Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2015, 7(3):846-851

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Stabilization of sludge from AAVIN dairy processing plant (Chennai) using Vermicomposting

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ABSTRACT

Land pollution has become a serious problem in the present scenario and resolving this issue is yet another challenging task. Solid wastes contribute to serious threats on environmental hazards and it has become the need of the hour to develop sustainable methods in handling them by enhancing cleaner technologies in recycling and thereby creating safe environment adding organic fertility to soil. Dairy industry is an important sector in both the developed and developing nations and the pollutants from these consists of organic compounds with enormous amounts of suspended solids, biochemical oxygen demand and chemical oxygen demand along with nitrate compounds. The wastewater from dairy industries when dumped or land filled has various disadvantages of being expensive occupying more open space resulting in polluting the ground water and soil resources. In the present work, the dairy sludge from AAVIN industry, Chennai was stabilized by the technique of vermiconversion. Initially dairy sludge and cow dung of varying proportions of 1:2 and 2:2 were mixed and earthworms of two different species called Eisenia foetida and Eudrilus Eugenia were added to the contents for about 55 days to create vermicomposting. The vermicomposted sludge exhibited very good results in comparison to normal sludge and were added to the radish plants where they yielded good growth results.

Keywords: Dairy sludge, Vermicomposting, Nutrient fixation, Earthworms.

INTRODUCTION

The treatment of solid wastes and converting them into useful manure is essential and in general several methods are employed in case of dairy sludge treatment like anaerobic digestion, composting, land spreading, constructed wetlands and lime stabilization. Several legislations have been issued in order to ensure safe disposal of solid waste. The waste management act of 1966, Nitrate directive, urban wastewater directive and water framework directive were few among the solid waste disposal legislations. Vermicomposting has proved to be the efficient method of treating the wastes and it ensures the availability of minerals and nutrients.

Earthworm species called Eisenia Andrei was vermicomposted in a mixture of paper mill sludge and dairy sludge along with cattle manure which was carried on a small scale. The process was done for a period of about six months and vermicomposts produced had rich nitrogen and phosphorous contents where the amount of metals found were also low. The stability and maturity was very good and can be effectively used as a soil fertilizer [1].The effects of earthworm on composting with various solid wastes were studied where four different waste materials were selected. They were pine sawdust along with poultry litter, combination of cotton industry waste and poultry litter, shredded paper with horse manure and mixture of cotton industry waste with horse manure. The composting was

carried out for 85, 64, 60 and 60 days. Then species of Eisenia Andrei were added in order to promote vermicomposting.The vermicomposting with earthworms yielded best results with horse manure[2]. Eisenia foetida earthworm species were employed for the conversion of wastes like kitchen waffle, agro wastes ,industrial wastes and textile sludge into vermicompost, yielding increase in percentage of nitrogen, phosphorous and potassium. Eisenia foetida on vermicomposting was highly efficient for industrial wastes [3].The vermicomposting of household wastes comprising of vermicomposting and windrow composting was carried out and this was compared with the effect of thermophilic precomposting and vermicomposting. The thermophilic precomposting and vermicomposting yield better results in conversion process[4].The vermicomposting of newspaper material and sawdust was done by biological parameter where the measurement of pH rate, worms and biomass were calculated. The variation of two types of bedding was studied. The results proved the increased worm biomass production and growth rate in newspaper with better cocoon production and worm numbers in saw dust [5].The sludge from milk plant, sugarcane trash and wheat straw were vermicomposted with Eisenia foetida and nine experimental vermin beds were established for about 90 days. Decrease in pH, organic carbon and C: N ratio were observed along with increase in total nitrogen, potassium and phosphorous. The end product showed richness and suitability as soil fertilizer [6].The ability of vermicomposting on removal of heavy metals was studied on a sewage sludge where reduction of metals like copper, nickel, lead, zinc and cadmium were observed and also reduction of water content, pH value, organic matter, total phosphorous and potassium content was noticed [7].Improvement of vermicompost quality was carried in a 15 liter reactor vessel meant for precomposting. The vermicomposting was carried on activated sewage sludge and corn stalk waste where the changes were observed for about 70 days which exhibited reduction of TOC, TVS, TKN and C/N ratio [8].

In the present study, both the species of Eisenia foetida and Eudrelius Eugenia were vermicomposted a dairy sludge from AAVIN dairy, Chennai and the proportions of cow dung was mixed with the sludge for a period of more than 54 days and the results were analyzed and compared for sludge and vermicomposted products.

EXPERIMENTAL SECTION

2.1Study of Earthworms

Eisenia foetida and Eudrilus eugenia shown in Figures 1.a and 1.b are the two species of earthworms preferred for the process of Vermicomposting in this work. These species are referred as non borrowing types of earthworms which live at the area between the leaf waste and the soil. These earthworms consume the decomposed organic matter by eating 10% soil and 90% organic wastes where they play a very essential role in improving the fertility of the soil. Eudrilus eugenia which can also be referred to as African crawler is prevalent in both tropical and sub tropical regions involving in the process of soil formation and organic decomposition. Eisenia foetida also called as red worms live in rotting vegetation and compost function in decay of organic matters and they convert the organic matter into dark soil nutrients.

Fig 1.a. Culture of Eisenia foetida

Fig 1.b. Culture of Eisenia Eugenia

3. Experimental Set up

The overall layout of the experimentation can be viewed from Figure 2 and the dairy sludge picture can be referred from Figure 3.Wooden bin of 1m*0.6m is initially filled with dairy sludge up to 5cm.Then cow dung is filled over the sludge for about 3cm and is made to spread in an even manner. Then soil is added to the matter for providing the earthworm survival in the bin and water is sprinkled over the layers in order to provide sufficient moisture in the

matter. Ventilation is done by the addition of shredded leaves over it. Water sprinkling is again done two days in advance of adding the worms. Earthworms are then added to the layers and the bin is closed with the cardboard to ensure absence of light. The bin is also placed in a shady area maintaining a room temperature which is friendly for the survival of worms as seen in the Figure 4. The bin is partitioned into two zones where the first zone contains dairy sludge and cow dung in the ratio of 1:2 and the second zone contains dairy sludge and cow dung at 2:2 ratios.

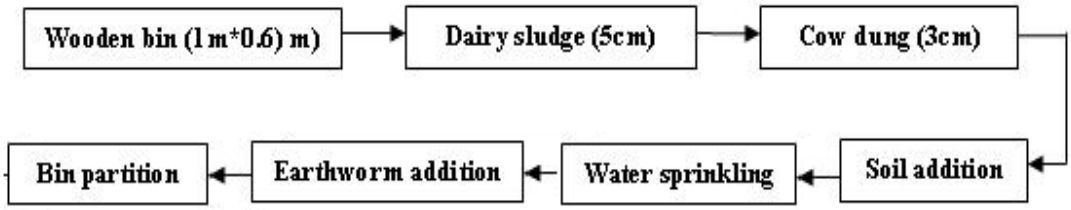

Figure 2. Flowchart of Experimentation

Figure 3. Picture of Dairy sludge

Figure 4. Picture of vermicompost bin

RESULTS AND DISCUSSION

4.1Sludge Analysis

The collected sludge from AAVIN dairy before composting was initially analyzed and parameters like pH, total organic carbon, C: N ratio, Nitrogen, phosphorous and potassium were found out by using standard methods. The pH value determined by the pH meter was found to be 7.1.The total organic compound was determined by Walkley and Black method and was found to be 20.15%.The carbon to nitrogen ratio was calculated to be 4:43.Nitrogen content was found by IS 10158:1982 standard which was 45485 mg/kg. Phosphorous and potassium were noted to be around 20815 mg/kg and 1706 mg/kg by AOAC 990.08:2005 standard and the values can be referred from Table 1.

Table 1.Sludge analysis before vermicompost

Parameters	Method used for analysis	Values before compost
pH	pH meter	7.1
Total Organic Carbon	Walkely and Black,1934	20.15%
C:N ratio	By calculation	4:43
Nitrogen	IS 10158:1982	45485 mg/kg
Phosphorous	AOAC 990.08:2005	20815 mg/kg
Potassium	AOAC 990.08:2005	1706 mg/kg

4.2Analysis after Vermicomposting

The Vermicomposting was carried out for a period of about 8 weeks and the parameters were tested as seen in the Table 2.The potassium content was found to be 3059 mg/kg for 1:2 ratio and 3584 mg/kg for 2:2 ratio which were higher compared to the sludge values. The total organic carbon increased which was about 21.32% for 1:2 ratio and 21.87% for 2:2 ratio. Phosphorous content was found to be 19424 mg/kg and 14788 mg/kg for 1:2 and 2:2 ratios. Higher carbon Nitrogen ratio was observed for the vermicomposted matter enhancing good nitrogen fixation to the

soil for the growth of plants. The chemical parameters before and after vermicomposting can be comparatively studied from Figure 5.

Table 2.Analysis after vermicompost for 1:2 and 2:2 ratios

Parameters	After vermicompost	
	1:2	2:2
POTASSIUM (K)	3059 mg/kg	3584 mg/kg
PHOSPHOROUS(P)	19424 mg/kg	14788 mg/kg
NITROGEN(N)	44332 mg/kg	35484mg/kg
C:N RATIO	4:81	6:18
TOTAL ORGANIC CARBON (TOC)	21.32%	21.87%

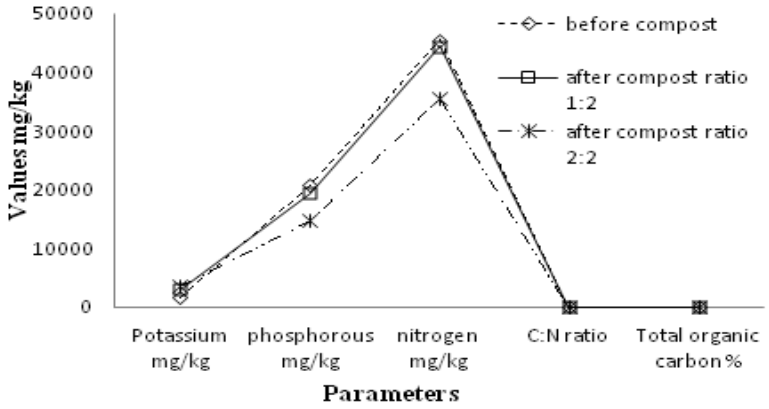

Figure 5.Chemical Parameters before and after vermicomposting

4.3 Tests with Radish plant growth

The vermicomposted dairy sludge shown in Figure 6 was mixed with ammonium phosphate sulphate manure shown in Figure 7 of varying proportions ad different trials were carried out. Initially 10% vermicomposted sludge and 90% ammonium phosphate sulphate manure were mixed and recorded as trial 1.Successive increase in proportions were carried on and finally 60% vermicomposted sludge and 40%ammonium phosphate sulphate were mixed and recorded as trial 6.The details of the trials can be referred from Table 3.

Figure 6. Vermicomposted Dairy Sludge

Figure 7. Ammonium phosphate sulphate manure

Table 3.Trials for radish plant growth

Compounds	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Ammonium Phosphate Sulphate manure	90%	80%	70%	60%	50%	40%
Vermicomposted sludge	10%	20%	30%	40%	50%	60%

Figure 8 shows the comparison of radish growth in normal soil or control and vermicomposted manure mixtures of above shown proportion. Initially in trial 1, the growth of radish plant was only 1cm with control and using manure, it was observed 1cm growth during the end of first week and about 3.5 cm growth in 4 weeks duration. During trial 6 very good result was observed where about 3.5 cm was observed at the end of seven days and at the end of 4th week, about 5.9cm growth of the radish plant was noticed which can be very well referred from Figure 9 and 10.

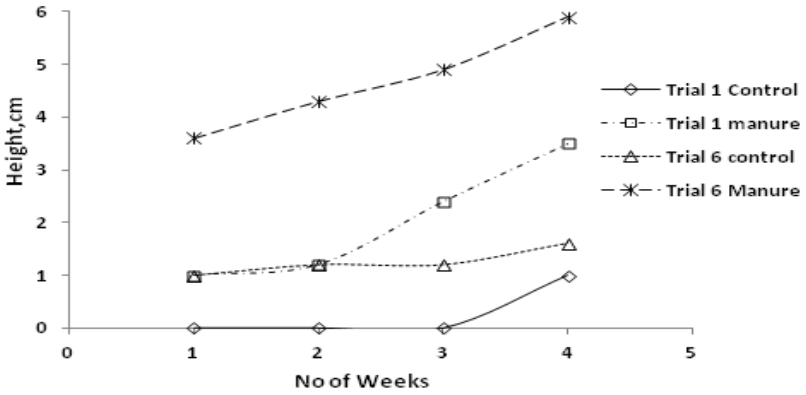

Figure 8. Radish growth trials with manure

Figure 9. Trial 6 Radish growth by control

Figure 10. Trial 6 Radish growth by Manure

CONCLUSION

This work revealed the vermicomposting by earthworms where they digested the dairy sludge from AAVIN plant, Chennai The vermicomposting was carried on by using dairy sludge for about 8 weeks and the parameters measured were found satisfactory yielding appropriate increase in chemical compounds and plant growing nutrients which made them suitable for manuring.The1:2 ratio of the vermicomposting yielded more fruitful results compared to the 2:2 ratio. The plant growth was also tested with the vermicomposted manure on radish plants where various trials with different proportions of manures were carried out. In plant trials vermicomposted sludge showed better growth and yield in radishes than control. About 5.9cm height of the radish plant was noticed with the vermicomposted sludge over a period of 4 weeks where the normal soil yielded only about 1.3 cm growths.

Acknowledgement
The authors feel thankful to the AAVIN dairy and SGS labs, Chennai, for extending their support in providing their samples and testing.

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