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STUDIES ON CONVERSION OF SOLID WASTE TO BIOFERILIZER BY VERMICOMPOSTING

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Abstract: Fertilizer play a vital role in agriculture and has a positive impact on both human and animal lives, though due to economic and environmental challenge there is need for a less harmful biofertilizer for healthy agricultural produce. The research took into cognizance solid waste management of Banana peel, Orange peel, Paper, Pineapple peel, Watermelon peel and mixture of all the aforementioned compost samples as A, B, C, D, E and F respectively in the ratio 5:1 g/worm for each compost by converting them to biofertilizers. Vermicomposting method was used for the process whereby *Eudriluseugeniae* (African worms) fed from the waste and excretes them as vermicast. Physical and chemical parameters were analyzed during the period of 4 weeks of composting which indicated the role of these species in vermicomposting). From the results obtained the pH increased, from 4.0 in the first week to 8.0 in fourth week. The F gave the best result of 17.21% N, 10.24% P, 48.32% K and C/N ratio of 29 in comparison with the controls, A, B, C, D and E with 1.14, 2.7, 1.63, 0.31 and 0.54 %N, 2.46, 1.8, 0.57, 4.14 and 1.26% P, 31.23, 5.7, 1.25, 0.68, 4.69% K and C/N ratios of 22, 9, 138, 12 and 23, respectively. Further comparison with commercial biofertilizer indicates that the biofertilizer produced via this technique can readily stand out as a commercial fertilizer pending on soil requirements and will be a safer substitute for harmful chemical fertilizers.

Keywords: Vermicomposting, banana-peel, orange-peel, paper, pineapple-peel, watermelon-peel

Introduction

Solid waste is simply organic and inorganic waste materials formedfrom different sources that have no value in the eyes of their owners (Londhe & Bhosale, 2015). It is complex in character and its volume is significantly increased due to increase in living standards and population density (Kaushal *et al.*, 2012). Hence, the importance of efficient solid waste management becomes incredibly relevant. Internationally, solid waste is the term used to describe non-liquid waste material gotten from domestic, commercial, hospital, industrial, agricultural and mining activities (Usharani & Karthikeyan, 2017). It comprises the mixture of countless different materials; dust, food waste, paper, metals, plastics, glass, discarded clothing, garden waste and host of others (Modak & Nangare, 2011). It could also be combustible and non-combustible waste (Roos & Quarles, 1990). Disposal of solid waste should be properly managed to prevent unhealthy environment for human and animal life, even though, every day management of municipal solid waste is a complex and a costly task (Mmereki *et al.*, 2016).

For the quest to keep the environment clean, safe and healthy for survival, it becomes indispensable to keep the solid waste load within the barest minimum, thus, recycling solid waste becomes a viable option (Bovea & Powell, 2006). One of such onsite method, that is simple and cost effective of solid waste management is vermicomposting technology which have gained cognizance globally (Sinha *et al.*, 2010). Vermicomposting is simply the use of earthworms for bioconversion of organic waste into a bio-fertilizer (Lim, Wu, Lim, & Shak, 2015). The earthworms feed on the organic waste and their guts act as a bioreactor thus, the vermicasts are produced (Sim & Wu, 2010). By the time the organic waste is excreted by the earthworms as vermicasts, it will be rich in nitrogen (N), phosphorous (P) and potassium (K) as well as trace elements depending on the feedstock type used (Selladurai *et al.*, 2010), as such in this work, various agricultural waste, like banana, orange, pineapple, watermelon peel and paper are used. The vermicomposting process is a mesophillic process (Jadia & Fulekar, 2008) and thus, operating conditions such as temperatures, pH, electrical conductivity and moisture content levels must controlled closely with keen observations. Normally, the vermicomposting process takes place in vermi-reactors which include plastic, earthed pots and wood worm bins (Londhe & Bhosale, 2015).

As at 2012, there exist an estimate of 1800 species of earthworms worldwide (Appeltans *et al.*, 2012). But the most commonly used is *Eisenia fetida*, commonly known as the “compost worm”, manure worm, ‘red worm’, and red wiggler (Card *et al.*, 2002), but with this research being conducted in Africa, African worm was used. Worms can digest several times than their own weight each day and large quantities of excreta are passed out through an average population of earthworm(Edwards & Bohlen, 1996). Also, the amount of substrate consumed depends on the substrate properties and environmental conditions (Londhe & Bhosale, 2015).

Vermicompost is the manure produced as the vermicast by earthworms (Sinha *et al.*, 2010). Earthworms are fed up by biological solid waste material(Suthar, 2009).The resulting compost is a fragrance-free, clean organic material with adequate quantities of N, P, K and several micronutrients vital for plant growth. Furthermore, the fertilizer produced does not only reduce the cost but also improves and increases the soil fertility and nutrient, and thus, the plants resistance to insects, pests and diseases (Tilman *et al.*, 2002). Due to the presence of soil required nutrients, it enhances soil arrangement and improves physical properties of the soil like soil-air, soil-temperature, soil water conservation and soil perfunctory impedance. Vermicomposting offers the nutrients and growth enhancing hormones compulsory for plant growth (Singh & Sharma, 2003). The flowers, vegetables, fruits and other plant yield grown-up using vermicompost are accounted to have better maintenance quality (Naik, 2005).

The greater the economic prosperity and higher the percentage of urban population, the larger the amount of solid waste produced which are hazardous to the environment. The aim is simply to study thesolid waste reduction by converting it to useful product (biofertilizer) using *Eudriluseugeniae* (African worms) in order to provide alternative recycling method for various agricultural solid waste (banana peel, orange peel, paper, pineapple peel, watermelon peel and mixture of all the waste) which may provide employment opportunity and significant dwindling of harmful waste released to the environment.

Materials and Methods

The materials used include, containers, crusher, water, solid waste, *Eudriluseugeniae* (African worm), thermometer, pH scale and sieve. Initially, pulverization of the collected degradable waste from the municipality was done. The shredded organic wastes were spread in layers and exposed to sunlight for 5 to 10 days to remove pathogenic microorganisms and noxious gases. The solid waste was then weighed and put into container followed by sprinkling of water on the waste to moisturize it within the range of (50 – 65%) and the temperature readings recorded; finally, the earthworms were introduced into the solid waste for the process in the ratio of 5:1 (g/worm). The important parameters i.e. moisture and temperature were controlled by means of sprinkling water over the bed as such the temperature was maintained at 35°C averagely by placing soil over bed and moisture were maintained between 50 – 60%, and it was then covered to protect earthworm from sunlight. Temperature and moisture content was checked frequently so also so the nitrogen, phosphorus, potassium and C/N ratio was measured.

Results and Discussion

The technical study of adopting vermicomposting was conducted to convert solid waste to biofertilizer. Five reactors were loaded with different waste which comprised of banana peel, orange peel, paper, pineapple peel and watermelon peel while the sixth reactor was loaded with all the combination of the above waste in same proportion with *Eudrilus eugeniae*. The pH of the waste increases from the 1st week at 4.0 to 4th week at 8.0, which goes in line with, earthworms were directly affected by low pH of <4 (Huang *et al.*, 2014). While the moisture content and temperature were duly observed and kept at the range of 50-65% and 25-35ºC, respectively; so as to have compost condition within the mesophilic range, to prevent the worms from dehydration when the temperature is too high or over hydration when the moisture content is too high.

Table 1: Properties of composted solid waste

S/N	Parameters	Banana peel (A)				Orange peel (B)				Paper (C)			
1	Weeks	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
2	pH	5.4	6.0	6.5	6.9	3.9	4.3	4.8	5.5	6.8	7.1	7.3	7.6
3	Temperature (ºC)	27	28	26	29	27	28	27	29	27	27	26	28
4	Moisture content	54.5	54.2	53.6	55.2	53.8	53.7	54.1	53.9	55.6	55.4	55.9	55.2
5	Nitrogen (N) %	3.14				2.7				1.63			
6	Phosphorus (P) %	2.46				1.8				0.57			
7	Potassium (K) %	31.23				5.7				1.25			
8	C/N ratio	22				9				138			

Table 2: Properties of composted solid waste

S/N	Parameters	Pineapple peel (D)				Watermelon peel (E)				Mixed combination (F)			
1	Weeks	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
2	pH	3.8	4.3	4.5	5.1	5.2	5.4	5.7	6.0	6.1	6.3	6.8	7.3
3	Temperature (ºC)	26	26	27	26	27	28	26	26	27	28	26	25
4	Moisture content	56.2	55.9	56.1	55.9	55.6	55.7	55.5	55.6	57.2	58.1	58.2	57.9
5	Nitrogen (N) %	0.31				0.54				17.21			
6	Phosphorus (P) %	4.14				1.26				10.24			
7	Potassium (K) %	0.68				4.69				48.32			
8	C/N ratio	12				23				29			

From the result gotten of all the five different solid waste compost separately that served as control experiments, orange gave highest nitrogen content (2.7% N), pineapple gave highest phosphorus content (6.14% P) and banana peel gave highest potassium content (31.23% K), while for the mixture of all solid waste compost in one bin, gave nitrogen, phosphorus and potassium content of (17.21% N), (10.24% P) and (58.32% K), respectively. The result indicates that the more the time of composting the greater the yield of the NPK content, also it shows that any biodegradable solid waste can be compost and yield a biodegradable fertilizer, less harmful to the soil and more economical (Tables 1 & 2).

Conclusion

The physiochemical parameters of the vermicast from different organic waste were analyzed. From the results obtained, there was increase in pH from 4.0 in the first week to 8.0 in fourth week. The F (the mixed combination) gave the best result of 17.21% N, 10.24% P, 48.32% K and C/N ratio of 29 in comparison with the controls, A, B, C, D and E (Banana peel, Orange peel, Paper, Pineapple peel, Watermelon peel, respectively) with 1.14, 2.7, 1.63, 0.31 and 0.54 %N, 2.46, 1.8, 0.57, 4.14 and 1.26% P, 31.23, 5.7, 1.25, 0.68, 4.69% K and C/N ratios of 22, 9, 138, 12 and 23, respectively. Further comparison with commercial biofertilizer indicates, thus, the biofertilizer produced via this technique can readily stand out as a commercial fertilizer pending on soil requirements and will be a safer substitute for harmful chemical fertilizers.

Conflict of Interest

There is no conflict of interest.

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