Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2012, 4(5):2585-2589

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Vermicomposting of water hyacinth with poultry litter using rotary drum reactor

Jagadish H Patil*, Prajwal H Sanil, Malini B M, Manoj V, Deepika D, Chaitra D

Department of Chemical Engineering, R. V. College of Engineering, Bangalore-560 059

ABSTRACT

The trend of using inorganic fertilizers is on a boom amongst agricultural society, farmers are magnetized towards the short term advantages privileged by inorganic fertilizers, but they are unable to understand the ill effects these fertilizers on human health and soil fertility. This has necessitated looking for traditional fertilizers like vermicompost. Water hyacinth (Eichornia crassipes) is one of the world's most destructive and noxious weed that has prolific growth rate. Many efforts were made to eradicate this weed but it has successfully resisted all the attempts. When looked from a resource angle, it has high organic content which makes it a potential source for vermicompost production. Hence possibility of converting water hyacinth to vermicompost with poultry litter as supplement was carried out in a rotary drum reactor. The reactor was fed 70% ground water hyacinth paste (3.5 kg), 10% aged poultry litter (0.5 kg) and 20% shredded cardboard (1 kg) along with 0.25 kg of Eisenia fetida earthworms. The reactor was rotated gently to facilitate better aeration and porosity. Moisture content, pH, carbon content, nitrogen, phosphorus and potassium were analyzed for every 15 days. After 45 days the product had 30% moisture, 9.67% Carbon with pH 7.26 while N, P, and K values were 0.72%, 0.51% and 0.60% respectively.

Keywords: Vermicompost, Water hyacinth, Eisenia fetida, Poultry litter, Vermireactor.

INTRODUCTION

Agriculture plays a major role in Indian economy; most of Indian population reside in rural areas and are directly or indirectly dependent on agriculture. India is one of the largest producers of wheat and rice. But the yield and quality of these agricultural products per hectare are very less when compared to western nations. This is mainly because of dependency on monsoon, and usage of inorganic fertilizers over the years which has gradually resulted in depletion of soil nutrients, deterioration of the soil structure, and contamination of soil with harmful chemicals, India is termed as a developing nation, along with rapid industrialization and modernization, advantages of traditional fertilizers like vermicompost have to be brought into focus, and implementation must be initiated.

Water hyacinth (Eichhornia crassipes) is a noxious weed. It is regarded as the world's worst water weed and is among the 100 most troublesome invasive alien species in the world [1]. The weed clogs up rivers, waterways and entire lakes and obstructs electricity generation, irrigation, navigation, and fishing. It facilitates proliferation of diseases like bilharzia, kills aquatic life endangering the livelihoods of millions of poor people in the tropics, and is now considered a serious threat to biodiversity. Much work has been carried out in different parts of the world to develop environmentally sound and appropriate methods for the management and control of this weed. It recapitulated that the only means of utilization of water hyacinth which has proved economically viable across the

world. In this background the utilization of water hyacinth as substituting bean straw with water hyacinth as animal feed, feed for solid-phase fermentation, raw material for making pulp, paper and paper board and the vermicomposting of water hyacinth [2] [3] [4].The weed is a good absorber of nitrogen, phosphorus and potassium from water and can be used as a good source for vermicomposting.

Poultry litter has higher protein content and in terms of phosphoric acid than any other animal manure. The aged poultry litter was used for the process of vermicomposting in order to prevent interference of inorganic salt, heating potential during the course of vermicompost and in pertaining scope for survival of the worms.

Vermicomposting, is the process by which earthworms are used to convert organic wastes into a useful product termed as vermicast, It is all-together a natural system in which the earthworms play major roles in degrading the organic portion of the waste. The use of earthworm in sludge management is called as vermicomposting or vermistablization [5]. In the process the nutrients contained in the organic matter are partly converted to more bio-available forms.

EXPERIMENTAL SECTION

2.1 Sample Collection

Perforated discs, Mesh, Angles and Iron rod required to fabricate Vermireactor were collected from Scrap materials storage unit of Chemical Engineering Department, R.V.C.E (Bangalore, Karnataka, India) .Water hyacinth used for the study was obtained from silver lake at HBR layout (Bangalore, Karnataka, India). Aged poultry litter was collected from J M J Poultry Farm (Bangalore, Karnataka). Horse Dung was collected from Race Course, Majestic (Bangalore, Karnataka). Corrugated cardboard was collected from waste recycling unit at Kengeri (Bangalore, Karnataka). Epigic species (Esinea Fetida) earth worms were collected from Department of Horticulture, GKVK, Hebbal (Bangalore, Karnataka, India).

2.2 Analytical Methods:

Moisture content of substrates was determined using Total Solid analysis method [6]. Partial decomposition of water hyacinth by underground burying method. Organic carbon was determined by the Walkley-Black method (1934). Total nitrogen (TKN) was determined using Kjeldhal method [7]. Phosphorus was analyzed by spectrophotometer while potassium was determined by Flame photometer [8, 9]. Light Retraction method and Sifting method was used to harvesting the product.

2.3 Vermireactor:

Vermireactor consists of 0.850 m^3 cylindrical vessel with length 0.8m and diameter 0.3m which is housed inside a cuboid of length 1.2m, breadth 0.6m and width 0.6m. Vessel has provision for gentle rotation which facilitates proper porosity and aeration. Vermireactor has an opening and closing arrangement to supply the feed material, bedding material and sample out the product periodically. A picture of a Vermireactor is shown in fig. 1.

Fig 1: Setup of Vermireactor

2.4 Preparation of Feeding Materials

Water Hyacinth (leaves, stem and roots) were chopped into smaller pieces and then stuffed into earthen pots of 20 liter capacity; the pots were then buried underground ensuring anaerobic conditions. After 20 days, partially decomposed water hyacinth was then ground to fine paste. 70% ground water hyacinth paste (3.5 kg), 10% aged poultry litter (0.5 kg) and 20% shredded cardboard (1 kg) were mixed homogeneously to prepare 5 kg of feed material.

2.5 Vermicomposting Process:

5 kg of feed material prepared earlier was placed inside the cylindrical reactor. 1.315 L of water was sprinkled to the feed material to maintain 80% moisture content. 0.25kg earthworm of species Eisenia fetida was inoculated into the feed material. The cylindrical reactor was rotated gently and periodically, to prevent agglomeration of feed materials and to facilitate better porosity and aeration. The samples were drawn from reactor for every 15 days and key parameters (Moisture content, pH, carbon content, nitrogen, phosphorus and potassium) were analyzed.

2.6 Harvesting Procedure

After the retention period of 45 days the contents of the reactor were emptied onto a sheet of plastic and then piled into molds. On exposure to sunlight the worms quickly moved away from the light source, burying down to the bottom of the pile. After 10 to 15 minutes, the top of the pile was scraped off. This procedure was repeated till the worms huddle together at the bottom of the pile, with very little castings. It was then sifted through a coarse screen [10]. Castings fell through the mesh, while the worms stay behind. The sifting was done quickly and with a gentle shaking, before the worms get a chance to wriggle down through the wire.

RESULTS AND DISCUSSION

3.1 Qualitative Analysis

The variation of moisture, pH, organic carbon, nitrogen, phosphorous and potassium in feed material was analysed for every 15 days and their trends are shown in figures 2, 3, 4, 5, 6 and 7 respectively.

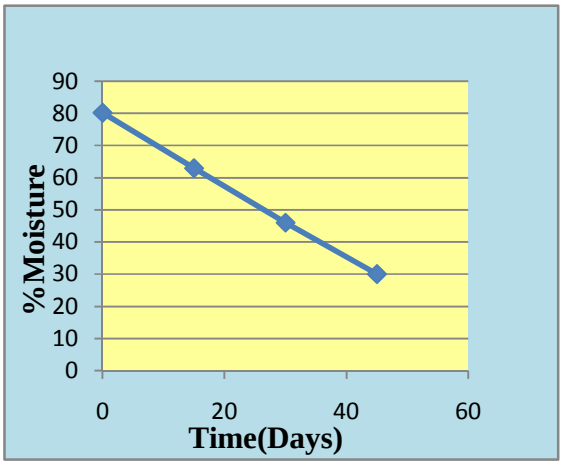

Fig. 2: Variation of moisture content with time

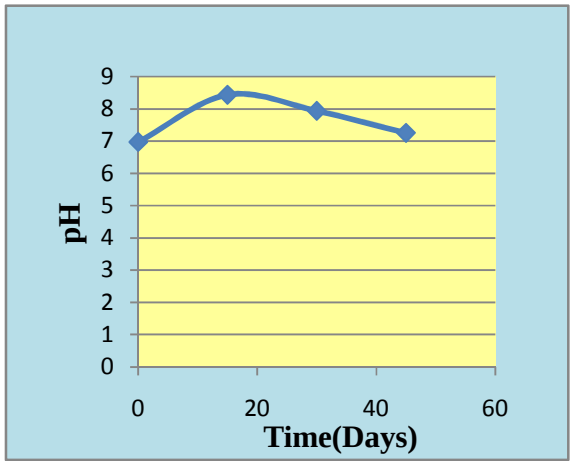

Fig. 3: Variation of pH with time

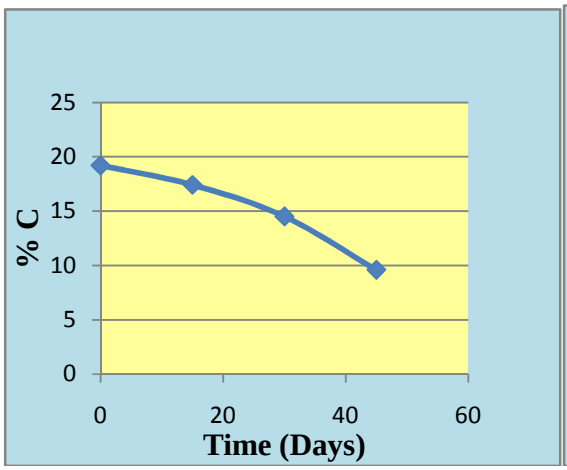

Fig. 4: Variation of Carbon with time

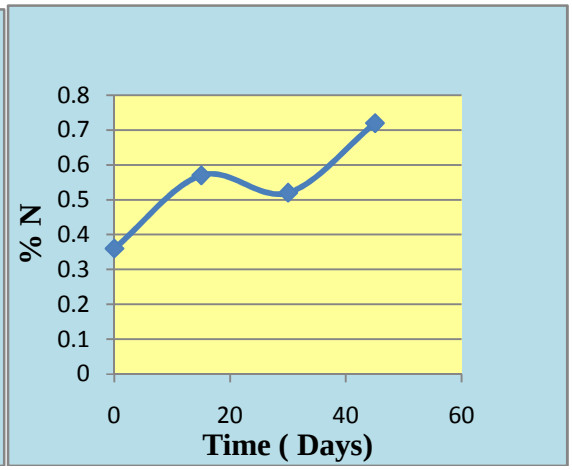

Fig. 5: Variation of Nitrogen with time

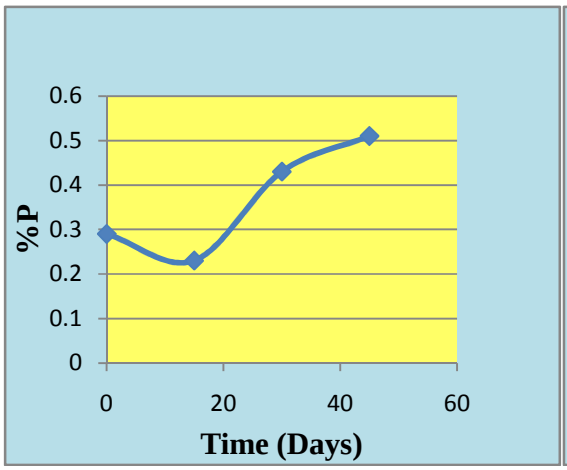

Fig. 6: Variation of Phosphorous with time

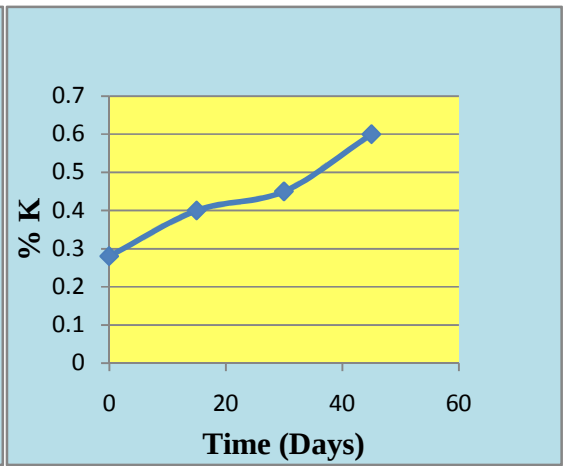

Fig. 7: Variation of Potassium with time

1. Fig. 2 shows the variation of moisture content with time. Moisture content decreased constantly during the course of vermicomposting which could be due to the evaporation of water and consumption by earthworms.

2. The increase in the pH level is shown in Fig. 3, and was due to the reduction of the volatile acids and its further combination with the ammonia gas released from the denaturing of protein [11].

3. Earthworms accelerated the decomposition of the organic matter by consuming carbonaceous material and hence there was a gradual decrease in carbon content which is shown in Fig. 4. Low carbon level is indication of enhanced decomposition [12].

4. The increase in nitrogen content with respect to time is shown in Fig.5. Initially nitrogen content increased gradually due to the breakdown of the protein and by nitrogen fixation under favorable aerobic condition. decrease in the trend during the course of retention period was observed due to leaching into the bedding material ,further the rise in the trend was contributed by earthworms through excretion of ammonia along with reduction of organic wastes to nitrogen components.

5. The curve plotted with % phosphorous against time is shown in Fig. 6. Initial decrease in phosphorous was due to consumption of feed by the earthworms. The rise in phosphate level is probably due to mobilization and mineralization. Mobilization of phosphorus is due to bacterial and fecal activity of earthworms.

6. Organic fertilizers contain the second largest amount of potassium, but these are released at a slow rate [14]. Initially, there was a decrease in potassium content due to consumption of feed which was relatively rich by earthworms. Later, the increase was due to the liberation of potassium, in the form of micronutrient that is boosted by the presence of earthworm activity on organic matter. Fig. 6 represents the variation of %K with time.

3.2 Quantitative Analysis

Vermicompost obtained was harvested using Light retraction and Sifting methods. The quantitative analysis of harvested vermicompost was carried out and the results obtained were as follows:

1. For given feed of 5kg, amount of vermicompost produced was 2.683kg with productivity of 53.06%.
2. Initially 0.25kg of earthworms was inoculated into the reactor and by the end of retention period the weight increased to 0.535kg.

CONCLUSION

1. Pre-digestion of water hyacinth has resulted in exemption of thermophilic stage during vermicomposting process, providing suitable environment for earthworms to persist.
2. The time consumed by rotary drum reactor to produce vermicompost is 45 days, which is almost half the time consumed by conventional methods (wedge method, bed and bin method).
3. The key parameters such as pH, Moisture, Carbon, Nitrogen, Phosphorous and Potassium met the quality standards.
4. The result obtained shows that Water Hyacinth is a good potential biomass for vermicompost production.
5. Vermiculture and vermicomposting technology is easy to practice, ecologically safe and economically sound.

Acknowledgements

We wish to thank Dr MA Lourdu Antony Raj for critically reading the manuscript and making several pertinent remarks.

REFERENCES

[1] Aoyama; Nishizaki I H. *Water Sci. and Technol*, **1991**, 28, 47-51.
[2] Holm L G; D L Plucknett; J V Pancho. *University Press of Hawaii, Honolulu, Hawaii*, **1977**, 609.
[3] Julien M H; W Orapa. *PNG Journal of Agriculture, Forestry and Fisheries* **2001**, 44(1 & 2), 49-60.
[4] Bhiday M H. Wealth from Waste. 'Vermiculturing' Tata Energy Research Institute New Delhi, India. **1995**, ISBN 81-85419-11-6.
[5] Edward C A. *SPB Academic Publishing, Netherlands*. **1998**, ISBN 90-5103-017-7.
[6] APHA, AWWA and WPCF, Standard methods for the examination of water and waste water, Washington D.C, **1995**, 19.
[7] Bremner J M; Mulvaney R G; Miller A. L; Keeney R H. *American Society of Agronomy*, **1982**, 575-624.
[8] Olsen S R; Cole CV; Watanabe F.S; Dean L.A. Estimation of available phosphorus in soils by extraction with sodium bicarbonate, Circ. US Department of Agriculjture **1954**, 939.
[9] Simard R R. *Lewis Publisher*, **1993**, 39-43.
[10] Martin J P. *Bookworm Publishing*, **1976**.
[11] Ismail S A. Vermicolgy 'Biology of earthworms' Orient Longman Limited, Chennai, India. **1997**, ISBN 81-250-10106.
[12] George. Feasibility of Developing the Organic and Transitional Farm Market for Processing Municipal and Farm Organic Wastes Using Large-Scale Vermicomposting, Good Earth Organic Resources Group, Halifax, Nova Scotia, **2004**.
[13] Govindan V S. *Ecotechnology for pollution control and Environmental Management*, **1998**, 48- 57.
[14] El-Serafy A M; Soliman H S; Khattab H M; El-Ashry; Swidan F Z. *J. Anim. Sci*, **1981**, 51, 698-706.