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Research Article

CITRONELLA OIL MEAL RECYCLING THROUGH VERMICOMPOSTING USING *EUDRILUS EUGINIAE*

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ABSTRACT: Many biomass materials have been composted normally and also through vermicomposting. Citronella oil meal is one unconventional waste biomass, which has not been used for vermicomposting. In the present work this organic waste has been successfully vermicomposted. Citronella has gained attention oflate and many farmers are cultivating this grass as it seems to be a cash crop. Minimum herbage of this citronella grass is around 20 tonnes per year per acre. This grass contains oil in the range of 0.6 – 1.5% which has a good insect repellant quality and has good market value. Citronella oil meal was subjected to vermicomposting using two different particle sizes viz.; 0.5 mm and 1.5 – 2.0 inches to see the feasibility of vermicomposting time period taken. In both the cases, the citronella oil meal was mixed with soil and cattle dung in the ratio 1:1:1 and allowed to pre-decompose. Smaller particle size of 0.5mm took only seven days while the larger particle size of 1.5 – 2.0 inches size took 16 days for partial decomposition. After partial decomposition, both the substrates were transferred to earthenware vermibed and a total of 15 numbers of earthworm species *Eudrilus euginiae* were introduced in the vermibed.

Particle size of 0.5mm took 46 days for complete vermicomposting while the larger pieces of citronella required 69 days for vermicomposting. In both the cases, good granular, cylindrical and uniform size of vermicompost was harvested, which had good NPK content. C/N ratio from original 123 reduced to 17.9 in the vermicompost.

Vermicompost prepared depicted a bulk density, porosity and water holding capacity in the range of 0.9281 – 0.9962 gm/cm, 81.7 - 84.8% and 90.2-94.5% respectively.

Key words: citronella oil meal, vermicomposting, C/N ratio, vermicompost, percent volatile solids of total solids, particle size

INTRODUCTION

In India about 180 million tonnes of animal waste, 270 million tonnes of crop residues and huge amount of agro industrial wastes are produced every year [1]. This residue poses a problem of disposal. One most ecofriendly and sustainable method of disposal/recycling of this waste is to convert it into a value added material by vermicomposting. Vermicomposting has been emerging as an important source in supplementing chemical fertilizers in agricultural activities, in view of its effectiveness as a soil conditioner.

Many biomass wastes have been converted into vermicompost with good manurial value. Municipal Solid Waste generation in India was around 15 million tonnes per year, as per the 1972-1973 report [2]. The disposal of this Municipal Solid Waste became an amazonian task (CPHERI- Solid Waste Report 1971-1973). Initially simple composting was being carried out. But, nowadays, vermicomposting is being advocated for biomasses, as it is an ecofriendly and sustainable technique. Left out food wastes from restaurants, hotels and marriage halls are also vermicomposted. Left out restaurant food has been successfully vermicomposted using *Eudrilus euginiae* [3]. Very sturdy and hard leaves of coconut trees have been reported to be vermicomposted successfully. It is well known that coconut leaves contain around 31% lignin which offers high resistance to natural decomposition. However, certain groups of earthworms that survive in organic matter can enhance the decomposition process of such materials [4]. It has been further reported that these coconut leaves were cut in to 15 cm pieces and mixed with cow dung in a ratio of 1:1 and predigested for 15 – 20 days.

This pre-decomposted waste was vermicomposted using 50 worms / kg waste using earthworm *Eudrilus euginiae*. Water hyacinth, a weed has been successfully vermicomposted using indigenous earthworm species of *Perionyx excavatus* [5]. Another weed Parthenium is very dangerous and creates allergy in humans. It grows rampantly everywhere and creates health problems. Its disposal is the major need of the hour. Recently, this weed has been vermicomposted using *Eudrilus euginiae*. The report further says that parthenium contains a toxin called parthenin and phenols, and can be eradicated using vermicomposting, if Parthenium weed is mixed with appropriate quantity of cow dung. Around 30 - 35% organic carbon and 32 – 48% phenol contents are reduced [6].

Vermicomposting plays a major role in improving the growth and yield of different agricultural products. Vermicomposting is an appropriate alternative for the safe, ecofriendly hygienic, cost effective disposal of many degradable urban biomasses. One biomass – banana peel has been effectively vermicomposted, using earthworm *Eudrilus euginiae* [7]. *Eisenia foetida* and *Eudrilus euginiae* have also been used for the vermicomposting of combined waste of banana stem and cow manure [8, 9]. Pre-composted paper waste was vermicomposted with *Eudrilus euginiae*. The results showed mild improvement in the fraction of nitrogen, during the process of vermiconversion of paper waste [10]. Biomass residues generated from palm oil meal has also been reported in vermicomposting [11]. Total waste (Municipal Solid Waste) generation in urban areas in India is estimated to be around 38 million tonnes per annum. It is understood by house hold survey that 70 – 75 % tonnes of Municipal Solid Waste can be generated every day in a town. The available quantities can safely and conveniently generate about 3 MWs of power or can be converted into vermicompost as manure. Few unusual wastes like human excreta, pig manure [12], poultry waste and textile and dye sludge have been successfully vermicomposted. From the literature, it is very clear that any biomass waste with permutation and combination with cattle slurry can successfully be converted into vermicompost [13, 14, 15, 16]. Special wastes like guar gum industrial wastes and also arcanut and cocoa waste also have been used for vermicomposting [17, 18]. Special wastes like ground nut shells, which are hard and contains lignin, in combination with rice husk, rubber plant leaf litter (Heveabrasiliensis Var PRIM 600) and some solid waste from aromatic oil extraction units were also efficiently vermicomposted [19, 20, 21]. Based on the above literature survey, it was envisaged to vermicompost the citronella oil meal. Its production is increasing day by day, as it seems to be a cash crop and side by side waste generation is also very high. So, it is preferable to vermicompost, to harvest value added manure and also achieve ecofriendly disposal.

This article discusses in detail the vermicomposting of citronella oil meal using two different particle sizes i.e. 1.5 – 2.0 inches and other 0.5mm size.

MATERIALS AND METHODS

Citronella oil meal was procured from a local farmer, who was not only cultivating citronella grass but also was distilling it to produce citronella oil. Raw material procured was subjected to routine physico chemical parameters and also heavy metal analysis as per the standard methods [22]. Cow dung was procured from a local cow shed.Table 1 shows the physicochemical characteristics of raw citronella.

Eudriluseuginiae was procured from vermiculture Centre of Science for villages at Wardha, Maharashtra, India. Vermicomposting was carried out in earthenware pots. Citronella oil meal as such (1.5 to 2 inches) and also pulverized to 0.5mm size were used for vermicomposting. Fresh cow dung brought from the cow shed was allowed to dry in shade, before its use in vermicomposting. During the experimental work, Citronella oil meal, soil and dry cattle dung were mixed in 1:1:1 ratio and left for pre-decomposing. After seven days of pre-decomposing of 0.5 mm size and 16 days of 1.5 – 2.0 inches size, were transferred to earthern ware vermin beds and a total of 15 earthworm species of *Eudriluseuginiae* were introduced. Pots were covered with mulch and daily water was sprinkled to keep it moist and maintain the moisture content in the required level. After 45 days, 0.5mm particle size of citronella was completely composted with beautiful dark brown colour granular mixture, while 1.5 – 2.0 inches size took 69 days for vermicomposting. These composts were also subjected to routine physical parameters like porosity, bulk density, water holding capacity and chemical parameters like nitrogen, phosphorus and potassium content etc. as per the standard methods [23]. Results of the same are indicated in Table 2. Chemical analysis results were constant in both particle sizes used while physical parameters showed marginal difference i.e. the vermicompost prepared using 1.5 – 2.0 inches size depicted slightly better bulk density porosity and water holding capacity.Plate1and Plate2 shows the quality of vermicompost to the naked eyes.

It is very clear from the studies that particle size does play an important role, during vermicomposting. Vermicomposting period can be reduced, when size of the biomass is reduced. Longer and harder the pieces, vermicomposting period taken is longer.

RESULTS AND DISCUSSION

Citronella oil meal is characterized with high values of pH and organic carbon. However, other nutrients such as total nitrogen, available phosphorus and exchangeable potassium were found in trace amounts. The process of vermicomposting activity significantly changed the physical and chemical properties of citronella oil meal that can be an important tool for organic farming. Results indicated in Table 2 clearly shows that the vermicomposting has brought the pH from original value of 10.32 to 7.24 on completion of vermicomposting. It is very clear that earthworms have successfully grazed on the citronella oil meal and the pH came to neutral level. Raw citronella oil meal had 85% volatile solids of total solids indicating that it is a very excellent substrate for both biogas production and also for vermicomposting. Final vermicompost had only 15.46% volatile solids of total solids indicating that all biodegradables have been efficiently consumed / converted by the earthworms. C/N ratio initially was on the higher side with a value of 123 and after vermicompost it reduced to 18.0, indicating loss of carbon as carbon dioxide during vermicomposting period of the citronella oil meal**.**

It is also clear from the results shown in Table 2, the value of total nitrogen, available phosphorus and exchangeable potassium increased during vermicomposting. Other physical parameters viz; porosity, bulk density and water holding capacity of vermicompost are very efficient. Vermicompost depicts better quality than the soil as indicated in Table 3.

Bulk density reduced considerably after vermicomposting, porosity and water holding capacity almost increased more than double as compared to only soil. So it is clear that vermicomposting is an efficient technique for biomass conversion into manure. Moreover no death of *Eudriluseuginiae* was observed during vermicomposting, infact good healthy growth of worm was observed as shown in Plate 3.

Table-1: Characteristics of Raw Citronella Oil Meal

Parameters*	**Values**
pH	10.3
Conductivity (ms/cm^2)	2.5
Alkalinity as $CaCO_3$	70
Total Hardness as $CaCO_3$	180
Calcium Hardness as $CaCO_3$	50
Magnessium Hardness as $CaCO_3$	130
Chloride as Cl	155.8
Sodium as Ma	166.9
Potassium as K	170.9
Nitrogen as N	0.48
Sulphate as SO_4	310.55
Phosphate as PO_4	ND**
% Total Solids	92.62
% Total Volatile Solids	78.36
% Ash content	15.40
% Volatile Solids of Total Solids	84.59
% Moisture	7.38
C/N Ratio	123
heavy metals (in mg/l)	
Cadmium	0.002
Cobalt	0.026
Chromium	0.071
Copper	0.400
Iron	12.552
Manganese	2.444
Nickel	0.059
Lead	0.110
Zinc	2.542

*All the values are expressed in mg/l except pH, Conductivity **Not detectable

It is very clear from the health of worms that they savour the citronella oil meal very heartily. Number of worms also increased. Apart from routine manurial nutrients, trace metals also showed improvement after vermicomposting. It can be inferred from the studies that citronella oil meal can be a good substrate for earthworms and can be easily converted into vermicompost. So that not only manure / soil conditioner is obtained from waste biomass but also ecofriendly disposal of huge mass of solid waste is achieved.

Table-2: Characteristics of Vermicomposting

Parameters*	Values
pH	7.2
Conductivity (µs/cm^2)	662
Alkalinity as $CaCO_3$	250
Total Hardness as $CaCO_3$	50
Calcium Hardness as $CaCO_3$	20
Magnessium Hardness as $CaCO_3$	30
Chloride as Cl	89.33
Sodium as Ma	1.9
Potassium as K	5.1
Nitrogen as N	0.48
Sulphate as SO_4	3.84
Phosphate as PO_4	0.84
% Total Solids	95.85
% Total Volatile Solids	14.82
% Ash content	81.03
% Volatile Solids of Total Solids	15.4
% Moisture	4.15
C/N Ratio	17.9
heavy metals (in mg/l)	
Cadmium	0.028
Cobalt	0.635
Chromium	0.398
Copper	0.602
Iron	249.400
Manganese	17.970
Nickel	0.596
Lead	0.124
Zinc	6.061

***All the values are expressed in mg/l except pH, Conductivity**

Table-3: Comparative Characteristics of Soil and Citronella Compost Bulk Density, Porosity and Water Holding Capacity

Parameters	Soil	Name of Sample	
		Citronella compost 1.5 – 2.0 inches size	Citronella compost 0.5 mm size
Bulk density (in g/cm^3)	1.6967	0.9281	0.9962
Porosity (in %)	46.8815	84.8433	81.726
Water holding Capacity (in %)	38.7447	94.5346	90.232

Plate-1: Vermicompost prepared from 0.5mm size citronella oil meal shows uniform granular size.

Plate 2: Vermicompost prepared from 1.5 – 2.0 inches size citronella oil meal shows uniform cylindrical size.

Plate-3: Healthy earthworm *Eudriluseuginiae*

CONCLUSION

It can be inferred from the studies that citronella oil meal can be effectively vermicomposted. No death of earthworms occurred. Moreover earthworm's growth also improved. Nutrient content and heavy metal contents improved in vermicompost and C/N ratio reduced to 17.9

It is most ecofriendly and cost effective in nature. Value added manure and at the same time waste disposal in a friendly manner is achieved.

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