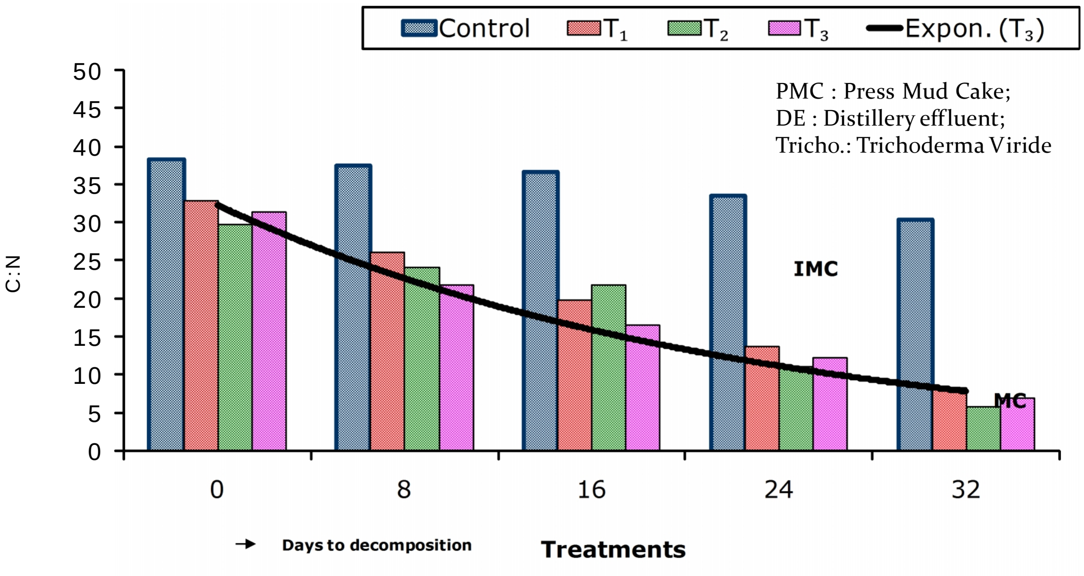

Fig. 2. Changes in C:N in composting process for improved quality of mature compost

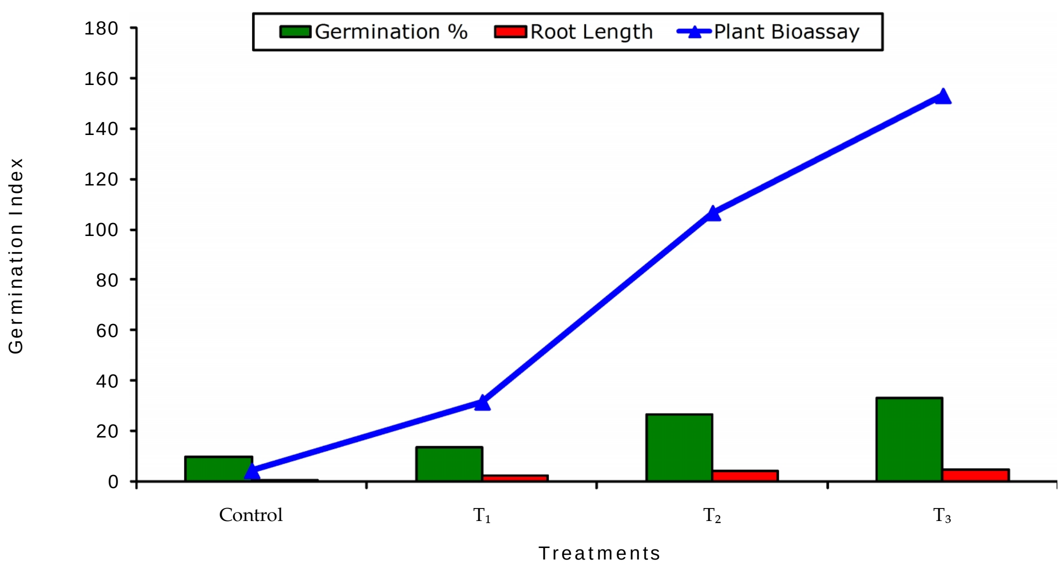

Fig. 3. Bioassay test of *Triticum aestivum* L.for immature compost (IMC) and mature compost (MC) at 32 days of composting

supply of these high energy compounds gradually decrease after 24th day to stabilization and mesophillicmicroorganisms once again take over the final phase poikilothermic (curing or maturation) of remaining organic matter. The red coloured worms were appeared in compost (Masood, 2006).With drop in temperature was observed in $T_2$and T_3 that indicated the effect of biodegradable *Trichoderma* which accelerate decomposition rate T_1 over control. During poikilothermic phase of compost continues to decompose and are finally converted to biologically stable 'HUMUS' (Table 2). The final finished product had a dark colour, a crumbly texture & an earthly smell of matured compost. (Kadalli *et al.*, 2004)

The high pH value just before 1st turningwas caused by ammonia liberated from proteins of composting substrates. Moreover, at high pH in the thermophillic phase, NH^+_4 equation shifted toward NH_3, high pH and high NH_3 concentration in thermophillic leaded NH_3 volatilization. Consequently pH dropped to near neutrality (Eiland *et al.*, 2001)

Highest mineralization and content of N_2 in the substrates were recorded in T_1 (1.95%), T_3 (1.98%) and control (1.05%) while T_2 (2.07%) Higher phosphorus content of compost were recorded in T_1 (1.67%) than T_2 (2.02%). Higher potassium content of K_2O_5 was recorded in T_2 (1.50%).

The carbon/Nitrogen ratio affects the speed of the composting process and the volume of material finished. C/N ratio was observed reduced from 8th to 32nd day of decomposting of compost. (Fig-2) T_1 treatment showed high C/N ratio (6:1) while the T_2& T_3 treatments revealed the low C/N ratio (5:2) & (5:3) over the control respectively. However C/N ratio of T_2& T_3 were observed (5:2) and (5:3) on 32nd day of maturity that shows the decomposting efficiency of *Trichoderma*. Wider C:N ratio and higher amount of resistant constituents like lignins are responsible for show decomposition (Rao and Tarafdar, 1996). Above said observations were studied by Mishra (2001b) that the faster decomposition could be due to lower lignin and narrow C/N ratio.

Bioassay test for germination (%) and root growth of *Triticum aestivum* in extract of treatments for immature and mature composts were studied (Fig. 3). Germination (%) was significantly increased in the trend T_1>T_3>T_2 with root growth over the control. The germination index obtained by multiplying germination (%) and root growth is the most sensitive parameter that is able to account for low toxicity affecting root growth and seed germination (Zucconi *et al.*, 1981).T_2 combination has high germination index 142 which revealed maturity of compost. However G.I<100% was observed for T_1 combination in 32nd days implying immaturity that's why these were phytotoxic. Bioassay test signifies that germination index was significantly negative correlated with T_1 compost that showed inhibited seed germination and root elongation. High germination index in T_2 treatment showed maturity of compost.

The level of EC (ds/m^{-1}) is lower in T_3& T_2 treatment of compost than T_1. (Table 2) EC concentration could be the major factor affecting seed germination and root growth while lower EC of T_3& T_2 have shown the higher G.I. which revealed that composting rate is accelerated by *Trichoderma*. However the quality of compost increased the high pH and EC might become the factor which is responsible for the phytotoxicity.

CONCLUSIONS

Compostingof biodegradables (Press mud cake, Distillery effluent, Sugar cane trash inoculated by *Trichoderma viride* were investigated under different identical phases (Initial-psycrophillic, Moderate-Mesophillic, High-Thermophillic, Cooling down-stablization and Maturation-Poilkilothermic). Neutral pH in the final compost as well as highest organic carbon C:N and bioassay test of both test crop make T_2 combination superior quality of compost. Agroindustrial waste management technology of manufacturing of compost has significant onus of accountability for law cost effective for cultivation which not only eliminates pollution load in lithosphere, biosphere &hydrosphere but will also build roadmap of sustainable, development for vision 2030 of 'developed India'.

Not with standing it will prove a local action or Global challenge after waste management of biodegradable industrial waste, Sewage sludge (S.S.) and Municipal waste (M.S.)

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