Journal of Advances and Scholarly Researches in Allied Education
Vol. XV, Issue No. 2, (Special Issue) April-2018, ISSN 2230-7540

An Overview: Feasibility of Earthworm Species for Organic Waste

P. A. Varal[1], S. B. Doifode[2], A. M. Gawade[3], S. V. Shahane[4], S. D. Unde[5]*, G. R. Gholap[6], Prof. P. B. Londhe[7]

[1,2,3,4,5,6] UG Student, JSPM's Imperial College of Engineering and Research, Wagholi, Pune

[7] Assistant Professor of Civil Department, JSPM's Imperial College of Engineering and Research, Wagholi, Pune

Abstract – Inadequate organic waste management can contribute to the spread of diseases and have negative impacts on the environment. Vermicomposting organic waste could have dual beneficial effects by generating an economically viable animal feed protein in the form of worm biomass, while alleviating the negative effects of poor organic waste management. In this study, a low-maintenance vermicomposting system was evaluated as manure and food waste management system for small-holder farmers. A vermicomposting system using the earthworm species Eudrilus eugeniae and treating cow manure and food waste was set up in Kampala, Uganda, and monitored for 172 days. The material degradation and protein production rates were evaluated after 63 days and at the end of the experiment. The material reduction was 45.9% and the waste-to-biomass conversion rate was 3.5% in the vermicomposting process on a total solids basis. A possible increase in the conversion rate could be achieved by increasing the frequency of worm harvesting. Vermicomposting was found to be a viable manure management method in small-scale urban animal agriculture; the return of investment was calculated to be 280% for treating the manure of a 450 kg cow. The vermicompost was not sanitised, although hygiene quality could be improved by introducing a post-stabilisation step in which no fresh material is added. The value of the animal feed protein generated in the process can act as an incentive to improve current manure management strategies.

Keywords - Conversion rate, Hygiene, Mass balance, Protein production, Vermicompost.

---------------------------------x---------------------------------

1. INTRODUCTION

Like many other fast-growing urban centres in the developing world, Kampala, the capital of Uganda, does not have the infrastructure nor the economic capacity to properly treat and dispose of solid waste (Lohri et al., 2013; Memon, 2010). In Kampala, an estimated 1500 tonnes of solid waste is generated every day, of which only 40% is collected and taken to landfill (OAG, 2010). The majority (92%) of the solid waste taken to landfill is organic material (Komakech et al., 2014b). At the landfill, this organic material decomposes anaerobically and produces the potent greenhouse gas methane (Eleazer et al., 1997). In Kampala there is one official landfill, which operates as an open dump, and many unofficial open dumps. Greenhouse gas emissions from open dumps have been estimated by Manfredi et al. (2009) to be 1000 kg CO2 equivalents tonne1 waste and therefore the organic waste discarded on open dumps has a high global warming factor.

Kampala has around 4000 cows, 3000 goats, 9000 pigs and 250,000 chickens, which together generate a considerable amount of manure (Komakech et al., 2014a). Most of the manure produced (59%) is discarded in one way or another (left untouched, dumped in storm channels), while 32% is spread untreated as fertiliser (Komakech et al., 2014a). Animal manure is a known source of zoonotic pathogens (Pell, 1997) and it is thus a major risk factor for the spread of disease among both animals and humans if left untreated (Albihn and Vinnerås, 2007). Organic waste and animal manure contain valuable plant nutrients and organic compounds that can restore degraded soils and ensure sustainable long-term agricultural activity (Diacono and Montemurro, 2010). Properly treating the organic waste fraction reduces the environmental impact by avoiding greenhouse gas emissions from landfills (Hoornweg and Bhada-Tata, 2012) and decreasing/avoiding the need for chemical fertiliser (Pimentel et al., 2005).

2. LITERATURE STUDY

P.B.Londhe & **S.M.Bhosale** (2015), studied The vermicomposting was done for 45 days in which E. fetida earthworm were used. There were four substrate prepared of different composition. The present study was carried out for recycling of different type of organic waste. Four different phases is to be preparing by using different type of partially decomposable organic waste. Eisenia fetida is introduced in each of these four partially decomposable phases. Moisture content in bed is maintained by spreading water over it and to cover with moist gunny bag. The temperature was monitored at every week. The parameter such as pH, electrical conductivity, C/N Ratio, N, P and K are measure during the specifics interval of time in which result show that the nutrient content at the end of 45 day is increases. Vermicompost is the process which will convert organic waste into valuable fertilizer.

Vo, H. Manha & **C. Ho Wangb** (2013), studied This study was conducted in National Pingtung University of Science and Technology during winter season to determine the effect of vermicompost on productivity of muskmelon seedling (Cucumis melo L.). Vermicompost produced from rice waste, were mixed at rate of different concentration into rice hulls ash and coconut husk. The pH, electrolytic conductivity (EC), water holding capacity (WHC), concentration of macro-micronutrient in substrates, vegetative growth, plant biomass, concentration of total macro-micronutrient in shoot were recorded. The result showed that using substrate that mixture of vermicompost with rice hulls ash and coconut husk following rate 1:1:1 respectively gave highest value of germination rate, plant height, leaf area, plant biomass and the concentration of P, K, Ca and Fe. Factors contributed to the in increasing of muskmelon seedling growth may be result of an improvement of physical and chemical properties of the substrate when combination between vermicompost, rice hull ash and coconut husk.

3. MATERIAL & METHOD

1. Pre-composting: The shredded organic wastes are spared in layer and expose to sunlight for 5 to 10 days to remove pathogenic microorganisms and noxious gases. The pre composting process takes 5 to 10 days for their completion except cotton waste which require 20 to 25 days for their decomposition.

2. Collection of material: The material required for vermicomposting such as vegetable waste, fruit waste are collected from house. Also paper wastes are collected from department of technology. While remaining material such as soil, cow dung, and coconut shell, agricultural wastes are collected from nearby farm house.

3. Collection of earthworm species: Earthworms are collected from vermicomposting center, located in Zill Parishad Office, Kolhapur.

4. Substrates used for vermicomposting: Followings are the substrates used for vermicomposting process

T1	Soil+Cowdung+kitchen waste (1:1)
T2	Soil+Cowdung+paper waste (1:1)
T3	Soil+Cowdung+Garden waste (1:1)
T4	Soil+Cowdung+Kitchen waste+paper waste+garden waste (1:1)

5. Experimental-design or Vermicomposting: The Vermicomposting was done in Plastic Boxes (42 x 24 x 18 cm) under shed condition. In to 4 set of experiment were conducted for Vermicomposting. In each set of experiment four different type of waste is used. In this experiment, four pots T1 to T4 were arranged. The important parameter i.e. moisture and temperature were controlled by means of spraying water over the bed thereby, the temperature maintain not to exceeding 35°C by placing wet gunny bags over bed and moisture were maintained between 50-60% at least 20 adult Eisenia Fetida was introduced in each tray. And the pre compost was finally covered with mat to protect earthworm from bird. The appearance of black granular powder on top of vermin beds indicates harvest stage of compost. Watering was stopped for at least 5 days at this stage and vermicompost was collected from the top without disturbing the lower layer. Liner is provided at the bottom of the boxes and finally fills up the material in it.

6. Preparation of Boxes: Vermicomposting can be made in concrete tanks, wooden boxes, and plastic boxes or in mud pots. Depending on the availability of the raw material and land it may vary. We are choosing the plastic boxes for our project work.

4. RESULT

LAYER	INGREDIENTS
7th	Soil (2cm)
6th	Cow dung (2cm)
5th	Earthworm species (1cm)
4th	Kitchen waste, Garden waste, paper waste. (3cm)
3rd	Soil (3cm)
2nd	Coconut Shell (3cm)
1st	Liner (1cm)

1. pH: The pH of solid waste constitutions was checked after 20 days and 45 days. For, the initial 20 days the pH decreased. The lowering of pH due to productions CO2 which was an acidic gas and when it came in contact with water it might had formed carbonic acid, due to which pH had decreased. But after some days the pH was B2 and B3 increased gradually during vermicomposting because the progressive utilization of organic acids and decomposition of organic waste. Near neutral pH of vermicompost may be attributed by the secretion of NH4+ ions that reduce the pool of H+ ions. Neutral pH helpful for effective decomposition and Due to mixing of inoculants increases their pH value. The initial pH value of all pit is 7.30. While after 20 days, value of B1, B2, B3 and B4, is 7.14, 6.67, 6.24, and 6.78 respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 6.97, 6.89, 6.51, and 6.60. The variation of pH is as shown below in table No.10. The variation in pH with respect time days.

2. Electrical conductivity: The electrical conductivity of all the bed was considerably decreasing during the vermicomposting process. The reduction of EC in all beds shows the reduction of salinity (mineral salt) considerably. The lower level of salinity is the essential character of good biocompost which is better for crop growth. The low value Electrical conductivity shows the greater the decomposition rate. A decrease in the electrical conductivity values in vermicompost may be due to the presence of exchangeable Ca, Mg, and K. The initial EC value of all pits is 3.75. While after 20 days, value of B1, B2, B3 and B4, is 3.64, 3.12, 3.49 and 3.62, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 3.51, 2.97, 3.24, and 3.47. The variation of EC is as shown below in table No.11. The variation in EC with respect time days.

3. Organic Carbon: In general, Organic Carbon loss has been observed during the vermicomposting process. Earthworm modifies substrate conditions, which consequently affects carbon losses from the substrates through microbial respiration in the form of CO2 and even through mineralization of organic matter. A large fraction of organic matter in the initial substrates was lost as CO2 by the end of the vermicomposting period. The initial OC value of all pits is 21.4. While after 20 days, value of B1, B2, B3 and B4, is 19.7, 18.8, 15.1, and 17.2, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 18.2, 16.6, 10.4, and 16.3. The variation of OC is as shown below in table No.12. The variation in OC with respect time days.

4. Total Nitrogen: The Total Nitrogen present in the vermicompost is depending upon the nitrogen content of waste used. The Total Nitrogen is increasing about 12% to 16% due to the recycling of Nitrogen in the process. The TN in the graph shows increase during every interval. The involvement of nitrogen also depends on number of earthworm and types of earthworm used in compost. The inoculation of worms in waste material considerably enhances the amount of N due to earthworm mediated nitrogen mineralization of wastes. It also suggested that the earthworm enhances the nitrogen levels of the substrate by adding its excretory products, mucus, body fluid, enzymes and even through the decaying tissues of dead worms in vermicomposting sub-system. The initial TN value of all pits is 0.91. While after 20 days, value of B1, B2, B3 and B4, is 0.98, 1.02, 1.03, and 0.95, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 1.12, 1.14, 1.09, and 0.99. The variation of TN is as shown below in table No.13.

5. Total Phosphorous: The TP in the graph shows increase during every interval. The passage of organic residue through the gut

of earthworm, results in phosphorous converted to forms, which are available to plants. The release of phosphorous in available form is performed partly by earthworm gut phosphates, and further release of P might be attributed to the P-solubilizing microorganisms present in worm casts. The earthworm responsible for increase in phosphorous in soils. The increase in Total Phosphorus content reveals that the vermicomposting process is in order. The initial TP value of all pits is 0.22. While after 20 days, value of B1, B2, B3 and B4, is 0.23, 0.24, 0.29, and 0.23, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 0.25, 0.26, 0.33, and 0.24. The variation of TP is as shown below in table No.14.

6. Total Potassium: The concentration of Total Potassium in the vermicomposting manure is as shown in graph. The amount of potassium is increases gradually which is also depend on the amount of raw organic waste used. The increasing of content of total Potassium shows that the composting is taking place in well order. The initial TK value of all pits is 0.18. While after 20 days, value of B1, B2, B3 and B4, 0.24, 0.34, 0.29, and 0.30, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 0.31, 0.47, 0.43 and 0.45. The variation of TK is as shown below in table No.15.

7. C:N Ratio: The C/N ratio gradually deceases. The carbon content present in the organics was utilized as source of energy for earthworms. And simultaneously, the Nitrogen is being recycled in the compost. During this process, the casting of earthworms in turn enriches the macronutrients such as N, P, and K and hence bio compost will become as an organic fertilizer. The C/N ration is about 15 to 20:1 for good compost. But the C/N ratio is depends upon the quality of raw organic waste used. The initial C:N value of all pits is 23.51. While after 20 days, value of B1, B2, B3 and B4, 20.10, 18.43, 14.66, and 18.10, respectively. Whereas, value of B1, B2, B3 and B4, after 45 days is 16.25, 14.56, 9.54, and 16.46.

4. DISCUSSION

4.1. Material Conversion

According to Edwards (1985), a waste-to-biomass conversion rate of 10% is possible. Mitchell (1997) achieved 4.9% biomass conversion when converting cattle manure to biomass using E. feotida. In the present low maintenance, unoptimised vermicomposting system, a waste-to-biomass conversion rate of 3.5% was achieved. Many factors have been found to influence the conversion rate. Yadav et al. (2011) found that the initial worm stocking density dictates which of the two products is optimised (i.e production of vermicompost or biomass). In that study, a high stocking density (3 kg m3) yielded a higher waste processing rate (increased vermicompost production), while a lower density (0.5 kg m3) optimised biomass production. Ndegwa et al. (2000) found that a higher feeding rate (1.25 kg.feed kg.worm1 day1) generated greater biomass production and also increased waste to biomass conversion. However, although the conversion rate was high, the material processing was not as high and a substantial part of the material was found unprocessed at the end of the experiment. For a better vermicomposting process, a lower feeding rate (0.75 kg.feed kg.worm1 day1) was necessary.

The degradation of material was high and the vermicomposted material was visually observed to be porous and homogeneous. It was further noted that it did not smell. The percentage concentration of nutrients decreased as they were incorporated into worm biomass. The concentration of P was rather low, probably because the cows were fed banana leafs, which are low in P (Mohapatra et al., 2010; Katongole et al., 2008).

CONCLUSION

A simple field vermicompost treatment unit was found to operate well even with low maintenance. The un-optimised system proved highly efficient in transforming cattle manure and food waste into odourless, porous and homogenised vermicompost, demonstrating a 45.9% material reduction on a TS basis. The waste-to-biomass conversion rate was estimated to be 3.5% on a TS basis, which is comparable to that found in other, more regulated systems. Increasing the maintenance level slightly, with more frequent worm harvesting, could increase the conversion rate further. The hygiene quality of the vermicompost was low but could be improved by introducing a post-stabilisation step in which no fresh waste is added. Alternatively, ammonia treatment using urea could be introduced as a rapid, low-cost post-sanitisation step. Vermicomposting has the potential to act as an economic incentive to improve manure management – with an ROI of close to and over 200%, depending on the amount of manure – in urban centres with a high prevalence of animals.

ACKNOWLEDGEMENTS

This research was carried out within the Waste to worth research program funded by the Swedish Research Council (Vetenskapsrådet) as part of their program supporting Swedish research relevant to low- and middle-income countries (U-forsk). We thank Dr. Charles Niwagaba and Dr. Robinah

Kulabako for use of laboratory facilities and Charles Azizi and Ronald Nsobya at MUARIK for maintenance of the system.

REFERENCES

Contreras-Ramos, S.M., Escamilla-Silva, E.M., Dendooven, L. (2005). Vermicomposting of biosolids with cow manure and oat straw. Biol. Fert. Soils 41, pp. 190–198.

Dedeke, G.A., Owa, S.O., Olurin, K.B. (2010). Amino acid profile of four earthworms species from Nigeria. Agric. Biol. J. N. Am. 1 (2), pp. 97–102.

Diacono, M., Montemurro, F. (2010). Long-term effects of organic amendments on soil fertility. A review. Agron. Sustain. Dev. 30 (2), pp. 401–422.

Dominguez, J., Edwards, C.A. (2010). Biology and Ecology of Earthworm Species Used for Vermicomposting. CRC Press Taylor & Francis Group, Boca Raton, USA, pp. 28–38.

Dominguez, J., Edwards, C.A., Dominguez, J. (2001). The biology and population dynamics of Eudrilus eugeniae (Kinberg) (Oligochaeta) in cattle waste solids. Pedobiologia 45 (4), pp. 341–353.

Eastman, B.R., Kane, P.N., Edwards, C.A., Trytek, L., Gunadi, B., Stermer, A.L., Mobley, J.R. (2001). The effectiveness of vermiculture in human pathogen reduction for USEPA biosolids stabilization. Compost Sci. Util. 9 (1), pp. 38–49

P.B. Londhe & S.M. Bhosale (2015). “RECYCLING OF SOLID WASTES INTO ORGANIC FERTILIZERS USING LOW COST TREATMENT: VERMICOMPOSTING” ISSN: 2394-3696 VOLUME 2, ISSUE 6, JUNE-2015

Corresponding Author

S. D. Unde*

UG Student, JSPM’s Imperial College of Engineering and Research, Wagholi, Pune

E-Mail – shubhamunde3010@gmail.com