ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 8, pp. 18973-18975, August, 2017

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

PHYSICOCHEMICAL CHARACTERIZATION OF VERMICOMPOST FROM CHICKEN WASTE USING *EUDRILUS EUGENIAE*

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DOI: http://dx.doi.org/10.24327/ijrsr.2017.0808.0605

ARTICLE INFO

Article History:

Received 18th May, 2017
Received in revised form 10th June, 2017
Accepted 06th July, 2017
Published online 28th August, 2017

Key Words:

Eudrilus eugeniae, vermicompost, chicken waste, cowdung, microbial digestion

ABSTRACT

Earthworms as one of the most significant organisms in bio-degradation convert raw organic waste into nutritive humus and the present study has used chicken waste which had been made to degrade through vermicompost by *Eudrilus eugeniae* with cowdung. The composts were analyzed for various physical and chemical parameters and the results showed significant difference in the gradual increase of nitrogen, phosphorous and potassium value, thereby revealing that treatment of chicken waste for production of vermicompost would be an effective method for maximum utilization of organic waste.

INTRODUCTION

Increasing population demands more food production which results in improper disposal of organic wastes leading to environmental concerns. India produces about 3000 million tons of waste every year (Achsah and Prabha, 2013), which are more frequently disposed by means of landfill or incineration which requires vast space of land that could serve as agricultural and residential space (Yadev *et al*., 2010). In India, annually 1-33% per capita of municipal waste are estimated to increase, and if the same conditions prevail, in 2047 the municipal solid waste is expected to increase approximately five times more than the present level (Ananthakrishnasamy and Gunasekaran, 2014). In India, where there is abundant availability of organic wastes and manpower, the technology of earthworm cultivation and its beneficial utilization in composting process can be very well utilized with the involvement of rural masses. The role of earthworms in the degradation of waste is significant and is best explained by Charles Darwin as he stated them 'as the great waste and environmental managers on earth' and by Aristotle as 'intestine of earth' (Darwin, 1881). Earthworms ingest large amount of organic debris including microbes, plant and animal matters and digest them. Ninety to ninety five per cent of the ingested food is excreted as mucus called 'vermicast' in the soil which is rich in nitrates, potash, phosphate, micronutrients and beneficiary soil microbes, as these castings absorb moisture from air and make it available to plants (Miles, 1963; Sinha *et al*., 2010).

Demands for poultry product has been increased commercially (Vetrivel and Chandrakumarmangalam, 2013) and improved poultry breeds accounts for about 59% of the total bird population in India. Despite the huge benefits in poultry industry, the wastes generated in the form of birds excrement, dead chickens and broken eggs (Akanni and Benson, 2014) are continually dumped near residential areas causing harmful environmental effects. Environment degradation is a major threat confronting the world and use of chemicals to degrade the waste further deteriorates the environment that could also lead to loss of soil fertility (Nagavallemma *et al*., 2005). Vermicomposting is one of the effective alternative that reduces the need for chemical fertilizers and decreases the amount of waste entering the landfills and the secretions in the earthworm's digestive track breakdown organic waste, making the castings to contain more nutrients available to plants (Punde and Ganorkar, 2012). Information on the efficiency of earthworms and nutrition value of compost in various fields are abundant, but information about the growth of earthworms in poultry waste is scanty. The greatest challenge to the environmentalists is the eco-friendly management of this waste and application of microorganisms in this context (Saha and Santra, 2014). Hence, in the present study an attempt has been made to study the influence of earthworm in poultry waste

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management in combination with microbial digestion and cowdung. This study was also taken up to determine the nutrient status of vermicompost prepared from cowdung using earthworm species, *Eudrilus eugeniae,* a tropical earthworm commonly called African night crawler which is relatively large in size and grows rapidly, capable of decomposting large quantities of organic materials into usable vermicompost.

MATERIALS AND METHODS

Collection of raw materials

Chicken waste used for the experimental study was collected from the local chicken shop, Tambaram, Chennai, Tamil Nadu, India. *Eudrilus eugeniae* were collected from the stock culture maintained at Madras Christian College Farm, Tambaram, Chennai, Tamil Nadu, India and cowdung from local farm at Tambaram, Chennai, Tamil Nadu, India.

Experimental setup

Collected chicken waste were shade dried for fifteen days and treated with Effective Microorganisms solution 1 (EM-1) for microbial activity. For the experiment, three plastic trays were used (size 45cm x 35cm x 24cm). A mixture of chicken waste and cowdung were loaded onto tray followed by release of forty healthy adult *Eudrilus eugeniae* to experiment 1 and 2. Experiment 1 consisted of EM-1 treated chicken waste + cowdung + earthworms and experiment 2 was chicken waste treated with water sample collected from chicken waste dumping area + cowdung + earthworms. EM-1 treated chicken waste + cowdung without earthworms served as control. Proper shading, temperature and pH were provided to ensure survival of earthworms. The moisture level was maintained at about 50-70% throughout the study by sprinkling adequate quantity of water. Experimental setups were allowed to degrade the waste for sixty days. Subsamples were analyzed every thirty days for physical and chemical parameters, *viz*., pH, Electrical Conductivity (EC), moisture, Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Iron (Fe), Copper (Cu), Organic Carbon (OC) and Carbon: Nitrogen (C:N) ratio.

RESULTS AND DISCUSSION

pH, nitrogen, phosphorous, potassium and all the micronutrients increased in all the experiments. Nutrient contents were found comparatively higher in experiment 1, followed by experiment 2 and control, emphasizing the efficiency of microbial treated chicken waste decomposition (Table 1). The difference in growth rate among different treatments seems to be closely related to substrate quality (Edwards and Lofty, 1972). In the present study, increase of pH, nitrogen, phosphorous, potassium and all the micronutrients were due to the following reasons. pH is an important factor that limits the distribution and number of species (Pandit *et al*., 2012). Several researchers have also stated that most species of earthworm prefer a pH of about 7.0 (Singh, 1997; Narayan, 2000). The level of pH increased slowly from acidic towards neutral in experiment 1 and 2. Increase of pH in treatments might be due to the participation of microbes in decomposition during vermicomposting. Increase in pH may also be attributed due to mineralization of nitrogen and phosphorous into nitrites/ nitrates and orthophosphates and bioconversion of organic material into intermediate species of organic acids (Yadev *et al*., 2013). Decrease in pH of vermicompost in control may be due to the presence of anaerobic bacteria present in the sample. Increase in nitrogen content in the experiments was due to the presence of nitrogen fixing bacteria. The decomposition of organic material by earthworms accelerates the nitrogen mineralization process and changes nitrogen profile of the substrate (Benitez *et al*., 1999). Phosphorous level increased progressively due to the mineralization of phosphorous during vermicomposting. The release of phosphorous in the available form is performed partly by earthworms gut phosphatases and further release of phosphorous might be attributed to the phosphorous solubilizing microorganisms present in the compost (Achsah and Prabha, 2013).

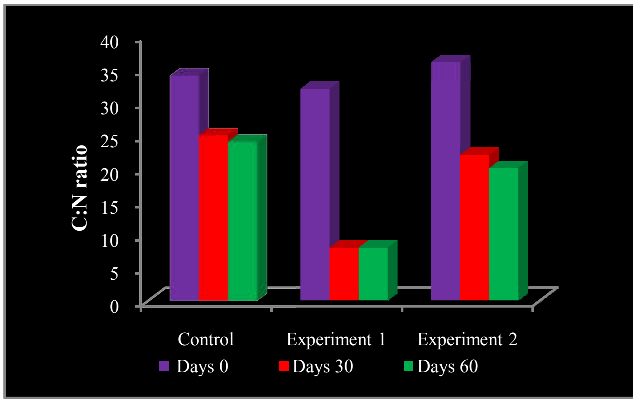

Figure 1 C:N ratio of vermicompost

Table 1 Physicochemical parameters and pattern of nutrient change in vermicompost

Parameters	Units	Control			Experiment 1			Experiment 2		
		Days								
		0	30	60	0	30	60	0	30	60
pH	---	6.70	6.40	4.70	6.70	6.90	7.20	6.70	7.10	6.90
EC	(mS/cm)	6.70	7.10	6.90	64.31	54.23	47.09	4.39	9.25	11.56
Moisture	(%)	63.60	62.93	64.93	55.34	66.74	62.12	64.31	54.23	47.09
OC		46.86	45.56	41.32	42.13	29.37	26.33	42.50	42.30	41.23
N		1.39	1.81	1.86	1.32	3.80	4.72	1.17	1.96	2.24
P		0.23	0.30	0.45	0.37	0.66	1.02	0.34	0.44	0.47
K		0.17	0.23	0.32	0.34	0.71	0.89	0.18	0.31	0.44
Ca		0.44	0.93	0.96	0.94	1.67	1.32	0.53	1.04	1.04
Mg		0.11	0.13	0.15	0.15	0.48	0.94	0.11	0.09	0.17
Zn	(mg\Kg)	57.32	71.42	73.51	59.92	133.89	135.78	64.98	85.35	87.91
Mn		81.89	88.14	92.16	100.99	190.0	195.11	100.53	138.06	139.05
Fe		2358.30	2085.19	2297.52	2825.89	3897.39	3991.45	2281.07	1832.81	1830.19
Cu		8.91	12.08	11.87	11.01	21.56	24.32	10.97	11.84	10.09

Potassium increase in content might be due to changes in the distribution of potassium between non exchangeable and exchangeable ion forms. Earthworms process waste material containing high concentration of exchangeable potassium which consequently enhances the rate of mineralization (Suthur, 2007). Micronutrients like iron, copper, calcium, zinc and manganese also increased in traces. Earthworms convert calcium oxalate crystals in ingested fungal hyphae to calcium bicarbonate which is then egested in cast materials. This increases calcium availability in the compost (Spiers *et al*., 1986). The increase of iron in the compost proves the presence of enzymes and co-factor in the earthworm gut and the increase of copper content was due to the presence of several copper containing oxidizing enzymes. Further, the C: N ratio exhibited a decreased level (Figure 1) which indicated biodegradation. All the above mentioned results demonstrated vermicomposting as an alternative technology for the management of chicken waste with cowdung and also increased efficiency of the vermicompost by increasing the cowdung ratio and the days of microbial treatment. It can be concluded that degradation of chicken waste by earthworm can be a promising method. Application of vermiculture in the degradation of chicken waste allows maximum utilization of organic waste and promotes eco-friendly environment and it may be concluded that vermicomposting appears to be the most promising biofertilizer which not only increases the productivity by nutrient supply but also is pollution free.

Acknowledgements

The authors are thankful to UGC (Sanction Order No. F MRP-5729/15 (SERO/UGC)) for the financial support provided.

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How to cite this article:

Monica, R.D *et al*.2017, Physicochemical Characterization of Vermicompost From Chicken Waste Using Eudrilus Eugeniae. *Int J Recent Sci Res.* 8(8), pp. 18973-18975. DOI: http://dx.doi.org/10.24327/ijrsr.2017.0808.0605

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