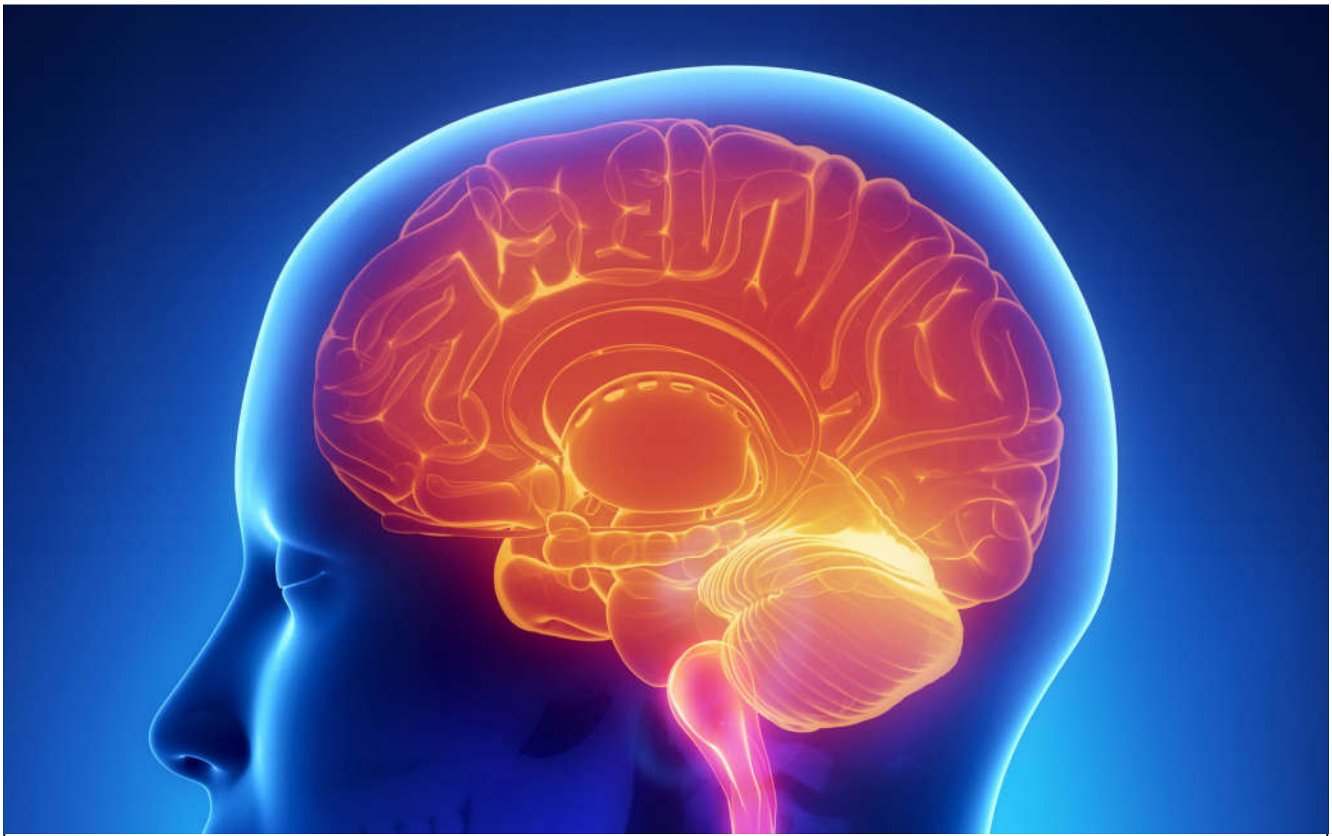

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RESEARCH ARTICLE

THE MANAGEMENT OF PIG WASTE USING EARTHWORM EUDRILUS EUGENIAE

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ABSTRACT

Pot culture experiments were carried out to process pig waste mixed with bedding materials (Eichhornia crassipes and cow dung) in the ratio of 1:1:2, 1:2:1 and 2:1:1 using earthworm Eudrilus eugeniae. Totally there were three treatments (T_1, T_2 and T_3) with three replicates for each. The pre-composed pig waste and vermicompost were separately subjected to chemical nutrients composition analysis. After two months the vermicomposts were harvested and characterized. The results showed that the vermicomposts had lower pH, total organic carbon (TOC) and carbon /nitrogen ratio (C/N ratio) but higher electrical conductivity (EC), nitrogen, phosphorous and potassium (NPK) content than the pre-composed. Heavy metal content in vermicomposts were higher than pre-composed. The results of the present study suggest that the vermicomposted pig waste with Eichhornia crassipes and cow dung at 2:1:1 proportion can very well be used as eco friendly organic manure.

INTRODUCTION

Over the last few years, as a regulation for application and disposal of animal manure has become more rigorous, the interest in using earthworms as an ecologically sound system for manure management has increased tremendously. Recently, pig production has rapidly increased to supply the demand for meat. The increased concentration of intensive livestock in associated with the pollution and the pig waste is becoming a serious environmental hazard. Livestock waste causes persistent and insidious damage to waterways, human health and aquatic life. Water bodies become unusable, while in the remote areas people are still using these for their daily activities. Managing piggery solid waste is often a challenge for pig farmers. It can be difficult to dispose of pig manure and effluent sludge in an environmentally friendly way. Worm farming can be an effective method of processing piggery waste and converting it into worm compost, which is a useful and potentially saleable product.

Water Hyacinth (Eichhornia crassipes Martius) is a monocotyledonous freshwater aquatic plant, belonging to the family Pontederiaceae, related to the lily family (Liliaceae) and is a native of Brazil and Equador region. It is also a well known ornamental plant found in water gardens and aquariums, bears beautiful blue to lilaccolored flowers along with their round to oblong curved leaves and waxy coated petioles (Anjanabha Bhattacharya and Pawan Kumar, 2010). Water hyacinth is considered as a noxious weed in many parts of the world as it grows very fast and depletes nutrient and oxygen rapidly from water bodies, adversely affecting flora and fauna. Shoeb and Singh (2002) reported that under favorable conditions water hyacinth can achieve a growth rate of 17.5 metric tons per hectare per day. There have been instances of complete blockage of waterways by water hyacinth making fishing and recreation very difficult. The vermicomposting process is a result of the combined action of the earthworms and microflora living in earthworm intestines and in the growth medium. Vermicompost improve the soil structure, increasing the water holding capacity and porosity which facilitate the root respiration and growth (Lee, 1992; Parthasarathi, *et al.*, 2008). The main objective of the study was to monitor the short-time changes of pig manure, after passing through the gut of the epigeic earthworm Eudrilus eugeniae under controlled environmental conditions. The changes in available pools of N, P and K of pig waste, water hyacinth and cow dung were monitored. The earthworm biomass and physico- chemical parameters were also analyzed.

MATERIALS AND METHODS

Procurement of Earthworms

The earthworms Eudrilus eugeniae were obtained from

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Periyar Maniammai University, Thanjavur, and cultured in the Vermicomposting unit of the PG and Research Department of Zoology, Periyar E.V.R College, Tiruchirappalli, India.

Table 1 Earthworm Biomass in various feed mixtures of pig waste with Eichhornia and cow dung

Treatment	Initial weight of Earthworms (g)	Final weight of Earthworms (g)
T1 + Ee	28.403 ± 0.224	39.866 ± 1.499
T2 + Ee	28.383 ± 0.585	36.736 ± 1.114
T3 + Ee	28.646 ± 0.703	40.116 ± 1.075

*Results are the mean value in triplicates Mean ± SD with significant difference at P < 0.05.

eugeniae were introduced into each pot. Earthworms were selected based on similar size and explicit maturity based on clitellum. The moisture content of materials was maintained at 50% throughout the study. Data were collected by recording the rates of survival of earthworms and their weights before and after the experiments.

Chemical analysis

Sample analysis was done before and after the experiments. The pH was measured using digital pH meter in 1/10 (w/v) aqueous solution. Total Organic Carbon (TOC) was determined by the partial-oxidation method (Walkley and Black, 1934), total Nitrogen (TN) by micro Kjeldahl method (Jackson, 1975) and total extractable Phosphorus (TP) by using Olsen's sodium bicarbonate extraction method (Olsen *et al.*, 1954). The carbon/nitrogen ratio (C/N) ratio was calculated from the measured value of TOC and TKN. Exchangeable elements (K, Ca and Mg) were determined after extraction of the sample using ammonium acetate extractable method (Simard, 1993). The concentration of micronutrients, i.e. Cu, Fe, Zn and Mn were determined using DTPA *(*diethyelene triamine pentaacetic acid*)* extraction method, and the samples were analyzed by double beam Atomic Absorption Spectrophotometer (AAS).

Table 2 Physico-chemical properties of pre digested and vermicomposted pig waste with Eichhornia and cow dung

	Pre-composed			Vermicomposed		
Parameters	T1	T2	T3	T1+ Ee	T2 + Ee	T3+ Ee
pH	7.92±0.20	7.74±0.15	8.41±0.06	6.50±0.17	6.44±0.01	6.58±0.06
EC (dsm^{-1})	0.29±0.01	0.30±0.01	0.46±0.01	0.57±0.01	0.63±0.01	0.66±0.00
OC (%)	1.07±0.02	0.93±0.01	0.95±0.00	0.91±0.00	0.87±0.00	0.82±0.01
TN (%)	0.61±0.00	0.90±0.00	0.47±0.01	1.11±0.00	1.90±0.00	1.97±0.00
TP (%)	0.53±0.01	0.61±0.00	0.72±0.01	1.80±0.00	1.84±0.00	1.90±0.00
TK (%)	0.41±0.01	1.33±0.01	1.21±0.01	2.81±0.01	2.16±0.00	2.90±0.01
C/N ratio	40.58±0.00	25.33±0.015	30.24±0.34	5.57± 0.01	7.87± 0.02	9.58 ±0.15
Ca (%)	9.31±0.04	9.46±0.01	9.95±0.02	10.09±0.01	10.10±0.01	10.70±0.00
Mg (%)	3.41 ±0.02	3.20±0.10	3.87±0.03	4.82±0.05	4.47±0.01	4.88±0.00
Zn (ppm)	0.16±0.02	0.14±0.01	0.10±0.01	0.38±0.01	0.27±0.00	0.35±0.00
Fe (ppm)	10.09±0.01	15.86±0.04	12.40±0.01	14.12±0.03	14.14±0.04	19.37±0.02
Cu (ppm)	0.48±0.01	0.41±0.00	0.22±0.01	0.22±0.01	0.46±0.01	0.58±0.00
Mn (ppm)	0.91±0.01	0.34±0.01	0.38±0.01	0.67±0.00	0.76±0.01	0.83±0.02

Procurement of Cow Dung, Pig Waste And Water Hyacinth

The cow dung (CD) was purchased from Lakshmi cow shed located in Khajamalai, Tiruchirappalli, India. The Pig waste (PW) was purchased from a piggery farm, Trichy, Tamil Nadu, India. The cow dung and pig waste was partially dried in shade and stored for further experiments. The water hyacinth (Eichhornia crassipes) plants were collected from the Uyyakondan river, Trichy, Tamil Nadu, India. The water hyacinth was chopped into small bits, shade dried and stared.

Experimental Design

The earthworms were acclimatized to the laboratory conditions for a period of 15 days before the commencement of the experiment. The experiments were conducted in an earthen pots, each of 2 kg capacity, with a small hole at the bottom. Nine earthen pots were taken. Totally there were three treatments (T1, T2 and T3) with three replications for each. Pig waste, water hyacinth and cow dung were mixed in the following combinations.

T1 - 1 : 1 : 2
T2 - 1 : 2 : 1
T3 - 2 : 1 : 1

The mixed wastes were pre-decomposed for 15 days prior to study. The mixtures were pre decomposed by sprinkling water and the wastes were turned over manually everyday for 15 days in order to eliminate volatile toxic gases. This process partially digests the material and fit for earthworm consumption. Wet dung should not be used for vermicompost production. Pre decomposition helps to avoid overheating in vermicomposting system and also kill weed seeds and pathogens if there is any. Twenty five matured Eudrilus

Statistical Analysis

One-way ANOVA was used to analyze the differences between treatments. Duncan multiple ranged test was also performed to identify the homogeneous type of the data sets. Statistical analysis was done with the SPSS computer software program.

RESULTS AND DISCUSSION

Biomass of Eudrilus Eugeniae in Different Treatments

Maximum worm biomass was recorded in T3 on 45th day, Which was followed by T1 and T2. The worm biomass started declining in T_2 and T_1 mixture after 45[th] day. Moreover, compost started granulating on the surface and it also indicated exhaustion of nutrients in the mixture. In general, earthworm biomass gain is directly related to the feeding rate, palatability of feedstuff and particle size of feedstock; however, there is a close relationship between feedstock quality and microbial richness of bedding substrates which directly or indirectly affects the earthworm feeding rate, as microbes are the important component of earthworm diets (Gomez Brandon *et al.*, 2011). Neuhauser *et al.*, (1988) and Edwards *et al.*,(1998) reported that population density of worms per unit volume or weight of feed was important in affecting the rate of growth and reproduction.

Nutrients in Vermicompost

Earthworms change both physical and chemical properties of ingested matter including the pH. It can increase and decrease the rate of bio degradation. The vermicompost from T1 (7.92), T2 (7.74) and T3 (8.41) showed a similar pattern of change in P^H that falls in the range of 6.50, 6.44 and 6.58, which is within the optimal range for plant growth (Goh and Haynes, 1977), which shows a shift from the initial acidic condition toward neutral condition. The mineralization of nitrogen and phosphorus into nitrites / nitrates and orthophosphates and bioconversion of the organic material in to intermediate species of organic acids may have decreased the pH (Ndegwa and Thompson, 2000).

The EC indicates the mineralization rate and availability of total soluble or plant available forms of nutrients in vermicompost (Renu Negi and Surindra Suthar, 2013). The EC values of vermicomposting was 0.66 (T3), which comparatively higher than pre compost. Increase may be due to mineralization and consequent formation of ions in pig waste mixtures in the presence of earthworms. The maximum increase in EC was recorded in 0.66 (T3) and minimum in 0.57 (T1). Deka *et al.* (2011) have reported that earthworms produce organic mineral compounds by digesting organic materials as feed and these minerals may accumulate in the final products. The result of OC content in present study shows decrease level after Vermicomposting. The results T1, T2 and T3 were 0.91, 0.87 and 0.82 respectively. The result we get was similar to that of previous study conducted by Aira *et al.* (2007). There were several factors which governed OC loss during the vermiprocessing of the Pig wastes. During this process earthworms fragmented and homogenized. The ingested material through muscular action of their foregut and also add mucus and enzymes to the ingested material and these by increased the surface area for microbial action (Edwards and Fletcher, 1988). Aira *et al.* (2007) reported that earthworm modified the substrate conditions which subsequently enhanced the carbon losses from the substrates through microbial respiration in the form of CO_2.

TN consists of the inorganic forms of Nitrogen NH4 N and NO_3 N. TN content was higher 1.97 in T3 followed by 1.90 in T2 and 1.11 in T1. According to Viel *et al.* (1987) losses in organic carbon might be responsible for nitrogen addition. Addition of nitrogen in the form of mucus, nitrogenous excretory substance, growth stimulating hormones and enzymes from earthworms has been reported by Tripathi and Bhardwaj, (2004). These nitrogen rich substances were not originally present in feed and might have contributed additional nitrogen content.

The increase in Phosphorus was in the range of 1.90. The final TP content in T3 was significantly ($P<0.05$) higher than in T1 and T2. Ghosh *et al.* (1999) have reported that vermicomposting can be an efficient technology for the transformation of unavailable forms of phosphorus to easily available forms for plants. According to Lee (1992) if the organic materials pass through the gut of earthworms than some of phosphorus being converted to such forms that are available to plants. Increasing in TP was attributed to direct action of worm gut enzymes and indirectly by stimulation of the micro flora.

The TK content of the initial Treatment was in the range of 0.41 in T1, 1.33 in T2 and 1.21 in T3 respectively. Final TK was higher than initial and was the range of 2.90. Maximum TK content was found (2.90) in T3, which was significantly ($P<0.05$) higher than T1 (2.81) and T2 (2.16). Similarly the study conducted by Delgado *et al.* (1995) and Suthar (2006) have reported that the processed waste material contains high concentration of exchangeable K due to enhanced microbial activity during the Vermicomposting process, which consequently enhances the rate of mineralization. Carbon to nitrogen ratio of the compost is ratio between carbon and nitrogen content in compost. It is a most important parameter of composting because it indicates the quality of the compost (Manish *et al.*, 2013). The C/N ratio decreased significantly by the end of experiment. According to Morais and Queda (2003), C:N ratio of below 20 indicates acceptable maturity and a ratio of 15 or below is preferable for agronomic use of composts. After vermicomposting the C/N ratio of T1, T2 and T3 was 5.57, 7.87 and 9.58. Since all the treatment groups were found to contain below 15. It was preferable for agronomic use of composts.

The Calcium (Ca) and Magnesium (Mg) concentration were found to be maximum 10.70 and 4.88 respectively. Calcium and Magnesium increased significantly ($P<0.05$) from initial in different feed mixture of treatments. The increase in Ca was high in vermibeds that had a higher proportion of bedding materials. Earthworm drives the mineralization process efficiently and transforms a large proportion of Mg from bind to free form (Suthar, 2008) which results higher concentration of Mg in the vermicompost (Suthar, 2008; Suthar, 2009). Total iron (Fe) content of vermicompost was high in T3 and T2 than in T1. Total Copper (Cu) content was higher after vermicomposting. The amount of copper content was lower in T1 (0.46 to 0.58) and slowly increased amount was seen in T2 and T3. Total Zinc (Zn) content was higher in T3 (0.35) , T1 (0.38) and T2 in (0.27) respectively. The Manganese (Mn) content was also higher in vermicompost than in precompost. It was 0.83 in T3, 0.76 in T2 and 0.67 in T1. This shows that E.eugeniae is a very good decomposer of pig waste. Pig waste composting at low amendments with cowdung may help its eradication for better utilization.

CONCLUSION

The results indicate that the pig waste along with cow dung and water hyacinth (Eichhornia crassipes) plants in different proportion can be used as a raw material in vermicomposting. The vermicomposts were rich in NPK and their C/N ratio was below 10 which indicate their agronomic importance as soil conditioner and manure. The quality of raw materials determined the physico-chemical characteristics of vermicomposts. The results suggest that vermicompost can be introduced as one of the technologies for converting organic wastes into value added products.

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