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# A study on vermicomposting of some complex organic wastes using earthworm *Eudrilus eugeniae*

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**Abstract**
Vermicomposting appears to be simple, effective and eco-friendly method of organic waste management with lot of promise for organic farming and sustainable development. In most of the vermicomposting units only cattle dung and some agricultural wastes are used and no attention is being paid to include other organic waste stuffs which also pollute the environment and pose human health hazards. In the present study an attempt has been made to explore the possibility of bioconversion of mentha waste (MW) and rise husk waste (RHW) using Nigerian earthworm, *Eudrilus eugeniae*. In present experiment, three substrates were mixed in different combinations so as prepare 19 culture media in plastic containers and 30 adult earthworms were released. Culture was maintained for 45 days followed by observations. All combinations of rise husk waste and dung, dung alone and mixture of rise husk waste + mentha waste + dung (1:1:1) were found to be highly suitable and rise husk waste alone was moderately suitable. All other combination using mentha waste mixed with dung or rise husk waste were either little suitable or unsuitable for vermicomposting by E. eugeniae. It can be concluded that rise husk waste and mentha waste need to be mixed with cattle dung in suitable proportion for their successful recycling through vermicomposting.

**Keywords:** mentha waste, rise husk waste, *Eudrilus eugeniae*, vermicomposting, organic waste

## 1. Introduction
Since very long time, earthworms have been regarded as friendly organisms for agriculture. They are the indicators of soil fertility. Their population is high in rich or fertile soil with plenty of organic material. Their burrowing behavior enhances soil mineralization and also increases circulation of air and water due to increasing porosity in the soil. They consume decaying organic wastes as food and produce vermin-casts containing plenty of nutrients for the growth and multiplication of plants. On account of increasing human population, all over the world, especially in under-developed and developing countries, importance of the efforts to increase crop production had always been there and will always remain. In order to make human living more smooth and comfortable new ideas and inventions have been made the results of which can easily be visualized. The forest land areas have been destroyed to convert them into residential areas and agricultural fields and modern tools of agriculture (mechanization and chemical fertilizers and pesticides) have been discovered and used to increase crop production. There is no doubt that today human life is more comfortable than it was ever before. But in the wave of development, drawbacks and side effects of modern civilization have been ignored and neglected. Enough attentions have not been paid to maintain integrity of nature and environmental safety. Excessive, non-judicious and long term use of chemical agents, particularly fertilizers and pesticides have resulted in several problems including environmental pollution, health hazards, pest outbreak, pest resurgence, emergence of new pests, pesticide resistance etc. Due to toxic residues of chemical fertilizers and pesticides and lack organic matter in the soil, biodiversity and populations of beneficial flora and fauna of soil including earthworms are declining (Edwards and Bater; 1992) [9]. The livelihood of the soil is at risk; soil is becoming dead and non-productive. It is getting deprived of micro and mega-nutrients and the situation of soil fertility is deteriorating to such an extent that nothing can be produced without addition of chemical fertilizers and increasing amounts of fertilizers are not resulting in increasing crop production to the desirable level. The input demands of soil are increasing and nobody knows where it would end. Safe disposal and management of waste particularly organic waste are global problems, which are much more serious in developing countries like India (Senapati and Julka; 1993, Srivastava and Beohar; 2004; Agrawal, 2005; Bharadwaj, 2010) [10, 14, 1, 5]. A major portion of the waste is burnt to quickly get rid of it. The other waste remains are collected and dumped at empty plots or barren land within or at outskirts of the city as land filling or heaping for self-decomposition. These practices create soil, air and water pollution which are the cause of environmental, climatic and health problems. During disposal, collection and handling of the garbage, other than organic wastes also get mixed up and recycling becomes much more difficult. In fact no serious thought is given for recycling and its benefits have largely been neglected. During recent years due attention has not been paid towards environment and environment related issues and problems. Several attempts have been made to assess and point out the harmful effects of environmental pollution and to suggest preventive and corrective measures. It has continuously been emphasized to follow remedial measures and to implement the ways and means to reduce pollution. It has been suggested that in order achieve the goal of sustainable development attempts should be directed towards: (a) alternative and renewable source of energy, (b) judicious

and controlled use of chemicals, (c) promotion of waste recycling using environment-friendly techniques, (d) organic farming. Several eco-friendly measures have been suggested, out of them vermitechnoloy is perhaps the most simple, cost effective, user's friendly and prospective.

## 2. Materials and methods

**Collection of Earthworm:** The earth worms are collected from Vermicomposting center of Krishi Vigyan Center Rura Mallu Orai Jalaun. *Eudrilus eugeniae* spices of Epigeic earthworms used for prepration of vermicompost.

**Collection of Organic Wastes:** Three complex organic wastes were collected from different locations of experimental areas. Mentha waste was collected from mentha extraction units, rise husk waste was collected from Rise fields and dung was collected from cow farms.

**Experimental set up:** This experiment was conducted in plastic (oil) cans of 31×28×16cm size. Each container was provided with few holes, to allow the excess of water to drain. Three pre-decomposed substrates (mentha waste, rise husk waste and dung) were mixed in ratio of 1:1, 1:2, 1:3 and 1:1:1. The mixtures were used as experimental culture media for earthworms. The containers were filled with 2.5 kg of culture medium that was covered by garden mesh cloth. Next day, after filling up of the containers with culture medium, 15 pairs (30) of mature, adult, clitellate earthworms, taken from a stock culture, were uniformly released on top of the medium. Weight of the earthworms was measured before releasing. The culture containers were covered by garden mesh cloth and maintained for a period of 30 days with weekly observation and monitoring of the moisture content at about 50 %. Each treatment was repeated three times. After 30 days, the content of the culture container was cleared and heaped on a plastic sheet. This stimulated the earthworms to move downward and formed on aggregate at the centre of the heap. Adult earthworms were collected for observations. The cocoons and baby worms (juveniles) were also separated for experimental observation Earthworm cast or excreta of earthworms (vermicompost) was dried in shade for 5 days and then separated by sieving. The quantity of compost was determined by weighing and the values were used for calculation of degree (percentage) of composting.

- Number of adult worms and % change
- Weight of adult worms and % change
- Degree of composting

## 3. Results

Result shows that all the experimental culture media were not found to be suitable for survival, growth and reproduction of *Eudrilus eugeniae*. The number of adult earthworms was reduced very significantly in almost all the containers containing mentha waste as a medium. Maximum reduction (from 30 to 4.33 = 85.5 %) was found in mentha waste only followed by MW + RHW (3:1) (30 to 17.00 = 43.3 %), MW + RHW (1:2) (30 to 18.33 = 38.9 %), MW + D(3:1) (30 to 19.00 = 36.66 %), MW + D (1:1) (30 to 19.33 = 35.56 %), MD+ D (2:1) (30 to 21.33 = 28.9 %), MW + RHW (1:1) (30 to 22.33 = 25.56 %), MW + D (1:2) (30 to 26.33 = 12.23 %) and MW + RHW (1:3) (30 to 29.33 = 2.23 %). The results of the biomass (weight) of adults worms also showed significant decline in the mentha waste medium and the sequence of decline from maximum to minimum was in the following order: mentha waste only (from 48.0 gm to 8.33 gm = 82.6 %), MW + D (1:1) (47.00 gm to 29.33 gm = 37.5 %), MW + D (3:1) (46.00 gm to 29.33 gm = 36.2 %), MW + RHW (3:1) (46.00 gm to 29.66 gm = 35.52 %), MW + RHW (1:2) (48.0 gm to 30.33 gm = 36.8 %), MW + RHW (2:1) (47.00 gm to 30.33 gm = 35.4 %), MW + RHW (1:1) (43.33 gm to 33.33 gm = 24.8 %), MW + D (2:1) (46.66 gm to 35.33 = 24.2 %), MW + D (1:2) (48.33 gm to 41.33 gm = 14.4 %) and MW+RHW (1:3) (45.33 gm to 43.33 gm = 4.4%).The mentha waste in which other wastes were mixed in higher proportion was suitable for earthworms. The number of adults showed an increase from 30 to 32.66 (8.86 % increase) in MW + D (1:3) followed by MW + RHW + D (1:1:1) (30 to 61.33 = 104.4%) (Table 2). The weight of adult earthworms also increased in these three media. The sequence from higher to lower degree of increase was noticed to be: MW + RHW + D (1:1:1) (48.33 gm to 113.66 gm = 135.2%) followed by MW + D (1:3) (47.0 gm to 52.33 gm = 11.3 %). In contrast to the mentha waste, rise husk waste alone as well as in combination with dung did not show any deleterious effects on the life and survival of earthworms. In all such media, the number and weight of adult worms were found to be higher than the initial values. In rise husk waste alone, the number of worms increased from 30 to 36.33 (21.1 % increase) and adult weight increased from 47.33 gm to 57.8 gm (22.1 % increase). In rise husk waste mixed with different quantities of dung, higher values of both parameters were reported, *viz*. in RHW+D (1:3), the number of worms increased from 30 to 63.33 (111.1 % increase) and adult weight increased from 47.0 gm to 109.66 gm (133.3 % increase), in RHW+D (1:1), the number of worms increased from 30 to 62.33 (107.7 % increase) and adult weight increased from 46.33 gm to 106.66 gm (130.2 % increase), in RHW+D (2:1), the number of worms increased from 30 to 58.33 (94.4 % increase) and adult weight increased from 45.33 gm to 99.33 gm (119.1 % increase), in RHW+D (1:2), the number of worms increased from 30 to 58.33 (94.4 % increase) and adult weight increased from 46.33 gm to 97.66 gm (110.7 % increase) and in RHW+D (3:1), the number of worms increased from 30 to 53.33 (77.7 % increase) and adult weight increased from 47.33 gm to 97.66 gm (106.3 % increase). In some of the combinations no significant difference was found with decreasing amount of RHW and increasing amount of dung. Thus at seems that rise husk waste is a suitable medium for Vermicomposting and inclusion of dung makes it still better. All combinations of substrates employed in the present study can be grouped into four categories (A) mentha waste + dung, (B) mentha waste + RHW, (C) RHW + dung and (D) mixture of three substrates. When the results were displayed in these groups, it became clear that the mentha waste as such was not suitable for vermicom posing by *E. eugeniae* and substrate combinations with high amount of mentha waste were poorly suitable for the activities of worms. The acceptance or the suitability of the medium increased with decreasing amount of MW and increasing amount of dung. The rise husk waste was found to be satisfactory with regards to the population growth, biomass

production and fecundity rate. Mixing of mentha waste and / or dung did not significantly improve the performance with respect to these parameters. However, the combination of three substrates (MW+AHW+D in equal ratio of 1:1:1) proved to a good medium for increase of all the parameters and the results were more or less at par with those in dung which is considered to be the best culture medium. Degree of composting was determined after culturing of earthworms in different substrate media for a period of 30 days. It was noticed that minimum quantity (5.1 %) of granular vermicompost was obtained from mentha waste. From the media containing good quantity of mentha waste mixed with rise husk waste and dung, the quantity of vermicompost received was lower (8.0 – 24 %). Maximum amount (55.4 %) of vermicompost was produced in dung as the culture medium followed by other media containing dung as the major ingredient: 51.1 % in RHW+D (1:3), 48.3 % in RHW+D (1:1), 47.3 % in RHW+D (1:2), 43.2 % in RHW+D (3:1), 40.3 % in MW+RHW+D (1:1:1), 40.2 % in RHW+D (2:1), 39.2 % in RHW only, 23.4 % in MW+D (1:1), 22.6 % in MW+D (1:3), 21.2 % in MW+D (1:2), 17.2 % in MW+RHW (1:3), 16.2 % in MW+RHW (1:1), 13.0 % in MW+D (2:1), 12.2 % in MW+RHW (2:1), 9.90 % in MW+RHW (3:1), 8.9 % in MW+D (3:1), 8.0 % in MW+RHW (1:2) and minimum 5.1 % in MW.

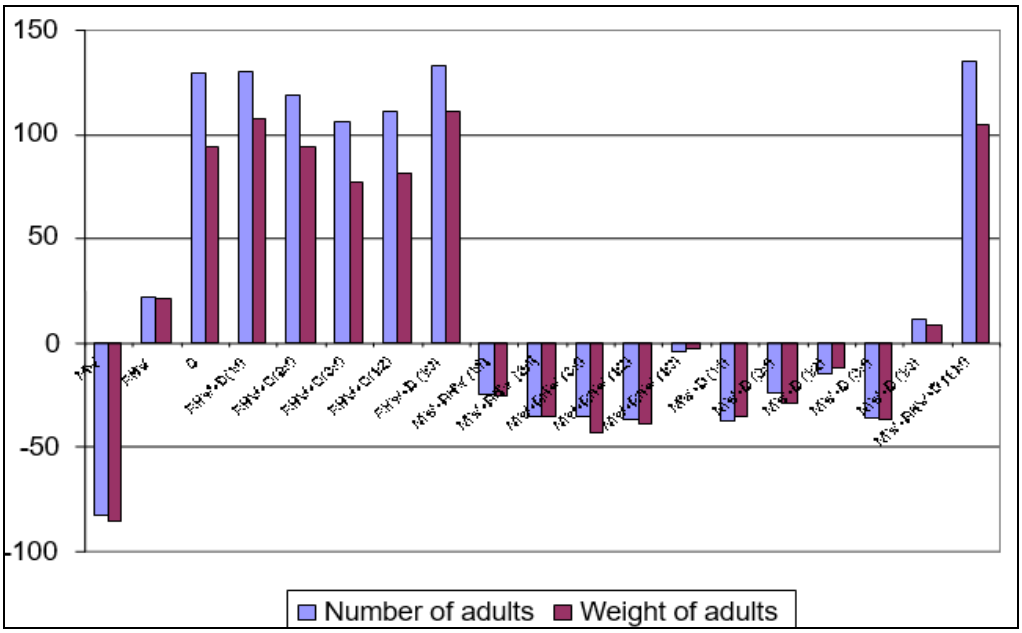


**Fig 1:** Percent change in the number and weight

## 4. Discussion

Production of large quantities of organic waste all over the world poses major environmental (offensive odors, contamination of air, ground water and soil) and disposal problems (Edwards and Bates, 1992.) [9]. The quantity of wastes, especially organic wastes is extensively increasing with increased human population, intensive agriculture, industrialization and modern life style. Therefore, the disposal of different types of wastes has become very important issue for maintaining healthy environment (Senapati and Julka, 1993; Sonal, 2006; Suthar, 2007) [10, 15, 16]. According to an estimate India produces about 7,000 million metric tones of wastes per year, out of which major crops like rice, wheat, millets and sugarcane contribute around 320 million tones of organic residues which are either burnt or land filled. Agricultural wastes such as crop residues and animal excreta need special attention for disposal or utilization as they can safely be recycled (composted) to provide nutrients to plants and can improve physical conditions and fertility of the soil. Some of these wastes can be directly added to the soil without any proper treatment as they do not possess any toxic pollutants and the soil microflora and some fauna (earthworms) can convert them into bio-fertilizer (Kitturmath, *et al.*, 2004) [11]. Several attempts have been made to study bio-degradation of different types of waste substrates using earthworms. It was reported that different species of earthworms have different preferences towards organic matter (Kale and Krishnamoorthy, 1981) [11]. Most of the people engaged in vermicomposting in India are using only cattle dung as earthworm feed and some of them mix up crop and plantation residues also. Nobody cares for proper disposal, processing and management of other types of wastes and they are cause of environmental pollution and unhygienic atmosphere.

The observations revealed that the number and weight of adult earthworms, and number and weight of cocoons and juveniles increased preferentially in all waste combinations containing high amount of dung. The mentha waste alone and the media containing high proportions of mentha waste were not suitable for the survival of adult worms and both the number and weight of adult worms were reduced as compared to the initial values. There may be several factor responsible for such negative effects on the biology of earthworms like non-hostile environment, lack of aeration, lower C/N ratio, very low or higher pH values, high temperature due to exothermic reactions, release of anti-feedants / repellents and toxicants

plan components and by anaerobic microorganisms etc. The deleterious effect of mentha waste was so high that its all combinations with rise husk waste reduction in the number and weight of adult worms was observed. The conditions in mentha waste-enriched media were un-favourable not only for the survival of the adult worms, but also for reproductive performance of the worms that could survive. The fecundity rate was low and number and weight of cocoons and baby worms were significantly lower in the mentha waste enriched media. With decreasing content of the mentha waste and increasing ratio of dung, the living conditions became better and improvement in all parameters was observed. The results of present study are in agreement with observations of several earlier workers on Vermicomposting of husk waste, poultry waste (Appelholf *et.al* 1998; Bansal and Kapoor, 2000; Barik *et.al*. 2002; Bhiday, 1994; Dhaliwal and Kansal, 1994; Ghosh *et al.* 1999; Gunadi and Edwards, 2003) [2, 3, 4, 6, 7, 8]. Present experimental findings are strongly supported by results of Saini (2007) [13] that maximum multiplication and reproduction of *E. foetida* was found in vegetable waste and dung mixture at the ratio of 1:3 followed by 2:3, dung (control) and 1:1. Present findings revealed that unlike mentha waste, the rise husk waste had not deleterious influence on the life earthworms. Both the number and weight of adult worms showed an increase even in the waste alone without mixed with dung. Mixing of dung made it more suitable and it significantly increased both the values.

## 5. Conclusion

It may be concluded from the study that Nigerian compost worm, *E. eugeniae* can be used as a successful tool for recycling of some complex organic wastes like mentha waste and rise husk waste in combination with cattle dung. Mixtures of MW and dung and MW + RHW + D (1:1:1) are highly suitable media for biomass production, fecundity and composting activities. The isolated substrates or their mixture should be first pre-decomposed so that the medium becomes easily acceptable by *E. eugeniae*. Vermicomposting is a ecofriendly and cost effective process for recycling of complex organic wastes and this can be maintained in easy way. The large scale practice of vermicomposting may have far reaching effect in environmental conservation, sustainable development and improving community health. Moreover, vermicomposting practice could also be utilized for self-employment and good production of crops in rural areas and villages.

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