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Physico-chemical parameters of vermicompost using *Eisenia foetida* in garden waste

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Abstract
The use of earthworms for composting of organic matter has been known technology since many years. The earthworm species *Eisenia foetida* has been widely and commonly used for this purpose. Many factors such as, pH, moisture, carbon/nitrogen ratio determine the quality and rate of vermicompost. The agricultural wastes that amounts about fifty percent of organic matter can be easily degrade for sustainable agriculture. The modern vermicompost has developed techniques where any organic matter can be used for vermireactor. The present study was conducted using *Eisenia foetida* and caesin as biodegradable plastic in garden wastes considering the modern apparoach of vermicompost.

Keywords: Caesin, vermicomposting, *Eisenia foetida*, physical parameters

Introduction

It has been estimated that municipal solid waste is the major source of pollution in all developing countries. The organic waste which is generated today has major portion from industrial, municipal and agriculture sector. The municipal waste (including municipal sludge) is generated by human biological and social activities and contains a large portion of organic waste readily available for treatment. These wastes include batteries, paint residues, ash, treated wood, electronic waste, livestock excreta, industrial sludge, leaf litter, vegetables and hotel industry wastes[1]. It has been estimated that around 600-700 million tonnes of agricultural residue is generated in India every year, but most of it remains unutilized. This huge amount of waste can be utilized for recovering important resources like fertilizer, fuel wood and fodder [2].

Plastic also forms the major risk factor for human health and environment in addition to organic wastes. The use of plastic is popular due to its inertness, flexibility, cheapness, ease with which its used. The global plastic production has increased from 5 million tonnes in 1950 to over 311 million tonnes in the year 2014 [3].

It has become a serious problem to discard and utilize this huge organic waste for better purpose. The organic waste has immense potential to produce four million tonnes of plant nutrients besides biogas and alcohol [4]. The earthworms play an important role in recycling these organic wastes. It works as physical aerator, crusher, mixer and chemical degrader and biological stimulator in decomposing the waste. Microbial composting of organic wastes through earthworm activity is called Vermicomposting [5].

For composting of organic waste the ideal physical conditions are needed, they are: pH- 6.8 to 7.1, moisture -80-90%, temperature- 15 to 24 ^{0}C oxygen needs- well ventilated and aerated area, Ammonia (< 0.5mg/gm), Salt content (<0.5mg/kg). The present study was conducted using garden waste along with caesin as biodegradable plastic. The biodegradable plastic are the plastics that are being decomposed by bacteria like *Flavobacteria* and *Pseudomonas* [6]. The aliphatic polysters are biodgradable due to their potentially hydrolysable ester bonds. The examples include naturally produced Polyhydroxyalkanoates (PHAs), Polyanhydries, Polyvinyl alcohol, starch derivatives, most of starch derivatives, cellulose esters and enhanced biodegradable plastics with additives [7].

Materials and methods

For the present study, the earthworm species *Eisenia foetida* has been used due to its easy availability and handling, more cocoon formation and easy maintainence. The experiment were performed in the laboratory using cement pots having capacity of around five kilograms.

The experimental set-up was divided into control set-up and experimental set-up. Each group had twenty earthworms. The one control group was taken along with experimental set-up in triplicate. The each set-up was watered periodically to maintain the moisture level upto 60-70%. The physico-chemical parameters were checked on following 30, 60, and 90 day respectively.

The set up can be summarized as

Table 1: Vermicomposting with two types of waste materials

Control	Experimental	Quantity of material used
Cow dung	Cow dung	2000grams
Green matter	Green matter	500 grams
Garden waste	Garden waste	500 grams
	Caesin	E1=150grams E2=200grams E3=250 grams
Brick, sand, coconut scrap, cardboard pieces	Brick, sand, coconut scrap, cardboard pieces	3 inches layer in each pot
Trichoderma viridae (powder form)	*Trichoderma viridae*	5 grams
Azotobacter (liquid form)	Azotobacter	15 ml

Preparation of caesin
Two litres of toned milk was taken and boiled thoroughly. It was made to cool down at room temperature and three large spoons of lemon juice was added to this. The pot was kept aside for 2 to 3 hours. This was followed by filtration of the content using muslin cloth. The watery portion was discarded and soild part was tightly tied to remove excess water. The whole solid part was kept under heavy weight for more than 12 hours and then it was used for experimental purpose (Steinbuchel A 2003) [8].

Results and Discussion
The physical parameters in the present study included pH, electrical conductivity, Carbon/ Nitrogen ratio, phosphate and potassium. The results were analysed following 30, 60, and 90 days respectively. Before analysis the samples were shade-dried and kept in glass bottles for analysis. The samples were analysed at Dist. Soil Survey and Testing Laboratory, Agricultural College Area, Maharajbagh Nagpur-44001.

Table 2: pH variations

Set up	30 days	60 days	90 days
Control set-up	7.10	7.40	7.40
Experimental set-up 1	7.20	7.10	7.80
	7.17	7.16	7.80
	7.15	7.12	7.10
Average E1	7.17	7.13	7.57
Experimental set-up 2	7.20	7.14	7.10
	7.40	7.15	7.12
	7.40	7.18	7.10
Average E2	7.33	7.16	7.11
Experimental set up 3	7.40	7.10	7.60
	7.20	7.12	7.10
	7.80	7.50	7.54
Average E3	7.47	7.24	7.41

From the above results, it was concluded that the pH in the control set up remains between 7.1 to 7.4 during the composting period. The pH in the experimental set up1 varies from 7.17 to 7.57. In the experimental set up 2 the range of pH remains between 7. 33 to 7.11. The experimental set-up 3 showed variation from 7.47 to 7.41. This pH range is highly suitable for plant growth and for healthy microbial activity also. The vermicompost prepared with this pH range can be recommended as fertilizer for plants.

Table 3: Electrical Conductivity (in milli-ohms)

Set up	30 days	60 days	90 days
Control set-up	2.74	0.99	0.84
Experimental set-up 1	0.81	0.98	0.9
	0.93	0.99	0.98
	0.92	0.99	0.99
Average E1	0.89	0.99	0.96
Experimental set-up 2	0.77	0.98	0.91
	1.16	0.98	0.99
	0.57	0.98	0.99
Average E2	0.83	0.98	0.96
Experimental set up 3	0.78	0.99	0.98
	0.59	0.99	0.98
	1.22	0.99	0.98
Average E3	0.86	0.99	0.98

The electrical conductivity depends upon the movements of ions from cathode to anode and vice-a-versa. In the present study during the initial stage, i.e. between 0 to 30 days of vermocomposting lot of microbial activity and high release of methane occurs and hence there is sharp increase in electrical conductivity. After 30 days, the compost becomes stable with less movement of ion exchange hence there was no change observed in conductivity.

In the vermicompost carbon/ nitrogen ratio is most important factor. Carbon is released during composting in the form of methane and nitrogen is slowly released. The nitrogen which is relased slowly helps the plant to grow. C/N following 30, 60, 90 days has been described in Table 4.

Table 4: Carbon/ Nitrogen ratio (in %)

Set up	30 days	60 days	90 days
Control set-up	4.41	2.92	1.9
Experimental set-up 1	2.78	3.36	3.79
	2.32	3.22	3.45
	3.82	3.43	3.41
Average E1	2.97	3.34	3.55
Experimental set-up 2	3.27	2.95	4.06
	3.11	2.99	2.75
	3.01	2.99	2.78
Average E2	3.13	2.98	3.20
Experimental set up 3	3.1	3.14	3.01
	3.1	2.99	2.96
	2.99	2.97	2.87
Average E3	3.06	3.03	2.95

It was observed that the initial stages there was drastic changes in the nutrient profile of all the substrates by the end of the experiment. During the initial stages i.e. from 30 to 60 days the rate of carbon/ nitrogen ratio increases followed by constant readings of this ratio, indicating stable decomposition at the end of the experiment. Similar types of results were obtained by Avinash Chauhan *et al* [10].

Table 5: Phosphate (kg/hectre)

Set up	30 days	60 days	90 days
Control set-up	615.54	352.76	300.67
Experimental set-up 1	470.57	407.72	390.01
	427.54	354.49	310.09
	455.76	321.90	299.00
Average E1	451.29	361.37	333.03
Experimental set-up 2	480.2	471.14	450.34
	495.49	471.14	442.78
	476.23	462.64	453.9
Average E2	483.97	468.31	449.01
Experimental set up 3	486.43	458.09	432.78
	462.62	400.32	355.7
	497.75	487.84	455.9
Average E3	482.27	448.75	414.79

The study showed different patterns of phosphorus mineralization. It was also observed that the values depend upon action of gut micro-organisms in worm casts and also phosphorus stabilizing bacteria. It was also found that phosphorus content also depends upon the waste material composted by earthworm as observed by Sannigrahi [11].

Table 6: Potassium (kg/hectre)

Set up	30 days	60 days	90 days
Control set-up	5577.6	5443.2	5200.89
Experimental set-up 1	2983.08	3346.56	3110.8
	2811.09	3342	3157.9
	2810.89	3354.02	3167.88
Average E1	2868.35	3347.53	3145.53
Experimental set-up 2	2862.72	2674.56	2808.96
	2845.67	2576.89	2808.9
	2800.01	2356.76	2701.09
Average E2	2836.13	2536.07	2772.98
Experimental set up 3	2653.12	3034	2674.56
	2546.66	3067	2543.87
	2454	2890.78	2455.9
Average E3	2551.26	2997.26	2558.11

The result showed that there was increase in potassium in the vermicompost which appeared to enhance mineralization due to enhanced microbial and enzyme activity in the guts of earthwom as reported by Pramanik *et al*. (2007) [12].

Summary

Present study indicated that caesin as biodegrable plastic along with garden waste has no ill-effect on the vermicompost. It is highly nutritive and safe to use. There was no mortality observed during the experimental study. Its slightly alkaline pH and low electrical conductivity made it safe for earthworm activity. The availability of phophate and potassium along with carbon and nitrogen makes it excellent vermicompost for plant growth.

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