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Nutrient Status of Compost and Vermicompost Produced by Different Organic Wastes

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Abstract: Epigeic earthworms play an important role in biodegradation and recycling of organic wastes so as to produce quality vermicompost with high nutrient status. The present work was undertaken to check the quality of compost (without worms) and vermicompost (with Perioynx excavatus) produced out of different organic wastes [Cattle manure (CM), Copper Pod Waste (CPW), Parthenium Waste (PW) and Lawn Grass Waste (LGW)]. The produced compost and vermicompost were analysed for different physico-chemical parameters such as pH, EC, % Organic Carbon (OC) and available macro nutrients (N, P, K) through standard prescribed methods. The % organic carbon (OC) was comparatively more (69- 76%) in compost as compared to vermicompost(42-70%) whereas other physico-chemical parameters such as pH, EC were more in vermicompost (7.39-7.98; 2.0X102- 3.5X102) as that of compost (7.10-7.65; 2.0X102- 3.4X102S/m), likewise other macro nutrients such as N,P,K were almost more in vermicomposts (395.75-435.90;16.0-19.20 & 317.61-370.51kg/hec) than that of composts (240.89-401.89;13.60-17.40 & 309.51-321.52kg/hec) of all organic wastes. Results of the present study revealed that the vermicompost produced from different organic wastes by the action of epigeic earthworm, Perionyx excavatus have all the essential physico-chemical parameters necessary for sustainable agriculture practices. Further, the quality of both compost and vermicompost primarily depends upon the nature of raw waste material used in the composting and vermicomposting process and the potentiality of the earthworm species used, role of saprophytic microorganisms in biodegradation and mineralization process and prevailing environmental conditions.

Keywords: Nutrient status, Compost, Vermicompost, Organic wastes and Epigeic earthworm- Perionyx excavatus

Introduction

Nowadays due to the rapid increase in the population, disposal and management of organic wastes has become a major problem in the society. Various types of environmental and disposal problems are due to the production of large quantities of different organic wastes all over the world. It requires sustainable approach in a cost effective manner (Edwards and Bater, 1992) and this has become a very important issue for maintaining a healthy environment (Senapati and Julka, 1993). It has long been known that earthworms play significant role in breakdown and recycling of organic matter and release of available plant nutrients (Darwin, 1881).The utility of epigeic earthworms in vermicomposting have been suggested by Fosgate and Babb (1972). Vermicomposting is a non-thermophilic biological oxidation process in which organic materials are converted into vermicompost (Mahalingam and Maruthmalai Rasi, 2014). Vermicompost produced after processing of organic wastes by the earthworms was proved as a suitable organic fertilizer as it contains more available plant nutrients due to rapid breakdown of complex organic molecules through biodegradation and mineralization process (Bano *et al.*, 1987).

The usage of several earthworm species from temperate and tropical regions in break- down of various organic wastes in vermicomposting process has been documented by various researchers (Tsukamato and Watanabe, 1977; Graff, 1981; Haimi and Hunta, 1986; Edwards, 1998). *Perionyx excavatus* is one of the oriental epigeic earthworm species used in vermiculture as it is a voracious feeder and breeder throughout the year.

Hence, the present study was undertaken to find out the quality of compost (without worm) and vermicompost (with *Perionyx excavatus*) produced out of different organic wastes through their physico-chemical parameters analysis such as pH, EC, %OC and other important macronutrients(N, P & K).

Materials and Methods

The abundantly available organic wastes such as Copper Pod Waste (CPW), Parthenium Waste (PW), Lawn Grass Waste (LGW) were collected in quantity enough and were chopped into small pieces and mixed with Cattle Manure in 10:1 proportion so as to maintain C:N ratio and Cattle Manure (CM) alone served as control. All experimental pots (both compost and vermicompost) were kept in uncontrolled laboratory conditions. The vermicompost pots were inoculated with 10 clitellate *P. excavatus* earthworms, whereas compost pots were maintained without worms, moisture content of about 70-80% was maintained by daily sprinkling of water. Both experiments were terminated after 60 days and the produced compost and vermicompost were collected separately. The individual compost and vermicompost samples were analysed for physico-chemical parameters to know the nutrient status.

The physico-chemical analysis of compost and vermicompost for different parameters such as pH (Hydrogen ion concentration), EC (Electric conductivity),

% OC (Organic carbon), N (Nitrogen), P (Phosphorus) and K (Potassium) were carried out through standard prescribed methods. pH was estimated by Sorensen (1909) and Electric Conductivity(S/m) was estimated by Trivedi and Goel (1986). The % Organic carbon (OC) was estimated by Walkey and Black (1934) method. Available Nitrogen (N) was determined by Subbiah and Asija (1956). Available Phosphorous and Potassium were determined by Bray and Krutz (1945) and Flame Photometer method respectively.

Statistical analysis: It was carried out by using ANOVA test of SPSS program to see the significant difference between and among compost and vermicompost produced out of different organic wastes.

Results and Discussion

Various physico-chemical parameters like pH, EC, Percent organic carbon and available macro-nutrients such as N, P and K of compost and vermicompost of different organic wastes were represented in Table-1 & 2 and Figs.-1 to 6. The statistical analysis of the data was represented in Table 3.1 and 3.2. Results revealed that the % OC was more (69% - 76%) in compost compared to vermicompost (42% - 70%) produced out of all different organic wastes. The less % OC in vermicompost was noticed may be because of utilization of organic carbon by the earthworm for building up of their body biomass during their growth and development along with decomposition of organic wastes in vermicomposting. Even percent OC was decreased with passage of time during composting and vermicomposting process as it lost in the form of CO_2 through microbial respiration and mineralization of organic matter. The decrease in percent OC in both experimental pots may also be attributed that microorganisms might use the carbon as a source of energy in decomposition of organic matter. The reduction of percent OC was much higher in vermicomposting compared to normal composting process was also noticed by many researchers (Cabrera *et al.,* 2005; Garg and Kaushik, 2005; Tognetti *et al.,* 2005)

Table - 1: Physico-chemical parameters of compost (without worms) produced out of different organic wastes and their 'F' and 'P' values

Sl. No.	Organic wastes	pH	EC (S/m)	% OC	N (Kg/hec)	P (Kg/hec)	K (Kg/hec)
1	Copper Pod Waste (CPW)	7.65±0.02	3.2±0.05	76.33±0.33	401.23±0.48	15.1±0.06	320.94±0.36
2	Parthenium Waste (PW)	7.24±0.02	2.6±0.15	67.00±1.00	372.34±0.36	17.5±0.20	319.18±0.11
3	Lawn Grass Waste (LGW)	7.39±0.00	2.33±0.17	73.66±0.66	395.77±0.24	16.36±0.18	317.52±0.34
4	Cattle Manure (CM)	7.10±0.00	3.56±0.08	68.66±0.33	240.57±0.44	13.5±0.20	309.36±0.07
5	F-Value	125.91	19.18	45.04	365.70	92.35	386.81
6	P- Value	0.00	0.00	0.00	0.00	0.00	0.00

Table - 2: Physico-chemical parameters of vermicompost (with *P. excavatus*) produced out of different organic wastes and their 'F' and 'P' values

Sl. No.	Organic wastes	pH	EC (S/m)	% OC	N (Kg/hec)	P (Kg/hec)	K (Kg/hec)
1	Copper Pod Waste (CPW)	7.58±0.00	3.1±0.05	69.66±0.33	435.45±0.23	19.1±0.05	360.53±0.23
2	Parthenium Waste (PW)	7.61±0.00	2.7±0.15	63.33±1.20	395.79±0.06	16.7±0.03	370.53±0.09
3	Lawn Grass Waste (LGW)	7.98±0.00	2.1±0.05	67.66±0.88	418.63±0.03	17.36±0.14	359.63±0.04
4	Cattle Manure (CM)	7.40±0.00	3.4±0.03	41.33±0.33	395.72±0.01	16.16±0.16	317.65±0.03
5	F-Value	1.91	42.28	278.60	247.90	121.07	333.1
6	P-Value	0.00	0.00	0.00	0.00	0.00	0.00

Table - 3.1: Analysis of variance between various physico-chemical parameters (pH, EC and OC) of compost (without worms) and vermicompost (*P. excavatus*) produced out of different organic wastes

Parameters			Vermicompost											
			pH				EC				OC			
			CPW	PW	LGW	CM	CPW	PW	LGW	CM	CPW	PW	LGW	CM
Compost	pH	CPW	**0.24**	-	-	-	-	-	-	-	-	-	-	-
		PW	-	0.00	-	-	-	-	-	-	-	-	-	-
		LGW	-	-	0.00	-	-	-	-	-	-	-	-	-
		CM	-	-	-	0.00	-	-	-	-	-	-	-	-
	EC	CPW	-	-	-	-	**0.52**	-	-	-	-	-	-	-
		PW	-	-	-	-	-	**0.52**	-	-	-	-	-	-
		LGW	-	-	-	-	-	-	**0.15**	-	-	-	-	-
		CM	-	-	-	-	-	-	-	**0.40**	-	-	-	-
	OC	CPW	-	-	-	-	-	-	-	-	0.00	-	-	-
		PW	-	-	-	-	-	-	-	-	-	0.00	-	-
		CPW	-	-	-	-	-	-	-	-	-	-	0.00	-
		PW	-	-	-	-	-	-	-	-	-	-	-	0.00

Table - 3.2: Analysis of variance between various physico-chemical parameters (N, P and K) of compost (without worms) and vermicompost (*P. excavatus*) produced out of different organic wastes

Parameters			Vermicompost											
			N				P				K			
			CPW	PW	LGW	CM	CPW	PW	LGW	CM	CPW	PW	LGW	CM
Compost	N	CPW	0.00	-	-	-	-	-	-	-	-	-	-	-
		PW	-	0.00	-	-	-	-	-	-	-	-	-	-
		LGW	-	-	0.00	-	-	-	-	-	-	-	-	-
		CM	-	-	-	0.00	-	-	-	-	-	-	-	-
	P	CPW	-	-	-	-	0.00	-	-	-	-	-	-	-
		PW	-	-	-	-	-	0.00	-	-	-	-	-	-
		LGW	-	-	-	-	-	-	0.00	-	-	-	-	-
		CM	-	-	-	-	-	-	-	0.00	-	-	-	-
	K	CPW	-	-	-	-	-	-	-	-	0.00	-	-	-
		PW	-	-	-	-	-	-	-	-	-	0.00	-	-
		CPW	-	-	-	-	-	-	-	-	-	-	0.00	-
		PW	-	-	-	-	-	-	-	-	-	-	-	0.00

The physical parameters pH and EC were more in vermicompost than that of compost and were ranged between 7.39 - 7.98; 7.10 - 7.65 and 2×10^2 - 3.5×10^2; 2×10^2 - 3.4×10^2 in vermicompost and compost respectively (Table-1&2). The higher pH and EC in vermicompost may be due to increase in soluble salts through biodegradation and mineralization process. Gunadi and Edwards (2003) have reported that pH shift after processing of cattle manure and other vegetable wastes in vermicomposting process. The increase in EC during vermicomposting process was probably due to degradation of OC and release of exchangeable minerals such as Ca, Mg, K and P in the available forms by the earthworms (Kaviraj and Sharma, 2003; Tognetti *et al.,* 2007; Jadia and Fulekar, 2008)

The macronutrients N, P, K were also recorded more in vermicompost of all organic wastes produced by *Perionyx excavatus* than that of normal compost produced by saprophytic microorganisms. (Table 1&2). The maximum and minimum NPK contents of composts were 401.49, 17.4 and 321.52 kg/hec in CPW, PW and CPW and minimum of 240.89, 13.6 and 309.51 kg/hec in CM alone respectively, where as in vermicompost, the maximum NPK were in CPW (435.90 kg/hec), CPW (19.2 kg/hec) and PW (370.51 kg/hec) and minimum in CM (395.75, 16.00 and 317.61 kg/hec) respectively was noticed. The increase in nitrogen content and other macronutrients were reported in vermicompost by Tripathi and Bhardwaj (2004) that may be due to accumulation of mucus, excretory substances and enzymes secreted by the earthworms. Higher contents of macro and micro nutrients during vermicomposting process than that of composting process were also reported by various researchers (Edwards and Lofty, 1972; Jambhekar, 1992; Delgado *et al.,* 1995)

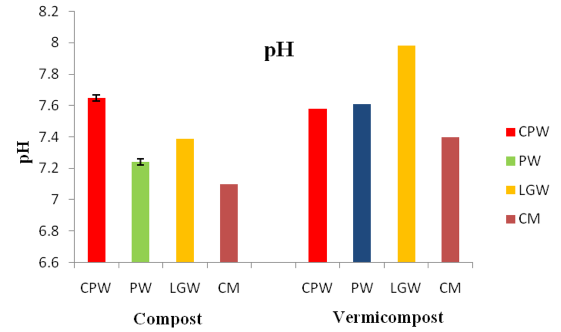

Fig -1: pH of compost and vermicompost produced out of different organic Wastes

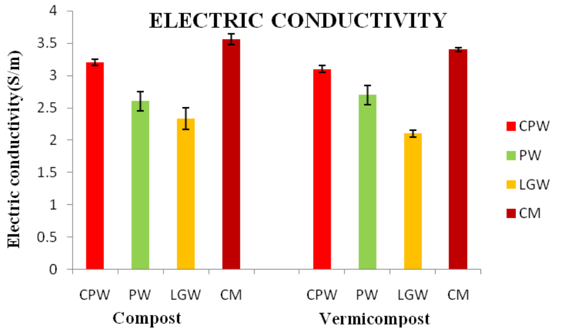

Fig.-2: Electric conductivity(S/m) of compost and vermicompost produced out of different organic wastes

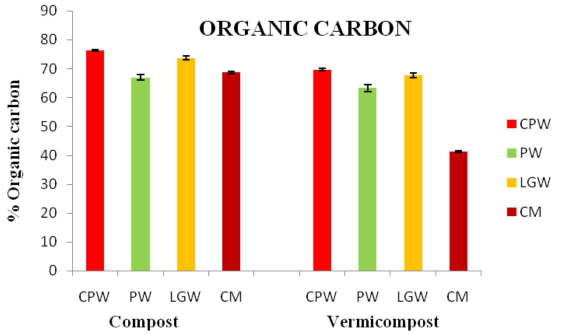

Fig.-3: Percent organic carbon of compost and vermicompost produced out of different organic wastes

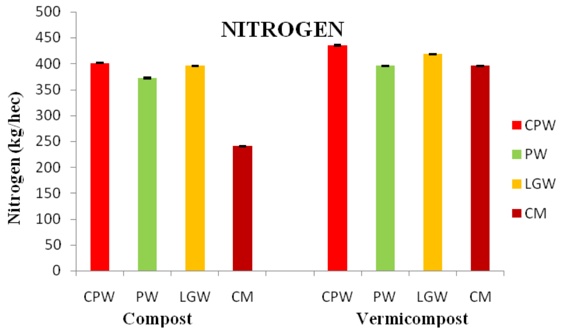

Fig.- 4: Nitrogen content of compost and vermicompost produced out of different organic wastes

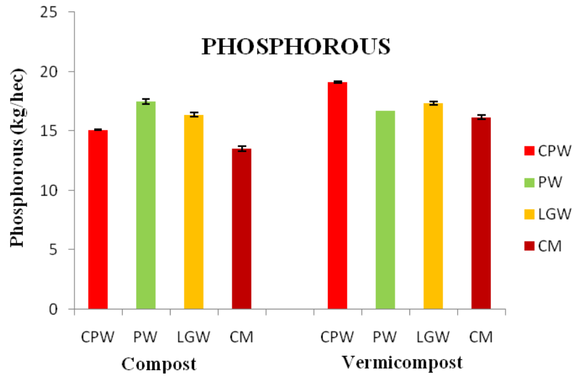

Fig.-5: Phosphorus content of compost and vermicompost produced out of different organic wastes

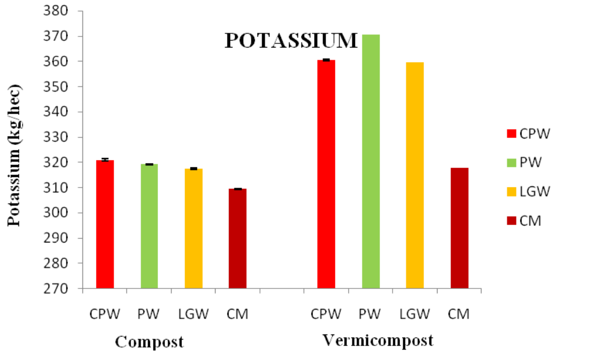

Fig.- 6: Potassium content of compost and vermicompost produced out of different organic wastes

There is a slight variation in all the physico-chemical parameters of both compost and vermicompost of individual organic wastes may be due to different chemical composition of respective parent materials. The variations among vermicomposts of different organic wastes may also be attributed to the worm's preferencial feeding habit towards particular organic wastes in biodegradation process. Crawford (1983); Gaur and Singh (1995) have also reported that Nitrogen content in compost and vermicompost is dependent on the raw materials and the extent of biodegradation and mineralization process by earthworms and saprophytic microorganisms respectively. Kale and Krishnamoorthy (1981a & 1981b) have also reported that the nature of food also influences worm activity and variation in the acceptability of wastes by the earthworms depending on the texture as well as chemical nature of particular organic wastes.

In the present study, it is revealed that comparatively more amount of pH, EC, N, P, K were recorded in vermicompost than that of compost in all organic wastes may be due to increased feeding and biodegradation activities of the earthworm, *Perionyx excavatus* that might enhanced the microbial population and their activity, in turn increased mineralization process that might ultimately enhanced the available plant nutrients.

Conclusion

The physico-chemical parameters such as pH, EC, N, P and K were more in vermicompost compared to normal compost whereas percent OC was less in vermicompost as that of compost in all organic wastes. Based on the results of physico-chemical parameters of both compost and vermicompost, it can be concluded that the vermicompost produced by the earthworm, *Perionyx excavatus* have all the potential nutrients essential for sustainable agricultural practice and can be used as valuable biofertilizer.

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