Nutrient Composition of Vermicompost and Vermiwash as Influenced by Different Substrates

ABSTRACT

Nutrient enrichment in vermicompost and vermiwash by using raintree litter waste andmushroomspentcompostwasstudiedatVermicompostYardofDivisionofSoilScience,CollegeofAgriculture,Puneduring2022-23.HDPEvermibedsofsize12X4X2feetwereusedforproductionof vermicompost and 200 litre capacity plastic drums were used for vermiwash preparation. Therewerefivesubstratecombinations *viz.*25%raintreelitter(RTL) +75%paddystrawspentmushroomcompost (PSSMC),50%tree litter+50% paddy straw spent mushroom compost (PSSMC), 75% treelitter+25%paddystrawspentmushroomcompost(PSSMC),100%raintreelitter,100%paddystrawspent mushroom compost (PSSMC) made for the preparation of vermicompost with earthwormspecies *Eisenia fetida*and replicated four times in completely randomized block design. There wereten plastic drums of 200 litre capacity were used for vermiwash preparation by using vermicompostprepared by different treatments. The drums were kept for conduct of experiment and sampling induplicate for first and second harvest of vermiwash from each drum for assessing characterizationand nutrient composition. It can be revealed from the data that pH, EC, organic matter, C: N ratio,totalnitrogen,phosphorus,potassium,iron,zinc,manganese,copperinvermicompostweresignificantly influenced by different proportions of rain tree litter and paddy straw spent mushroomcompost. The C: N ratio of these vermicompost prepared by using rain tree litter and paddy straw spentmushroomcompostwasrangedbetween9.02and14.26.Significantlyhighertotalnitrogen(2.23%),phosphorus (1.13%), potassium (0.823%), iron (1150ppm), manganese (276.5ppm), zinc (276ppm)and copper (73.25ppm) were found significantly higher in vermicompost prepared from 100% raintreelitter.SignificantlyhigherEC(totalsolublesalts)ofvermiwashwasobservedatfirst(7.20dSm^{-1})andsecond(5.58dSm^{-1})harvestwhenitwaspreparedbyusing100%raintreelittervermicompostthanrestofthetreatments.Vermiwashpreparedbyusing100%raintreelittervermicompostreportedsignificantly higher nitrogen (0.65 and 0.51%), phosphorus (0.33 and 0.27%) and potassium (0.27and 0.23%) content at both harvest respectively but higher content was in first harvest. Vermiwashprepared from 100% raintree litter vermicompost reported significantly higher Fe, Mn, Zn and Cucontentat both harvestingstage.

Keywords: Raintreelitterwaste,spentmushroomcompost,vermicompostandvermiwash

Introduction :

Soil fertility decline over the globe is one of the major cause for decreasing nutrient use efficiencyand crop productivity. Health and quality of soil deteriorating consistently due to soil erosion, lessuse of organic manures, injudicious use of irrigation water and fertilizers, mono-cropping, no soiltesting, poor crop management, reluctant for green manuring crops etc. are the major causes fordeclining soil fertility resulted in less nutrient use efficiency. In order to improve health and qualityof soil, it is necessary to adopt integrated nutrient management system. Green manuring, compost,vermicompost, vermiwash etc. are important components of INM. Uses of FYM and compost havehigh bulkiness per unit nutrient content which seems to be a constraint for transport and application.Compost enrichment and vermicomposting is an efficient way of recycling various bio-wastes intocompostor vermicompostbyusingmicrobesandearthworms.Earthwormsare voraciousfeeders on organic waste and while utilizing it only a small portion for their body synthesis they excrete a largepart of these consumed waste material in a half digested form. Since the intestine of earthwormsharbor wide ranges of microorganisms, enzymes, hormones, etc., these half-digested substratesdecompose rapidly and are transformed into a form of vermicompost within a short time (Edwardsand Lofty 1972). The final product is a stabilized, well humidified, organic manure, with adhesiveeffects for the soil and stimulator for plant growth and most suitable for agricultural application andfavourable environmentally. Biochemical changes in the degradation of organic matter are carriedout through enzymatic digestion, enrichment by nutrient excrement, and transport of organic andinorganicmaterials.About5-10%ofingestedmaterialisabsorbedintothetissuefortheirgrowthandmetabolic activity and rest is excreted as vermicast. The vermicast is mixed with mucus secretion ofthegutwall,andofthemicrobesandtransformedintovermicompost(EdwardsandLofty1972).Thedecompositionprocesscontinuesevenafterthereleaseofthecastbytheestablishmentofmicroorganisms.Thestudiesontheeffectofvermicompostingonsomecomponentsoforganicwasteshowed that vermicompost enhances degree of polymerization of humic substances along with adecrease of ammonium N and an increase of nitric N (Cegarra et al. 1992). The plant growthregulatorsandotherplantgrowthinfluencingmaterials,thatis,auxins,cytokinins,humicsubstances,etc.,producedbymicroorganismshavebeenreported fromvermicompost(Atiyehetal. 2002).

Vermiwash is a natural liquid product formed by vermicomposting of organic matter from richpopulationofearthwormsandvermicompost.Thecompositionofvermiwashanditsqualitydependson the type of raw organic matter used during vermicomposting. Vermiwash contains hormone,mucous,enzyme,vitamins,proteins,differentmacroand micronutrients,andalargenumberofmicrobes.Ascomparedtoapplicationofsolidvermicompost,itsliquid form(vermiwash)ismoresuitable due to its bioavailability to reach quickly to targeted area around the roots of plants (Gudetaet al (2020). Further, vermiwash is a coelomic fluid of earthworms which contains several enzymes,plant growth hormones, vitamins along with micro and macronutrients. Vermiwash is a liquid bio-fertilizer can be collected through the column of activated earthworm. It contains excretory productsof earthworm secretions, the worm coelomic fluid oozing through dorsal pores, mucus, enzymessecretedbyworm&microorganisms,plantnutrients,vitamins&plantgrowthpromotingsubstances.Italsocontainsplantgrowthhormones(auxin&cytokinin)andnitratefixingbacteriaandphosphorussolubilizingbacteria.

Enrichment of compost or vermicompost by using locally available nutrient rich organic matter likeraintreelitteravailableabundantlycanbeusedefficientlyfornutrientenrichment.Itsleavesandtwigscontain substantial amounts of N, P, K, S andother micronutrients.In the urbanareas manygovernmentandprivateorganizationshavevarioustreesparticularlyraintreesintheircampuses.Thelitter falls every year in these campuses is not used for composting due to the constraints in thecollection and transport. At present this litter is collected or burned on site which increases CO_2 intheair causingairpollution.Raintreeleaves canbeusedinsoilas greenorbrownmanuretoincreasesoil and crop productivity (Haque *et.al.*, 1999). Higher nitrogen content in the rain tree litter rangesfrom1.88to2.25whilephosphoruswas0.8to1.1%andpotassiumtothetuneof1%canbesuitabilityusedfornutrient enrichment(Unchalika*et al.*,2021)and (Ritu Nagar*et al.*,2017).

The rain trees in College of Agriculture, Pune campus, which are over 25-30 meters high and 125 - 150 years old, produces large quantities of tree leaf litter in every winter. Mushroom spent compostis also generated in the campus after the harvest of oyster mushrooms. Hence, the attempt was madeto study the enrichment of vermicompost and vermiwash by using raintree litter waste and spentmushroom compost. The use of raintree leaves and their proper management not only reduces theneed for chemical fertilizers but also decreases CO2 release in air.However, in view of this, nutrientenrichment in the vermicompost and vermiwash through mineral rich leaves and litter of rain treewas assessed. Therefore an experiment was conducted to develop and optimize the method for thepreparationanddevelopmenttechniquesforenrichingthenutrientstatusinvermicompostandvermiwas h.

MATERIALANDMETHODS

An experiment was conducted to assess the nutrient enrichment in vermicompost and vermiwash byusingraintree(*Samaneasaman*)litterwasteandmushroomspentcompostatVermicompostYardofDivision of Soil Science, College of Agriculture, Pune during 2021-22. Different proportion of raintree litter and paddy straw spent mushroom compost were used for the production of vermicompost.HDPE vermibed of size 12 X 4 X 2 feet(Figure 2) were used for this study. The five substratecombinations*viz.*25%raintreelitter(RTL)+75%paddystrawspentmushroomcompost(PSSMC),50%treelitter +50%paddystrawspent mushroomcompost(PSSMC), 75%treelitter +25%paddystraw spent mushroom compost (PSSMC), 100% rain tree litter, 100% paddy straw spent mushroomcompost(PSSMC) werestudied incompletelyrandomizedblock designreplicated fourtimes.

Methodforpreparationofvermicompost:

Therewеretotal20HDPEvermibedswereinstalledbyusingsixteenbamboosticksof2.5feetheight.(Figure 1). The required quantity of rain tree litter was collected from the campus of College ofAgriculture,Pune.Paddyspentmushroomcompost(PSSMC)wasprocuredfromAICRPonMushroom Project, College of Agriculture, Pune. Rain tree litter and paddy straw spent mushroomcompost was mixed thoroughly on dry weight basis as per the treatment. Total quantity of organicmatter either from rain tree litter or paddy straw spent mushroom compost was kept 4000 kg in eachbed **(Table1)**. The treatment wise rain tree litter and paddy straw spent mushroom compost wereallowedtopartiallydegradefor45daysbyadoptingpitmethodandthereafterusedforvermicomposting.Thevermibedswerefilledlayerwisefirstlayerof10-15cmthickundecomposedfresh rain tree litter and paddy straw spent mushroom waste was given as per the treatment. Secondlayerofsimilarthicknesswasgivenwithpartiallydecomposedorganicwasteofrespectivetreatment.Third layer was given uniformly over second layer with cow dung slurry (40 lit. cow dung + 100 lit.water + 1 kg decomposing culture). Similar type of alternate layering was completed up to a heightof 70 to 80 cm of the HDPE vermibeds. Then watering was started and whole material was allowedto soak water. After 15-20 days, 3 kg earthworms of species *Eisenia fetida* **(Figure 1)** were releasedineachvermibed.Moisturecontent50-55%wasmaintainedtillharvestingofvermicompost.Thewetgunny bags were used for cooling purpose over the surface. The composition of rain tree litter andpaddystrawspentmushroomcompostwerecarriedoutaccordingtothestandardmethodsgivenby A.O.A.C(2012)and presentedin Table2.

Methodfor preparationof vermiwash:

Plasticdrumsof200litrecapacityalongwithopen/close(on/off)tapfittedat4inchfrombottom(forharvesting of vermiwash) were used for vermiwash preparation **(Figure 3)**. The ten plastic drumswere filled with the layering adopted as stated in table 3. Two vermiwash drums were kept for onetreatment and quadruplicate sampling of vermiwash from each drum was carried out for assessingcharacterization and nutrient composition. The treatment wise rain tree litter and paddy straw spentmushroomcompostwereallowedtopartiallydegradefor45daysandthereafterusedforvermicomposting.Vermicompostpreparedfromvariousproportionsofraintreelitterandpaddystrawspent mushroom compost was used for extracting vermiwash. Bricks pieces, gravel, coarse and finesand,plasticnet,cowdung,partiallydecomposedcompostandvermicompostofrespectivetreatment,earthwormsandgunnybagswereusedfor fillingthe vermiwash drum.

The vermiwash drums were filled layer wise **(Table 3)**. After filling vermiwash drums, they wereallowedforincubationupto15days**(Figure2)**.Themoisturecontentwasmaintained50-55percentin the vermiwash drums. After 15 days of incubation, 10 litres of water added in each drum andallowed to saturate for 48 to 50 hours for incubation and then treatment wise vermiwash harvested.Harvested vermiwash was analysed for characterization and nutrient composition by followingstandardmethods. (A.O.A.C 2012)

Table1Treatmentwisequantityoforganicmatterusedineachbed

Treatment no.	Proportion oforganicmatter	Quantityof organic matter on dryweightbasis(kg)	
		Raintree litter	Paddystraw spent mushroomcompost
T_1	25%RTL+75%PSSMC	1000	3000
T_2	50%RTL+50%PSSMC	2000	2000
T_3	75%RTL+25%PSSMC	3000	1000
T_4	100%RTL	4000	-
T_5	100%PSSMC	-	4000

Table2Characterizationofraintreelitterandpaddystrawspentmushroomcompost

Sr.no.	Parameter	Raintreelitter	Paddystraw spent mushroomcompost
1	pH(1:10)	7.6	7.3
2	ECdSm^{-1}(1:10)	1.22	0.44
3	Organiccarbon(%)	118	41
4	N(%)	2.08	0.66
5	P(%)	0.98	0.45
6	K(%)	0.79	0.38
7	Fe(mgkg^{-1})	186	54
8	Mn (mgkg^{-1})	78	27
9	Zn(mgkg^{-1})	69	22
10	Cu (mgkg^{-1})	29	21
11	C:Nratio	56.73	62.21
12	C:P ratio	120.40	91.11

Table3Layering in thevermiwashdrum

First Layer(frombottom) (15-20cmThick)	Brickspieces 75-100nos.
SecondLayer (10-15cmThick)	Coarsesand 25kg
ThirdLayer(5-10cm)	FineSand(size2-3cm)25kg
Fourth Layer(15-25cm)	Partiallydecomposedcompost(100to150kg)mixed withcowdung (15-20daysold)50to 60 kg
Fifth Layer(5To10cm)	Vermicompostapproximately40 to80 kg
SixthLayer	Earthwormsofspecies(*Eiseniafetida*)4-5kgor 1000to 1500numbers.
SeventhLayer	Vermicompost+cowdung(15-20daysold)in50:50 proportion50 kg
EighthLayer	Partiallydecomposedcompost(100to150kg)mixed withcowdung (15-20daysold)50to 60 kg
NinthLayer	Vermicompost(40to80kg)
TenthLayer	Wetgunnybags

Figure1 Earthwormsofspecies*Eisenia fetida*

Figure2HDPE vemibeds(12X4X2)

Figure3Vermiwashunitwith200litreplasticdrumsRES

ULTAND DISCUSSION

Nutrientenrichmentinvermicompostasinfluencedbyraintreelitterwaste

The nutrient enrichment and characterization of vermicompost as influenced by using raintree litter and paddy straw spent mushroom compost in different proportions was presented. **(Table4 and 5 and Figure 4 and 5)**. The chemical properties like EC, organic matter and C: N ratio ofvermicompost was found significantly influenced by the rain tree litter and paddy straw spentmushroom compost. Non- significant results were reported for 'days required for vermicompost' byusing different combinations of rain tree litter and paddy straw spent mushroom compost. Almostsimilar period were required for the production of vermicompost by using 100% rain tree litter (55days) and 100% paddy straw spent mushroom compost (54 days). Use of rain tree litter and paddystrawspentmushroomcompostindifferentproportionreportednon-significantresultsforthepHforvermicompost. Numerically lowest pH (6.65) was reported in the vermicompost prepared by using100%paddystrawspentmushroomcompostwhilehigherpH(7.17)wasrecordedwith50%raintreelitter(RTL)and50%paddystrawspentmushroomcompost(PSSMC).TheECofvermicompostwasranged between 1.47 to 2.81 dSm^{-1}. Vermicompost prepared from 100% rain tree litter reportedsignificantly higher EC (2.81 dSm^{-1}) which was closely followed by 50% rain tree litter and 50%paddystrawspentmushroomcompost.LowerEC(1.47dSm^{-1})wasreportedwith100%paddystrawspent mushroom compost. Organic matter content in vermicompost prepared by using raintree litterandPSSMC was rangedfrom 17.77 to 18.98%.

Significantly lower organic matter (17.77%) in vermicompost was reported by using 100% paddystrawspentmushroomcompostwhichwasfoundtobeatparwith50%raintreelitterand50%paddystraw spent mushroom compost (18.98%). Lower organic matter in paddy straw spent mushroomcompostmightbeduetoalready thestrawwasdecomposedby oystermushroom(*Pleurotussajarcaju*). The C: N ratio of these vermicompost prepared by using rain tree litter and paddy strawspent mushroom compost was ranged between 9.02 and 14.26. The 50% rain tree litter and 50%paddystrawspentmushroomcompostcombinationwasreportedsignificantlylowerC:Nratio8.83%whichwascloselyandstatisticallyatparwith100%raintreelitter(9.02)and75%raintreelitterand25%paddystraw spent mushroom compost (11.72).

Rate of decomposition of any organic matter depends upon total carbon and total nitrogen ratio. Thecarbon to nitrogen ratio is an important parameter, which will relate the composting reactions to therelative concentrations of essential chemical constituents required for the growth and metabolicreactions of the microbial populations. As organic matter with lower C:N ratio at early stage ofdecompositionshowsmoremicrobialactivityandmoreCO_2evolutiontherebyrateofdecompositionbecomesfaster.HoweverhigherC:NratioorganicmatteratlaterstagereleaseshigherCO_2andCH_3causesslowerrateofdecomposition.Compoundssuchascarbohydrates,inadditiontobeingsourcesof carbon for the microbial biomass, will generate energy required for the microbial metabolicactivity.Nitrogenisanessentialcomponentofproteinsandaminoacidsrequiredforthegrowthof themicrobialbiomass.Generally,itisrecommendedthat,tomaintainandactivemicrobialpopulationduring composting,theavailablecarbontonitrogenratioshouldbekeptatappropriatelevels.Lowerratios will result in losses of nitrogenous compound, while higher ratios will reduce the rate ofcomposting process. So in case of rain tree litter, the nitrogen content was higher than that of paddystrawspentmushroomcompostthathasresultedinlowerdaysrequiredforraintreelittervermicompos tthanrestofthetreatment.FurthertheC:Nratiocanberegulatedbyselectingthemostsuitable combination of organic matter by using rain tree litter and paddy straw pent mushroomcompost. In these experiment vermicomposts prepared by using various combination of organicmatter were reported to have less than 30 C: N ratio which indicates good quality of compost andafter application in soil rate of mineralization will be high. However lower the C: N ratio, the morerapidlynitrogen will bereleased into the soil forcrop use(Martin., 2007).

Nitrogen,phosphorusandpotassiumcontentinvermicompostpreparedfromvariouscombination ofrain tree litter and paddy straw spent mushroom compost were ranged from 1 to 2.23%, 0.383 to1.135% and 0.303 to 0.832% respectively (Table 5). Vermicompost prepared from 100% rain treelitterwasreportedsignificantlyhighernitrogen(2.23%),phosphorus(1.135%)andpotassium(0.823%)content.However,lowernutrientcontentwasreportedinvermicompostpreparedfrom25%rain tree litter + 75% paddy straw spent mushroom compost (N:1%, P:0.383% and K:0.303%). Itcould be observed from the data that as the proportion of rain tree litter increase with paddy strawspentmushroomcompost,thenutrientcompositioninvermicompostalsoincreases.Furthermagnitu de of increase in the enrichment of nutrient was also higher with rain tree litter than that ofpaddystraw spent mushroom compost.

Metallicmicronutrients(*viz.*,Fe,Mn,ZnandCu)contentinvermicompostalsoaffectedsignificantlywithdif ferentsubstratesandtheirproportions.TheFe,Mn,ZnandCuconcentrationinvermicompostwasrangedbet ween472to1105mgkg^{-1},150.25to276mgkg^{-1},79to276mgkg^{-1}and33.5to77.25mg kg^{-1}, respectively. It could be noticed from the data that significantly higher Fe (1105 mg kg^{-1}),Mn (276 mg kg^{-1}), Zn (276 mg kg^{-1}) and Cu (77.25 mg kg^{-1}) concentration was reported in thevermicompostpreparedbyusing100%raintreelitter.HoweverlowerFe(472mgkg^{-1}),Mn(150.25mg kg^{-1}), Zn (79 mg kg^{-1}), and Cu (33.50 mg kg^{-1}) content was observed in vermicompost preparedby using paddy straw spent mushroom compost. Higher concentration of nitrogen, phosphorus,potassium, iron, manganese, zinc and copper was reported in the vermicompost prepared by using100% rain tree litter which might be due to higher content of these nutrients in the rain tree litter(Tableno.5).Howeverlowernutrientconcentrationinthevermicompostpreparedfrompaddystrawsp ent mushroom compost might be due to the absorption /extraction of nutrients by mushroom.Similar results were also reported by Chaudhuri *et al.*, (2016), Ritu Nagar *et al.*, (2017),Klomklang*et al.*, (2021). Gaur and Singh (1993) reported that enrichment of final compost with phosphatesolubilizers,nitrogenfixersand microbescapable ofcellulose degradationispromisingmethod.

The reduction of carbon in vermicomposting resulted from respiration and mineralization of organicmatterproducedbymicroorganismsandearthworms.Earthwormsthroughtheirfragmentationacti onmodify the substrate conditions which increases the surface area for microbial action (Ansari andSukhraj,2010).Furthernutrientenrichmentwasfoundhigherinvermicompostpreparedfrom100%rai n tree litter which might be due to higher nutrient concentration in litter or leaves of rain tree.Further, increment of nitrogen in vermicompost might be resulted due to the addition of mucus,nitrogenase casts which facilitates microbial mediated mineralization through decomposition ofearthwormtissues. Similar results werealsoreported byJaikishun*et al*2014.

Table4.Characteristicsofvermicompost

Treatment	Daysrequiredfor vermicompost	pH	EC (dSm^{-1})	Organic matter(%)	C:N ratio
25%RTL+75%PSSMC	64	6.77	1.56	24.31	14.26
50%RTL+50%PSSMC	58	7.17	2.10	18.98	8.83
75%RTL+25%PSSMC	60	7.10	1.97	30.86	9.68
100%RTL	55	7.02	2.81	28.90	11.72
100%PSSMC	54	6.65	1.47	17.77	9.02
S.E.+(m)	3.77	0.190	0.174	2.471	1.010
C.D.at5%	N.S.	N.S.	0.542	7.697	3.140

Table5.Nutrientcontentinvermicompostasinfluencedbyraintreelitterwasteandpaddystraws pent mushroomcompost

Treatment	Macronutrients(%)			Micronutrients ($mgkg^{-1}$)			
	N	P	K	Fe	Mn	Zn	Cu
25%RTL+75%PSSMC	1.00	0.383	0.303	472	150.25	79	33.50
50%RTL+50%PSSMC	1.28	0.415	0.410	592	175.25	135	35.75
75%RTL+25%PSSMC	1.90	0.725	0.565	654	204.18	201	44.25
100%RTL	2.23	1.135	0.823	1105	276.50	276	73.25
100%PSSMC	1.17	0.505	0.310	673	197.00	163	53.50
S.E.+(m)	0.104	0.086	0.082	75.230	18.824	12.314	5.436
C.D.at5%	0.323	0.269	0.256	234.37	58.645	38.362	16.936

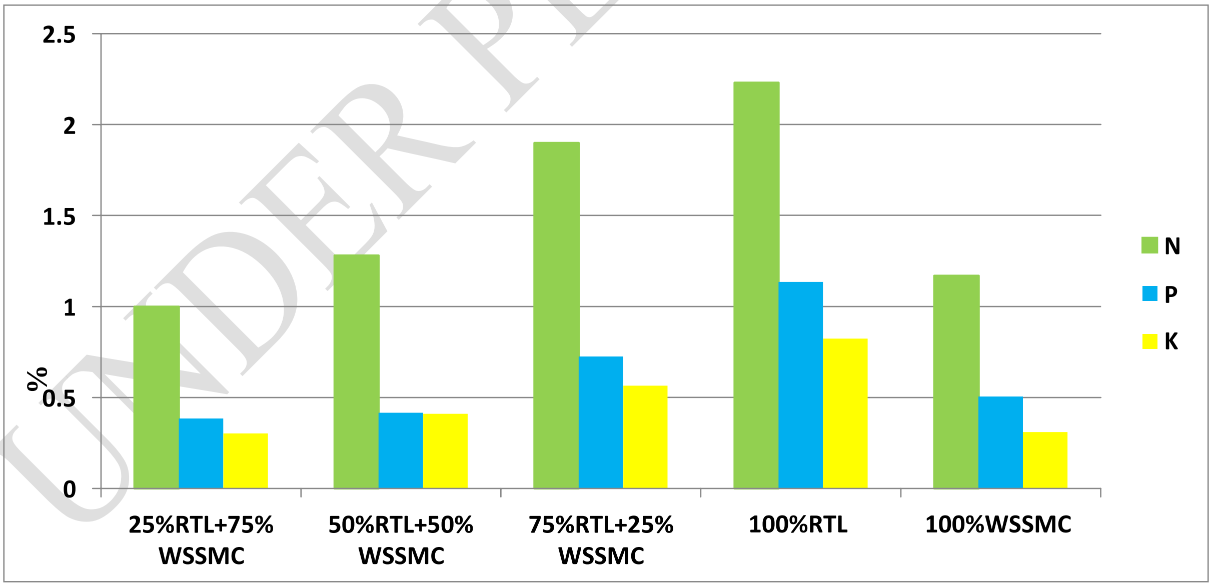

Figure4Totalnitrogen,phosphorusand potassiumcontentinvermicompost

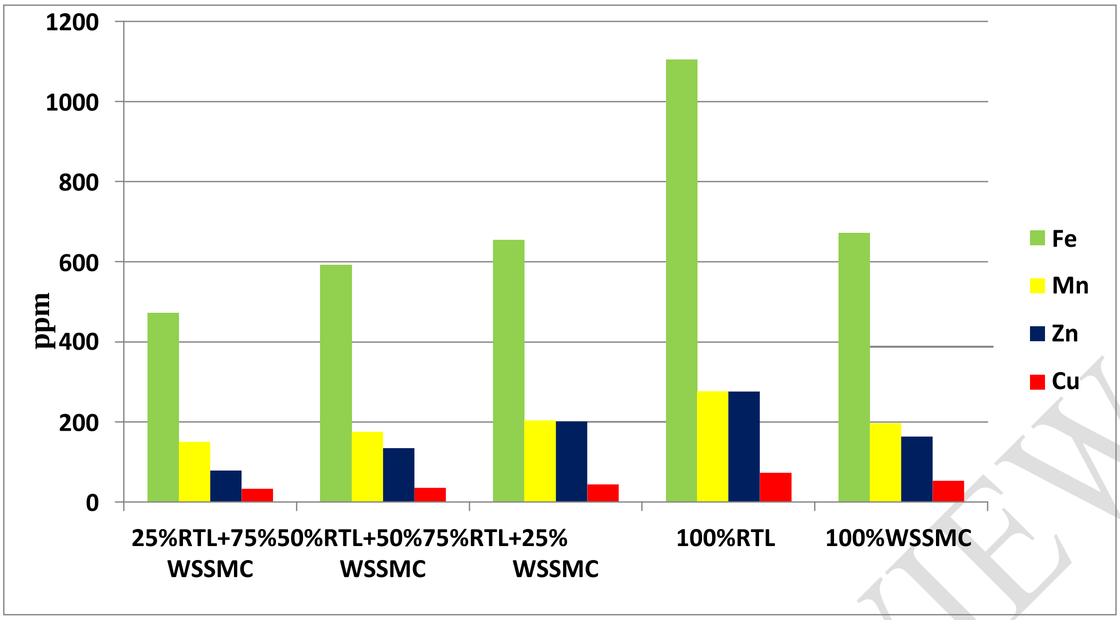

Figure5Totaliron, manganese,zincandcoppercontentininvermicompost

Nutrientenrichmentinvermiwashasinfluencedbyraintreelitterwaste

Thecolourofvermiwashinfluenceddrasticallybyusingdifferenttypesofvermicompostusedfor the preparation of vermiwash. Vermiwash prepared for 100% rain tree litter vermicompost75%RTL+25%spentmushroomwasobserveddarkincolourthanrestoftreatments**(Figure 6)**.ThepHandelectricalconductivity,nitrogen,phosphorus,potassium,iron,manganeseandzinccontentin vermiwash influenced significantly by different proportions of rain tree litter and paddy straw spentmushroom compost **(Table 6, 7 and 8)**. However, pH of vermiwash at both harvesting was foundnon-significant.NumericallyvermiwashpHwasrangedbetween6.73to7.50and6.40to7.75atfirstandsecondharvesting.Electrical conductivityof vermiwashwasrangedfrom3.43to7.20dSm^{-1}forfirstharvestingand2.43to5.58dSm^{-1}forsecondharvesting.Electricalconductivityoffirstharvestedvermiwash was found higher in all the treatments than second harvest.Significantly higher EC ofvermiwash was observed at first (7.20 dSm^{-1}) and second (5.58 dSm^{-1}) harvest when it was preparedbyusing100%raintreelittervermicompostthanrestofthetreatments.Itcouldbeobservedfromthe data that as the proportion of rain tree litter for the preparation of vermicompost increases, the ECalsoincreases.Thecontentofnitrogen,phosphorusandpotassiuminvermiwashatboththeharvesting stage was also significantly affected by the different combinations of raintree litter andpaddy straw spent mushroom compost used for vermicompost. Nitrogen, phosphorus and potassiumcontent in vermiwash were ranged from 0.21 to 0.65 and 0.20 to 0.33 %, 0.14 to 0.33 and 0.10 to0.27% and 0.06 to 0.27 and 0.05 to 0.23% at first and second harvest respectively. Vermiwash byusing100%raintreelitterreportedsignificantlyhighernitrogen(0.65and0.51%),phosphorus(0.33and 0.27%) and potassium (0.27 and 0.23%) content at both harvest but higher content was in firstharvest. While lower content of nitrogen (0.21 and 0.20%), phosphorus (0.14 and 0.10%) andpotassium (0.06 and 0.05%) was observed when 25% RTL +75% PSSMC was used for vermiwashpreparation.

Decompositionrateofraintreelitterandpaddystrawspentmushroomcompostbymicrobialactivityresulting in the production of $CO_2$and organic acids which reflected in the reduction of pH. ThereductioninpHofvermiwashandvermicompostmightberesultedinthehigherrateofnitrogenandphosphorusintonitrite/nitrateandphosphorusmineralization.Nutrientenrichmentinvermiwashwashigherwhenitwaspreparedfrom100%raintreelitter/leaveswhichmightbeduetothehighernutrientcontent in rain tree leaves and litter. Further feeding of *Eisenia fetida*on partially decomposedcompostandvermicompostpreparedfromraintreelittermighthavereleasedmoremucus nitrogenous excretory substances, growth hormones and enzymes from the gut of earthworms mighthave contributed for nitrogen, phosphorus and potassium enrichment in vermiwash. Similar resultswas also reported by Hand *et al* (2008) and Durga and Ramasubramanian (2015). Higher nutrientcontent in rain tree litter or leaves might have released nutrients elements in vermiwash as well asvermicompost duringdecomposition.

It could be evident from the data presented in table 8 that, iron, manganese, zinc and copperconcentrationinvermiwashwasnoticedmoreinfirstharvestthansecond.Amongthemicronutrients ,theconcentrationofironinvermiwashatbothharvestwasfoundhigherfollowedbymanganese,zincand copper. Vermiwash prepared by using 100% rain tree litter reported significantly higher iron(16.73 and 12.66 mg kg^{-1}), manganese (3.18 and 1.76 mg kg^{-1}) and zinc (3.06 and 2.08 mg kg^{-1})content than rest of the treatments. Vermiwash prepared from the vermicompost of 100% raintreelitter/leaves reported significantly higher iron content (16.73 and 12.34 mg kg^{-1}) at first and secondharvestbutvermiwashpreparedfrom75%RTL+25%PSSMC(12.66mgkg^{-1})wasfoundstatisticallyatparonlyatfirstharvest.Lowerconcentrationofiron,manganese,andzincwasreportedinvermiwash preparedfrom using25%RTL+75%PSSMC and 100%PSSMC.

Conclusions

Data revealed that raintree litter waste/leaves was found suitable organic matter for nutrientenrichmentinvermicompostbyusingearthwormspecies*Eiseniafetida*thanthatofpaddystrawspentmushroomcompost.Furtherthevermicompostpreparedbyusingraintreelitterwastewasalsofoundsuperiorforgettingnutrientrichvermiwash. Itcouldbeconcludedfromthisexperimentthatraintreelitter/leaves could be a good nutrient source enriching vermicompost and vermiwash rather thanburning in open air.This study can be converted into a start-up with HDPE vermibeds and plasticdrumsof200 litreforthein-situproduction ofnutrientrich vermicompostandvermiwash.

Table 6.Characteristics of vermiwash as influenced by tree litter and paddy straw spentmushroomcompost

Treatments	pH		EC (dSm^{-1})	
	First Harvest	Second harvest	First Harvest	Second harvest
25%RTL+75%PSSMC	6.73	6.40	3.93	2.43
50%RTL+50%PSSMC	6.98	7.05	3.75	3.00
75%RTL+25%PSSMC	7.28	7.08	5.30	3.73
100%RTL	7.50	6.78	7.20	5.58
100%PSSMC	7.00	7.75	3.43	2.53
S.E.±(m)	0.14	0.14	0.33	0.24
C.D.at5%	N.S.	N.S.	0.98	0.70

Table 7. Macronutrient content in vermiwash as influenced by tree litter waste and paddystraw spent mushroomcompost

Treatments	Nitrogen		Phosphorus		Potassium	
	First Harvest	Second harvest	First Harvest	Second harvest	First Harvest	Second harvest
25%RTL+75% PSSMC	0.21	0.20	0.14	0.10	0.06	0.05
50%RTL+50%PSSMC	0.45	0.39	0.20	0.12	0.11	0.11
75%RTL+25%PSSMC	0.49	0.38	0.21	0.15	0.14	0.12
100%RTL	0.65	0.51	0.33	0.27	0.27	0.23
100%PSSMC	0.36	0.34	0.21	0.14	0.16	0.13
S.E.+(m)	0.08	0.08	0.02	0.01	0.02	0.02
C.D.at5%	0.15	0.29	0.08	0.05	0.08	0.07

Table 8. Micronutrient content in vermiwash as influenced by tree litter and paddy strawspentmushroomcompost

Treatments	Fe(mgkg^{-1})		Manganese (mgkg^{-1})		Zinc (mgkg^{-1})		Copper (mgkg^{-1})	
	First Harvest	Second harvest	First Harvest	Second harvest	First Harvest	Second harvest	First Harvest	Seconddharvest
25%RTL +75%PSSMC	6.27	4.31	0.55	0.27	0.33	0.16	Trace	Trace
50%RTL +50%PSSMC	7.88	4.77	0.94	0.29	1.17	0.33	Trace	Trace
75%RTL +25%PSSMC	12.66	8.81	2.07	0.89	1.76	0.98	0.45	0.17
100%RTL	16.73	12.34	3.18	1.76	3.06	2.08	1.05	0.45
100%PSSMC	5.65	4.05	0.54	1.02	1.82	1.09	0.13	Trace
S.E.+(m)	1.39	1.11	0.27	0.14	0.24	0.22	--	--
C.D.at5%	4.11	3.30	0.79	0.42	0.72	0.65	--	--

Figure6Vermiwash(firstharvest)fromdifferenttreatments.

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