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Bioactive Compost - A Value Added Compost with Microbial Inoculants and Organic Additives

R. Kavitha and P. Subramanian
Department of Environmental Sciences, Tamil Nadu Agricultural University,
Coimbatore-641003, Tamil Nadu, India

Abstract: A study was conducted in the Department of Environmental Science, Tamil Nadu Agricultural University, Coimbatore, to transform the normal compost into bioactive compost through the addition of various substrates, which has multiple benefits to the crop system. The key players in this transformation process were *Azotobacter*, *Pseudomonas*, Phosphobacteria, composted poultry litter, rock phosphate and diluted spent wash. This enrichment process has increased the nutritive value of compost. The highest nitrogen content (1.75%) and phosphorus content (1.16%) was observed in the treatment T_5 (compost enriched with composted poultry litter, spent wash, microbial inoculants and rock phosphate). The beneficial microorganism viz., *Azotobacter*, *Pseudomonas* and Phosphobacteria population were higher in the treatment T_5 where all the inputs (composted poultry litter, microbial consortium, rock phosphate and spent wash) were added to the compost. The plant growth promoters viz., IAA and GA content was more in the treatment applied with spent wash and microbial inoculum. Beneficial microorganisms, composted poultry litter, rock phosphate and diluted spent wash contributes maximum level of nutrients and growth promoters to the compost with small expenses.

Key words: Enrichment, bio-active compost, spent wash

INTRODUCTION

The piles of municipal wastes are growing at a faster rate. In India, approximately 36.5 million tones of municipal solid waste are generated annually. Composting is a well-know system for rapid Organic Matter (OM) stabilization and humification (Adani, 1995; Desai, 1997), Large amounts of compost prepared from municipal refuse are available. But most of these have low nitrogen and phosphorus content and are poor sources of nutrients for plant growth (Kapoor *et al*., 1983). City compost produced at mechanical composting plants are generally low in plant nutrients and therefore their economic feasibility is very low. For improving its quality and nutrient content, the enrichment of compost is essential (Talashilkar, 1985).

One of the possible ways of increasing the nutrient content of the final compost product is microbial enrichment technique with nitrogen fixers, P solubilisers and cellulose decomposers (Manna *et al*., 1997). Microbial inoculation and application of 1-5% rock phosphate increased the nitrogen content of city compost by 24-30% (Gaur and Singh, 1993). The present experiment was undertaken to improve the nutrient content and quality of the compost produced from municipal waste through inoculation of microbial consortium, composted poultry litter, diluted spent wash and rock phosphate.

MATERIALS AND METHODS

An incubation experiment was conducted in the compost unit of Department of Environmental Science, Tamil Nadu Agricultural University, Coimbatore to study the effect of different materials composted poultry litter, diluted spent wash, rock phosphate and microbial consortium consists of *Azotobacter*, *Pseudomonas fluorescence* and Phosphate sloubilising bacteria on compost. The following treatments were adopted in the enrichment study in the compost.

T_1	:	Municipal Solid Waste Compost (MSWC)
T_2	:	MSWC + 10% Composted Poultry Litter (CPL)
T_3	:	MSWC + 10% CPL + 0.5% Microbial Consortium + 0.5% Rock Phosphate
T_4	:	MSWC + 10% CPL + 10% Spent wash (10% diluted)
T_5	:	MSWC + 10% CPL + 0.5% Microbial consortium + 0.5% Rock phosphate + 10% Spent wash (10% diluted)

Corresponding Author: R. Kavitha, Department of Environmental Sciences, Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India

The experiment was conducted in a Completely Randomized Block Design with two factors and four replications. Five kilograms of well sieved compost was taken for study. Initial compost sample was taken and all nutritive parameters were analysed in the laboratory and given in the Table 1. Compost material was spreaded and additives were mixed uniformly as per treatments. The composted poultry litter was added at the rate of 10% (500 g) on weight basis to all the treatments except T_1. The secondary treated spent wash was diluted to 10% and added to the T_4 and T_5 at the rate of 10% (500 mL). Rock phosphate was added at the rate of 0.5% (25 g) to T_3 and T_5. The microbial consortium viz., *Azotobacter*, *Pseudomonas fluorescence* and Phosphobacteria were added at the 0.5% (25 g) to T_3 and T_5 on 10 days after incubation. Moisture level in the compost was maintained at 60% by sprinkling water once in two days. The heaps were left for 20 days incubation and samples were taken for nutrient analysis on 0, 10 and 20 days after incubation and on 10 and 20 days after incubation for microbial analysis.

The samples were air dried, powdered and sieved for the analysis of total nitrogen, phosphorus and potassium content and plant growth promoters. Fresh samples were used for microbial analysis.

Total nitrogen content of the sample was estimated using the Microkjeldahl's method, as explained by Humphries (1956) and Phosphorus content by Vanadomolybdate method and Potassium content (Jackson, 1973). The microbial population was enumerated using serial dilution and plating techniques (Waksman and Fred, 1922). Plant growth promoters like IAA and GA were estimated in the methanol extract according to Gorden and Paleg (1957) and Borrow *et al.* (1955), respectively. Analysis of variance was used to test significance ($p<0.05$) of treatment effects.

Table 1: Physio-chemical parameters of municipal solid waste compost before enrichment

Parameters	Concentration
Moisture content (%)	29.0
Bulk density (g cc^{-1})	0.80
Porosity (%)	60.00
Particle density(g cc^{-1})	1.21
pH	8.10
EC (dS m^{-1})	2.23
Organic carbon (%)	11.25
CN ratio	17.57
Total nitrogen (%)	0.64
Total phosphorus (%)	0.56
Total potassium (%)	0.70
IAA (μg g^{-1})	0.17
GA (μg g^{-1})	12.50
Azotobacter sp.	Nil
Pseudomonas flurosence	Nil
Phosphobacteria	Nil

RESULTS AND DISCUSSION

Changes in the Microbial population during the enrichment of compost: There was no beneficial microorganism present in the compost material before enrichment as per the data collected in the control sample on 10th day. But after enrichment the compost material showed the presence of beneficial microorganisms viz., *Azotobacter*, *Pseudomonas* and Phosphobacteria, The treatments, which were received the microbial inoculants and spent wash, were found to have maximum population of beneficial microorganisms, when compared to other treatments (Table 2).

The beneficial microorganism population was received higher in the treatment T_5 where all the inputs (composted poultry litter, microbial consortium, rock phosphate and spent wash) were added to the compost. The beneficial microorganism has all the nutrients, energy from the enriched substrate. The nutrient lacuna in compost is made up with organic additives. This is followed by the treatment T_3 where except diluted spent wash all the materials were added to the compost.

The maximum *Azotobacter* population was observed in T_5 with 4.50×10^3 CFU g^{-1} followed by T_3 with 2.25×10^3 CFU g^{-1}. The increase in population could be attributed by the addition of microbial consortia in the compost material. The findings were similar to the result of Kapoor *et al.* (1983) who observed that there were 3 to 6-fold increase in the *Azotobacter* population in 3 weeks after inoculation of compost. He observed that *Azotobacter* inoculation could be done only after composting because it does not have the ability to survive the high temperature prevailing during composting.

Table 2: Studies on changes in the beneficial microbial load during the enrichment of municipal solid waste compost through organic sources and microbial inoculum

	Sampling period (days)					
	Azotobactor ($\times10^3$ CFU g^{-1})		Phosphobacteria ($\times10^2$ CFU g^{-1})		*Pseudomonas* ($\times10^3$ CFU g^{-1})	
Treatments	0	20	0	20	0	20
T_1	0.00	0.00	0.00	0.00	0.00	0.00
T_2	0.00	1.00	0.00	0.00	0.00	0.00
T_3	1.25	2.25	2.00	3.75	1.75	5.75
T_4	0.00	0.00	0.00	0.00	2.50	3.50
T_5	2.00	4.50	3.25	3.50	3.50	7.25
SEd	0.158	0.508	0.303	0.570	0.592	0.904
CD (0.05)	0.337	1.083	0.645	1.215	1.261	1.926

T_1-Municipal Solid Waste Compost (MSWC) T_2-MSWC + 10% Composted Poultry Litter (CPL), T_3-MSWC + 10% CPL + 0.5% Microbial Consortia (MC) + 0.5% Rock Phosphate (RP). T_4-MSWC +10% CPL+ 10% diluted-0% Spent Wash (SW), T_5-MSWC + 10% CPL + 0.5% MC + 0.5% RP + 10% SW

Similarly, T_5 (compost enriched with composted poultry litter, microbial inoculants, rock phosphate and spent wash) was having higher population of *Pseudomonas* (7.25×10^3 CFU g^{-1}), followed by T_3 (compost enriched with composted poultry litter, microbial inoculants and rock phosphate) with 5.75×10^3 CFU g^{-1} and 3.50×10^3 CFU g^{-1} in T_4 (compost enriched with composted poultry litter and spent wash). The Pseudomonas population increased due to the addition of spent wash to the compost material.

In the Phosphobacteria population, the treatment T_3 (compost enriched with composted poultry litter, microbial inoculants and rock phosphate) recorded maximum population with 3.75×10^2 CFU g^{-1} followed by T_5 (compost enriched with composted poultry litter, microbial inoculants and rock phosphate) with 3.50×10^2 CFU g^{-1}. In case of Phosphobacteria, the rock phosphate could also be the source to increase its population count along with spent wash.

Zayed and Motaal (2005) used together the *Aspergillus niger* and *Trichoderma viride* strains as a fungal activator in the presence or absence of Farmyard Manure (FM) for composting of bagasse enriched with rock phosphate. Quality of the composts produced was compared with that obtained from non-inoculated bagasse. An excellent decomposition in a relatively short time however was obtained with the use of *A. niger* and *T. viride* as inoculant agents with or without FM. The inoculation with *A. niger* + *T. virid e* with or without FM, also represented the most suitable conditions for phosphate solubilization. There were no phosphate-dissolving fungi present in any composted piles except those treated with *Aspergillus niger* and *Trichoderma viride*. The number of phosphate-dissolving bacteria increased only in the treatments that were treated with FM. The non-fertilized sandy soil and the non-inoculated bagasse compost did not provide broad bean plants with phosphorus while the composts produced by inoculation with *A. niger* + *T. viride* provided the plants with the highest amounts of phosphorus.

Azotobacter population was found to be 85% more in the compost material added with both the microbial consortia and spent wash when compared with the compost enriched only with microbial consortia. Similarly in the *Pseudomonas* population, T_5 treatment recorded 43% more population. There was about 23% increase in the population of Phosphobacteria in the T_5. This shows that the addition of spent wash has influenced the population of beneficial microorganisms since it contains high nutritive content and growth promoters. This is in line with Mattiazo and Ada Gloria (1985) who reported increase of soil microbial activity due to oxidation of organic matter in treated spent wash applied soil. Devarajan *et al*. (1993) studied the population dynamics of bacteria, fungi, actinomycetes, in field soil grown with turmeric, paddy, gingelly, cotton and groundnut and found that 50 and 40 times diluted spent wash irrigations enhanced or maintained the population dynamics of microorganisms in soil. Gopal *et al*. (2001) observed increased microbial population in spent wash applied soils.

Changes in the total nitrogen and total phosphorus content during the enrichment of compost: It was observed that the total nitrogen content greatly increased in the treatments where the microbial inoculants added to the compost. An increasing trend in the nitrogen content was observed till the enrichment process was over. The nitrogen content was maximum in the treatment T_5 (compost enriched with composted poultry litter, spent wash, microbial inoculants and rock phosphate) with 1.75% followed by T_3 (compost enriched with composted poultry litter, microbial inoculants and rock phosphate), which was on par with the recordings of the treatment T_4 (compost enriched with composted poultry litter and spent wash) (Table 3).

The addition of microbial inoculants increased the nitrogen content by about 36% when compared to compost material without enrichment. Similar results were obtained by Gaur and Singh (1982) that there was 27% increase in nitrogen content, when mechanized compost inoculated with *Azotobacter* and rock phosphate. It is also evident from the experiments of Kapoor *et al*. (1983) that *Azotobacter* inoculation helps in increasing the N content of compost.

During enrichment, the phosphorus content was increased conspicuously with addition of composted poultry litter, rock phosphate and microbial inoculants. The phosphorus content increased significantly in the treatment T_5 when compared with T_1 (compost alone) on

Table 3: Studies on changes in the total nitrogen and total phosphorus during the enrichment of municipal solid waste compost through organic sources and microbial inoculum

	Sampling period (days)					
	Total Nitrogen (%)			Total Phosphorus (%)		
Treatments	0	10	20	0	10	20
T_1	0.87	0.85	0.87	0.52	0.61	0.62
T_2	0.97	1.09	1.23	0.62	0.69	0.71
T_3	0.98	1.05	1.47	0.79	1.08	1.06
T_4	1.01	1.06	1.30	0.7	0.92	1.02
T_5	1.12	1.37	1.75	0.92	1.1	1.16
SEd	0.0443	0.0451	0.0572	0.010	0.018	0.025
CD (0.05)	0.0944	0.0962	0.1218	0.020	0.038	0.053

T_1-Municipal Solid Waste Compost (MSWC), T_2-MSWC + 10% Composted Poultry Litter (CPL), T_3-MSWC + 10% CPL + 0.5% Microbial Consortia (MC) + 0.5% Rock Phosphate (RP), T_4-MSWC,+10% CPL+ 10% diluted-10% Spent Wash (SW), T_5 – MSWC + 10% CPL + 0.5% MC + 0.5% RP + 10% SW

20th day, the enriched treatments have subsequent increase in total phosphorus. The phosphorus content was higher in the treatment T_5 (compost enriched with composted poultry litter, diluted spent wash, microbial inoculants and rock phosphate) with 1.16% followed by T_3 (compost enriched with poultry litter, microbial inoculants and rock phosphate) and T_4 (compost enriched with poultry litter and spent wash with values of 1.06 and 1.02%. This might be due to the phosphorus contribution by composted poultry litter, which is a rich source of phosphorus and application of rock phosphate and microbial inoculants. The results can be evident from Gaur and Singh (1993) who reported that the available P_2O_5 content of city compost was increased by 60-114% where rock phosphate was applied and inoculated with *Aspergillus awamorii.*

Phospho-composts were prepared with two indigenous phosphate rocks, namely Udaipur and Mussoorie, applied at three levels (0, 2 and 4 kg P 100 kg substrate) and three levels of pyrites (0, 1 and 2 kg S 100 kg substrate) using rice straw as substrate after 120 days of composting. Phosphate enrichment at the rate of 2% was more effective than 4% P enrichment. Pyrites addition was not effective in increasing the total P content but it increased organic P and N content. Addition of 1% pyrites was more effective than 2% (Sreenivas and Narayanasamy, 2003).

According to Ladan (2006) the inoculation of nitrogen-fixing bacteria *Azotobacter chrococcum* into compost prepared from the sugarcane bagasse increased contents of N and P. Enriching compost with rock phosphate and urea improved significantly the available P when inoculated with Enterobacter cloacea.

Changes in Indole Acetic Acid (IAA) and Gibbrellic acid (GA): The IAA content varied significantly among the treatments (Table 4). On 20th day, the highest IAA content was recorded in T_5 (compost enriched with composted poultry litter, microbial inoculants, rock phosphate and spent wash) with 1.72 $\mu g\ g^{-1}$, which was on par with T_4 (compost enriched with composted poultry litter and spent wash) and followed by T_3 (compost enriched with composted poultry litter, microbial inoculants, rock phosphate) with 1.26 $\mu g\ g^{-1}$. Similarly, the GA content also had an increasing trend with substrate addition and T_5 recorded highest GA content of 40.25 $\mu g\ g^{-1}$ followed by T_3 with 36.75 $\mu g\ g^{-1}$ (Table 4).

The IAA and GA content was more in the treatment applied with spent wash and microbial inoculum. The increase in the growth promoter content was contributed by addition of spent wash and microbial inoculum. The results are in confirmation with the findings of Sangeeta and Verma (2000) who have proved that *Azotobacter* could synthesize and excrete plant growth promoters like IAA. Spent wash added compost was found to contain significant amount of IAA and GA, when compared to control. Similar results were reported by Murugaragavan (2001) that spent wash, in addition to its use as a liquid fertilizer, was found to contain growth promoting substances like IAA (52-61 $\mu g\ g^{-1}$) and GA (4669- 4943 $\mu g\ g^{-1}$).

Table 4: Studies on Changes in the total IAA and total GA during the enrichment of municipal solid waste compost through organic sources and microbial inoculum

	Sampling period (days)			
	IAA ($\mu g\ g^{-1}$)		GA ($\mu g\ g^{-1}$)	
Treatments	0	20	0	20
T_1	0.15	0.21	12.50	13.75
T_2	0.29	0.34	15.25	20.50
T_3	0.53	1.26	23.25	36.75
T_4	0.84	1.51	17.50	31.50
T_5	0.94	1.72	24.75	40.25
SEd	0.043	0.043	1.393	1.099
CD (0.05)	0.091	0.091	2.907	2.343

T_1-Municipal Solid Waste Compost (MSWC) T_2-MSWC + 10% Composted Poultry Litter (CPL), T_3-MSWC + 10% CPL + 0.5% Microbial Consortia (MC) + 0.5% Rock Phosphate (RP), T_4-MSWC + 10% CPL + 10% diluted-10% Spent Wash (SW), T_5-MSWC + 10% CPL + 0.5% MC + 0.5% RP + 10% SW

CONCLUSION

It is known fact that enrichment is mandatory for compost prepared from municipal solid waste. Beneficial microorganisms, composted poultry litter, rock phosphate and diluted spent wash contributes maximum level of nutrients and growth promoters to the compost with small expenses. The added benefits in turn reflect on crop productivity.

REFERENCES

Adani, F., 1995. A new index of organic matter stability. J. Compost Sci. Util., 3: 25-37.

Borrow, A., V.E. Brain, P.J. Chester, H.G. Curtis, C. Hemming, E. Henenhan, G. Jeffereys, B. Lloyld, J.S. Nixon, G.L.F. Norris and N. Radley, 1955. Gibbrellic acid, a metabolic product of fungus *Gibberella fujikuroi*-Some observations on the production and isolation. J. Sci. Food. Agric., 6: 340-348.

Desai, J.D., 1997. Microbial Production of Surfactants and their Commercial potential. J. Microbi. Mol. Biol Rev., 61: 1-47.

Devarajan, L., G. Rajannan, G. Ramanathan and G. Oblisami, 1993. Sugarcane cultivation with distillery effluent. SISTA Sugar J., 20: 23-25.

Gaur, A.C. and G. Singh, 1982. Influences of *Azotobacter* and Rock Phosphate on Enriching Mechanized Compost. In: Recycling of crop, animal and industrial waste in agriculture. Tandon HLS (Ed.), pp: 12.

Gaur, A.C. and G. Singh, 1993. Role of IPNS in sustainable and environmentally sound agricultural development in India. PAO/RAPA Bulletin, 199313.

Gorden, S.A. and L.P. Paleg, 1957. Quantitative measurement of Indole Acetic Acid. Physiol. Plant., 10: 347-348.

Gopal, H., C. Kayalvizhi, M. Baskar, M.S. Dawood, S.C.M. Bose and K. Rajukkannu, 2001. Effect of distillery effluent on soil properties, microbial population dynamics, yield and quality of sugarcane. In: Proc. Nat. Sem. on use of poor quality water and sugar industrial effluents in agriculture. Feb 5 2001, ADAC and RI (TNAU) Thiruchirapalli, pp: 75.

Humphries, E.C., 1956. Mineral Components and Ash Analysis. Modern method of plant analysis. Springer Verlag, Berlin, 468-502.

Jackson, M.L., 1973. Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi, pp: 498.

Kapoor, K.K., K.S. Yadav, D.P. Singh, M.M. Mishra and P. Tauro, 1983. Enrichment of compost by *Azotobacter* and phosphate solubilising microorganisms. Agric. Wastes, 5: 125-133.

Ladan, R., 2006. Enriching Sugarcane Bagasse Compost by Sulfur, Nitrogen Fixing (*Azotobacter chroochoccum*) and Phosphate Solubilizing Bacteria (*Enterobacter cloacae*) Bagasse Decomposition and Produced Compost Enrichment. 18th World Congress of Soil Science July 9-15, 2006-Philadelphia, Pennsylvania, USA.

Manna, M.C., J.N. Hazra, N.B. Sinha and T.K. Ganguly, 1997. Enrichment of compost by bioinoculants and mineral amendments. J. Indian Soc. Soil Sci., 45: 831-833.

Mattiazo, M.E. and N. Ada Gloria, 1985. Effect of vinasses on soil activity. STAB (Portuguese), 4: 38-40.

Murugaragavan, R., 2001. Distillery spent wash on crop production in dryland soils. M.Sc. Thesis, Tamil Nadu Agric. Univ., Coimbatore.

Sangeeta, P. and O.P. Verma, 2000. Application of *Azotobacter* for improved compost quality. Indian J. Microbiol., 39: 249-251.

Sreenivas, C. and G. Narayanasamy, 2003. Preparation and characterization of phospho-composts: Effect of rock phosphate source, p enrichment and pyrites level. J. Indian Soc. Soil Sci., 51: 262-267.

Talashilkar, S.C., 1985. Effect of microbial culture (*Azotobacter chroococcum)* on humification and enrichment of mechanized compost. Indian J. Agric. Chem., 22: 193-195.

Waksman, S.A. and E.B. Fred, 1922. A tentative outline of the plate method for determining the number of microorganisms in soil. Soil Sci., 14: 27-28.

Zayed, G. and H.A. Motaal, 2005. Bio-production of compost with low pH and high soluble phosphorus from sugar cane bagasse enriched with rock phosphate. World J. Microbiol. Biotech., 21: 747-752.