EFFECT OF VARIOUS ADDITIVES ON VERMICOMPOSTING OF PAPER WASTE USING EPIGEIC EARTHWORM, *EUDRILUS EUGENIAE* (ANNELIDA: CLITELLATA)

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ABSTRACT: Earthworms perform wonderful job to maintain nutrient balance in the soil by recycling of organic waste. Earthworms have been used in the degradation of various types of wastes from prehistoric times. This study examines the potential of the African night crawler, *Eudrilus eugeniae* in the vermicomposting of waste paper. The effect of some additives on the process of vermicomposting was also observed. A mixture of waste paper and cow dung in the ratio of 1:1 was found to be the best for the growth and survival of *Eudrilus eugeniae*. Trichoderma treated media was the most preferential medium (35%) followed by Vermiwash (28%) and Jaggery + Buttermilk (21%) and control (16%). An increase was noticed in various parameters like percent number, weight, percent population growth and biomass production of earthworms.

KEY WORDS: *Eudrilus eugeniae,* Paper waste, Trichoderma, Vermiwash, Gwalior.

A significant amount of paper waste is produced in day-to-day life, particularly in offices, business concerns, packaging industries and homes. Shredded paper is used for packaging and transport of fruits, vegetables, foods, breakable items etc. For confidential reasons, the paper waste is not sold in the market and usually torn into pieces and burnt. The paper and card board waste from market yard is also not sorted out for recycling. A huge amount of such waste along with other waste are disposed off by dumping, land-filling and burning. The paper and paper based wastes are rich in cellulose (carbon) and poor in nitrogen content. They have much higher C/N ratio. Shredded paper has low bulk density permitting enough aeration, but water soaked stuff becomes too dense and does not allow free aeration. The aerobic bacteria are unable to utilize complex cellulose of paper waste. Thus vermicomposting of paper waste is not an easy task. No sincere attempts have been made to recycle the paper waste so that pollution caused by its disposal be prevented and useful end product can be generated. Earthworms are important Vermiresources having simple, cylindrical, coelomate and segmented body characterized by presence of setae.Many organic by-products of agricultural production and processing industries are currently seen as .waste' and thus become potential environmental hazards. A portion of this waste is currently reused, recycled or reprocessed. However, a majority of it is disposed off in Landfills (anaerobic composting), which is a matter of concern due to many factors including cost and environmental issue. During recent years, applied use of earthworms in the breakdown of a wide range of organic residues, including sewage sludge, animal wastes, crop residues, and industrial refuse to produce vermicompost, has been recommended (Mitchell et al., 1980; Reinecke & Venter, 1987; Edwards & Neuhauser, 1988; Hartenstein & Bisesi, 1988; Van Gestel et al., 1992; Dominguez & Edwards, 1997; Edwards, 1998; Kale, 1998; Garg et al., 2006). Vermicompost is rich in microbial populations and diversity particularly fungi, bacteria and actinomycetes (Edwards, 1998). The importance of the earthworms in waste management, environmental conservation, organic farming and sustainable agriculture has been highlighted by several workers (Edwards & Neuhauser, 1988; Senapati, 1992; Mitchell, 1997; Ismail, 1997; Eijasackers, 1998; Talashikar & Powar, 1998; Tripathi, 2003). It has been observed that although paper sludge is a good source of organic carbon, this sludge cannot be applied directly to fields as it is deficient in other nutrients (Kaur et al., 2010). It is reported that paper sludge can be used as a good bulking agent or good source of carbon in composting (Suriyanayanam et al., 2010). It was reported that paper waste can be managed by earthworms (Sinha et al., 2008).

MATERIALS AND METHODS

The fresh cattle dung was procured from nearby buffalo dairy farm. The moisture content of the medium was maintained at about 50%-60% and the paper waste (A4 size sheets) was procured from office and research laboratories of the Department and they were converted into small pieces using paper shredder machine. Earthworms were procured from vermicomposting center, charak Udhyan, Jiwaji University, Gwalior (India). For the present study, vermi-beds were made using ten days (10 days) old cattle dung for mass culture of *Eudrilus eugeniae*. The culture was constantly monitored throughout the period of study with time by time spraying of water. Mature worms for experimental purpose were taken from this stock culture. During preliminary studies, preference of earthworms towards cultured media was determined. A free choice experiment was conducted in ceramic tanks of 55x40x15 cm measurement (Fig. 1). This tank was divided into four equal size chambers with the help of thermocole sheets provided with some holes so that earthworms can pass through from one chamber to another, according to their preferential habits. In the first chamber, mixture of dung and shredded paper was filled, which was pre-decomposed by using water. Dung and shredded paper was filled in chamber B, which was pre-decomposed by sprinkling with a solution containing of Butter milk and Jaggery (450 ml + 250 gm in 5 litre of water). In the chamber (C), mixture of dung and shredded paper was filled which was pre-decomposed by adding vermiwash and in the chamber (D), mixture of dung and shredded paper was filled, which was pre-decomposed with a solution containing 5 gm of *Trichoderma harzianum* in five litres of water. The quantity of the medium in all the four chambers was kept constant (3 kgs.). 100 adult earthworms were released and the whole assembly was covered by garden mesh net. Free choice experiment was repeated three times and the results were recorded after 15 days by counting the number of earthworms.

Detailed composting experiments were carried out (in triplicates) using different additives as enhancers in plastic containers of 45 x 30 x 10 cm (Fig. 2) dimensions in all the experiments except the first one which was kept control. A mixture of waste paper and dung in the ratio of 1 : 1 treated with different additives i.e. *Trichoderma herzianum,* Vermiwash and Buttermilk + Jaggery used during the pre-decomposition period of 15 days. These additives enhance the process of decomposition of waste.

After 15 days, 25 mature weighed earthworms were taken from the stock culture and were uniformly released in all the containers. The culture containers were covered by mesh garden cloth for a period of 60 days. After 60 days, the contents of the culture containers were emptied on a white plastic sheet. It was then sieved to separate the vermicompost and earthworms. The cocoons and juveniles were also separated for experimental observation. Degree of composting was obtained by weighing the vermicompost. Also percent increase in number, weight, population growth and biomass production were calculated. In order to determine the overall efficiency, pecentile scoring was calculated for all the media. This was obtained by adding all the parameters. The medium giving maximum value was taken equivalent to 100 percent. The percent scores of other substrates was calculated. The percent scores of different media followed the sequence. Finally prepared vermicompost was analyzed for the following parameters: pH, Electrical conductivity, Total Nitrogen, Phosphorous and Potassium.

RESULTS

Results obtained during free choice experiment were depicted in figure 3. The maximum number (35%) of earthworm's prefered the medium that was treated with Trichoderma for their settlement. Vermiwash treated medium was next with 28% preference. Next choice was shown for Jaggery and Buttermilk (21%). Least preference was shown for control (17%). Results obtained in main composting experiment revealed that a significant increase in number and weight of adult worms, number of cocoons and juveniles and a good amount of good quality compost was obtained during the 60 day period experiment time.

Numbar & weight of adult worms: A percent increase was observed in the number & weight of worms (Fig. 4) in media treated with different additives. Maximum increase was in number was noticed in Trichoderma treated media (101%) followed by Vermiwash (84%), Jaggery + Buttermilk (72%) and least increase was shown by control containers (61%), table 1. The trend of biomass (weight) was more or less similar to that of biomass (number). Maximum increase in biomass (weight) was recorded in containers treated with trichoderma (142%). This was followed by Jaggery + Buttermilk treated medium (117%), Vermiwash (108%) whereas minimum increase was shown by Control (90%) (Table 2).

Worm population: Percent population growth was also recorded in all the treated and control media. Maximum increase was shown by containers containing Trichoderma (937%), followed by Vermiwash (813%), and Jaggery + Buttermilk (746%). The minimum population growth was shown by control (680%) (Fig. 5).

Biomass production: Maximum biomass production was recorded in Trichoderma treated medium (182%) followed by Jaggery + Buttermilk (150%) and Vermiwash (140%). The minimum increase in percent biomass production was recorded in control containers (120%) (Fig. 5).

Degree of composting: Maximum degree of composting was observed in Trichoderma treated medium (59%), followed by vermiwash treated medium (50%), and Jaggery+ Buttermilk treated medium (45%). Lowest degree of composting was observed in control (42%) (Fig. 6).

Results obtained for percentile scoring are depicted in figure 7. The trend of percentile scorings was as follows: Trichoderma > vermiwash > Jaggery + Buttermilk > Control.

Physico-chemical analysis: The results of physico-chemical analysis of the vermicompost obtained from differentially treated substrates and control are given in table 3. The pH (7.6) was observed maximum in vermiwash treated media followed by *Trichoderma* (7.5) and Jaggery + Buttermilk (7.5), while least value for pH was recorded in control (7.3). The Elecrical conductivity values obtained for the compost obtained from various treatments were 0.36 in vermiwash, 0.50 in trichoderma, 0.70 in Jaggery+Buttermilk and 0.85 in control. With regard to percent Nitrogen in compost obtained from different treatments, the values were 0.50%, 0.43%, 0.41% and 0.36% in Trichoderma, Vermiwash, Jaggery +Buttermilk and Control. Phosphorous and potassium content in the various treatments was also analyzed. The maximum phosphorous content was observed in Trichoderma (1.41%) followed by Vermiwash (1.30%), Jaggery + Buttermilk (1.28%) and Control (1.18%). The potassium content was also maximum in Trichoderma treated compost (0.34%). Vermiwash treated compost was having (0.30%) potassium content. Minimum potassium content was observed in Control group (0.19%) in which no any additive was added.

DISCUSSION

Results obtained for number, weight & biomass production are more or less similar to the findings of Kale et al. (1986) and Nagavallemma et al. (2004) who reported increase in number & weight of earthworms on the basis of quality and quantity of available food. The results obtained for vermicomposting performanance were more or less similar to Pramanik & Chung (2011); Rasal et al. (1988); Buswell & Chang (1994); Milala et al. (2009) and Parray (2012), who reported that the composting can be enhanced by adding different additives like spirulina, vermiwash, sugarcane and *Trichoderma*. Also the time of predecompostion was reduced by adding different additives. The results were in agreement to the studies of Kumar et al. (2010) who demonstrated that overall time required for composting can be reduced to 20 days by adding different additives.

It can be concluded that vermicomposting is a feasible technology for the conversion of carbon rich waste paper after mixing with cow dung slurry and pre-digestion with different additives into a valuable product i.e. vermicompost.

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Table 1. Showing number of adults, cocoons and juveniles in substrate treated with different additives.

Sr. No.	Treatments	Initial No	Final number of adults	Number of cocoons	Number of juveniles & baby worms
1	*Trichoderma*	25	50.33±1.45	90.00±1.15	119.00±1.52
2	Vermiwash	25	46.00±1.00	80.33±2.02	102.00±2.08
3	J+BM	25	43.00±1.15	76.33±1.76	92.33±1.75
4	Control	25	40.33±0.88	71.66±1.45	83.33±1.20

Table 2. Showing weight of adults, cocoons and juveniles in substrate treated with different additives.

Sr. No.	Treatments	Initial weight of adults	Final weight of adults	Weight of cocoons	Weight of juveniles
1	*Trichoderma*	33.66±0.88	81.66±1.17	1.27±0.02	12.05±0.04
2	Vermiwash	35.66±0.88	74.33±0.87	1.09±0.04	10.27±0.03
3	J+BM	34.33±1.15	65.66±0.88	1.04±0.02	9.32±0.05
4	Control	34.66±0.88	63.00±1.15	0.98±0.01	8.36±0.02

Table 3. Showing the reults of physico-chemical parameters of differentially treated vermicompost.

Sr. No.	Treatment	pH	EC (dS/m)	N (%)	P (%)	K (%)
1	*Trichoderma*	7.5	0.36	0.50	1.41	0.34
2	Vermiwash	7.6	0.50	0.43	1.30	0.30
3	J+BM	7.5	0.70	0.42	1.28	0.29
4	Control	7.3	0.85	0.36	1.18	0.22

Figure 1. Showing container used in free choice experiment.

Figure 2. Showing containers used for composting experiments.

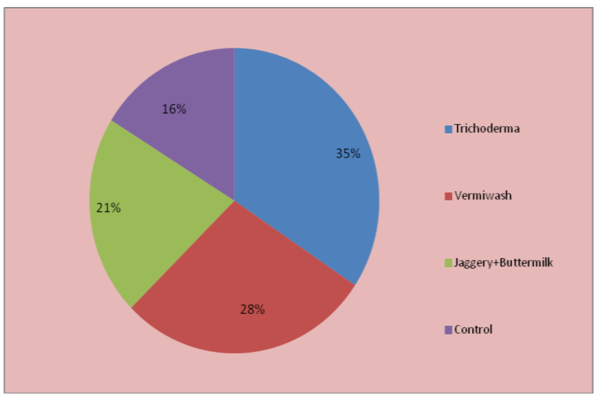

Figure 3. Showing the relative preference of earthworms during free choice experiment.

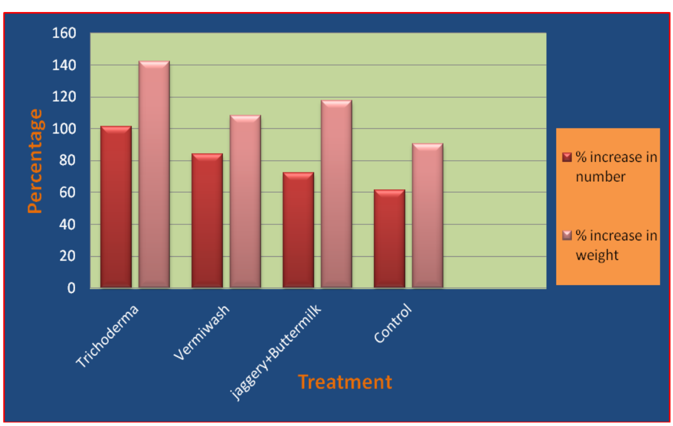

Figure 4. Showing percent increase in adult number and weight in media treated with different additives.

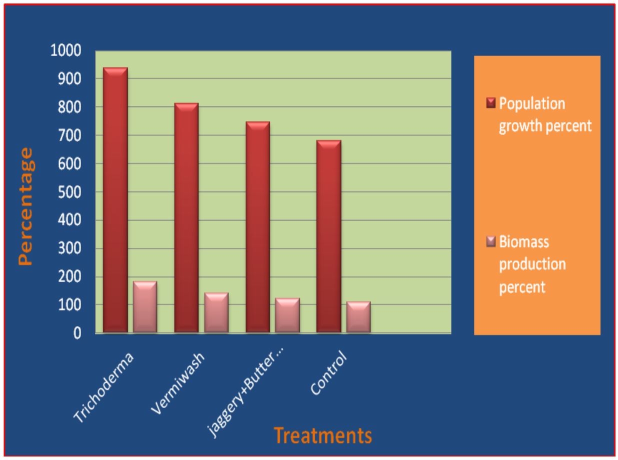

Figure 5. Showing percent increase in population growth and biomass production in media treated with different additives.

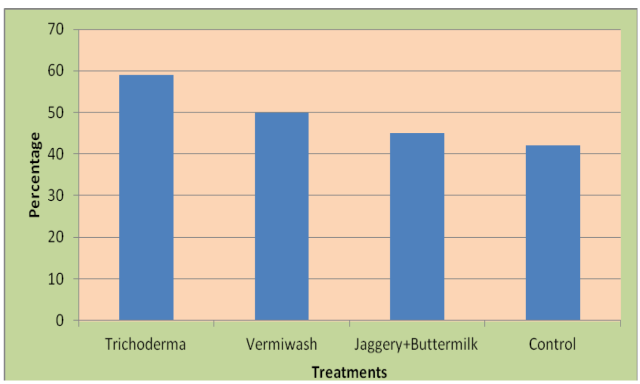

Figure 6. Showing degree of composting in differentially treated media.

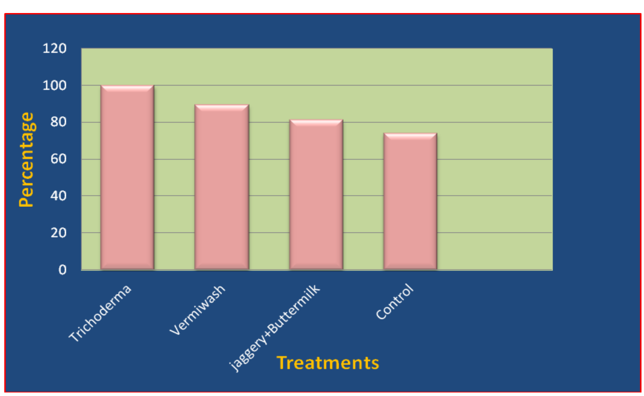

Figure 7. Showing the net percentile score differentially treated media.