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Recycling of biodegradable waste by vermicomposting: Role of students for awareness

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Abstract
Our institute is inculcating a practical approach for sustainable development among the students and neighborhood community by a method of vermin-culture. The main objectives of this process is recycling of biodegradable solid waste through vermicomposting and to develop awareness among the students. Vermicomposting is a process where worms reared, cultured and their excreta used as a manure for the plants. This is a student participatory activity and helps to spread awareness. Through this activity department has also established a bonding with neighborhood community. Institute had provide a portable pit to the students who were staying nearby college and encourage them to setup a small unit of vermicompost at their home. Students learnt and understood the recycling of the biodegradable solid waste and developed their own vermicomposting pit in their houses and are producing vermicompost and vermiwash at their homes. This method is set up as a module for the sustainable development through recycling the biodegradable waste.

Keywords: recycling, biodegradable, vermicomposting

1. Introduction
Increase in the population leads to the generation of massive waste and to manage this waste is a serious problem today. Recycling and reduction of organic waste by physical and chemical processes are expensive [1]. To mitigate this problem vermiculture is one of the easy and cheap method. Vermiculture is the method of breeding and raising earthworm. The use of vermicomposting techniques reduces production costs and decontaminates the environment. The key product of vermiculture is worms, vermicompost and vermiwash. Vermicomposting technology is globally popular to manage the solid waste [2, 3]. Vermicompost is obtained from a wide variety of organic waste including residual sludge; when sewage sludge is managed with vermicomposting techniques, the resulting product supplies nutriments, more stable organic matter and works as a soil conditioner [1].
Students are pillar of our society, they have so many ideas about the world and future. It is the goal of the teacher to encourage them and do what they can to bring out the best in each of them. To use strength and enthusiasm of the students, in our college we have established a vermiculture unit to train them about the procedure and usage of vermicomposting. They are the real messengers to the society to spread awareness about the importance of recycling of biodegradable solid waste. In this paper we will discuss about process of vermiculture, vermicomposting, products of vermiculture and the role of students to create awareness among the neighborhood society for recycling of biodegradable solid waste through vermicomposting

2 Procedure of Vermiculture
2.1 Species of Earthworm
There was a counting of 3500 species of earthworm known to man until the end of the 20th century [4, 5]. It belongs to phylum Annelida and class Oligochaeta most of the species belong to family, Lumbricidae. The various species used in vermiculture are *Allolophora, Aporrectodea, Bimastos, Dendrobaena, Lumbricus, Megascolex mauritii, Eisenia fetida, Eudrilus eugeniae, Perionnyx excavatus, Lampito mauritii, Eisenia andrei, Lampito rubellus and Drawida willis*, etc. [6, 7. 8, 9]. *Eisenia fetida* known as redworm, brandling worm, red wiggler worm is the first choice for vericomposting as it is adaptable to changing conditions [10, 11, 12, 13, 14].
In our college we use two different species of earthworm, *Eisenia fetida* and *Pheretima elongate* for vermiculture.

2.2 Preparation of Vermiculture pit
Earthworms are often referred to as farmer's friends and natures ploughmen. Earthworms are extremely important in soil formation, principally through their activities in consuming organic matter, fragmenting and mixing it intimately with mineral particles to form aggregates [15]. The organic waste is converted to a bio-fertilizer by earthworms' action over a certain period of time [16]. Various feedstock have been employed in vermicomposting ranging from animal, plant, pharmaceutical, food and sewage waste over vermicomposting periods ranging from 28-120 days [17, 18, 19].
At our institution we have vermiculture bins which take care of the solid waste generated in our premises daily. We use kitchen waste and garbage from residential areas and the intuitional campus collected by students. The vermiculture bins are taken care by the students. The worm's feeds on the organic waste, in the process of feeding, earthworms fragment the waste substrate, enhance microbial activity and the rates of decomposition of the material, leading to a composting or humification effect by which the unstable organic matter is oxidized and stabilized. The end product, commonly termed vermicompost and obtained as the organic wastes pass through the earthworm gut, is quite different from the parent waste material.

3. Products of Vermiculture
There are foremost three yields of vermiculture they are earthworms, vermi-compost and vermi-wash.

3.1 Earthworm
As vermiculture is the process of breeding and raising earthworm, the main product of it is earthworms. The multiplication of worms depends upon the temperature, moisture, pH, airing, particle size, capacity of cationic interchange (CCI), organism matter (OM), nitrogen (N) and C/N ratio of the soil [5]. These parameters regulate all the biological activities of the worm; temperature helps manipulate the lifecycle of the worm [20]. The production of worm biomass can also be considered pro-biotic feed for fishery, poultry industry [21].

3.2 Vermicompost
Vermicompost is an odourless, dark brown bio-fertilizer obtained from the process of vermicomposting [1, 22]. Vermicompost also called as vermicast is actually the casts expelled from the earthworm gut. The vermicompost thus formed is used as a fertilizer to improve the production of agricultural crops. The quality of the vermicompost is measured by the vermicompost biodegradability coefficient [23]. Vermicompost has substances such as humic acids (HA) and hormones that together regulate the growth and production of plants [24], and in the environmental field the worm helps alleviate environmental pollution and takes part into bio-accumulation and bio-remediation processes [25].

3.3 Vermiwash
Vermiwash is a leachate that is produced during the vermicomposting process and is dark brown in colour [17,26, 27, 28]. Vermiwash can also be used as a foliar spray whereby it acts as a pesticide in sustainable agriculture [26]. The quality of vermiwash produced by earthworms depends on the vermicompost that is used [29]. It is a non-toxic and ecofriendly compound, which arrests the bacterial growth and forms a protective layer for their survival and growth. Vermiwash at 5-10 percent dilution inhibits the mycelial growth of pathogenic fungi [30].

4. Advantage of Vermiculture
Composting is an effective 'zero waste' method for treating organic wastes, which follows nature's way of recycling. There are several advantages of composting such as; a safe treatment option for high nutrient waste and the production of natural fertilizer as an end product. Vermicomposting is in conservative side of resources like water, energy and land required for treatment of per unit of biowaste as compared to aerobic composting. Vermicomposting is rapid, low cost and sustainable alternative for organic waste treatment managed by earthworms, with the added advantage of more aesthetic, plant nutrients, humic acids and PGRs enriched compost in the slow-release form. The worm casts hold nutrient for a longer period without adversely impacting the environment. Vermicompost dramatically improves soil structure, texture, aeration, fertility, water holding capacity and soil ecology. This replaces valuable nutrients taken out of the soil when crops are harvested.

5. Role of students to create awareness
In our institution students take part in the whole process of management and maintenance of vermiculture pit. They collect the biodegradable waste from their kitchen, from garden and college premises. They regularly monitored the moisture of the pit. After completion of vermicomposting process they collect the manure or compost and vermiwash. During this process, students learnt recycling of the biodegradable solid waste by the process of vermicomposting. Few students developed their own vermicomposting pit at their homes (Fig. 1 and Fig. 2) and are producing vermicompost and vermiwash. These students were also trained to create awareness among their neighborhood community about importance of vermicomposting. They also help the people to install a vermicompost pit at their homes.

Fig 1: Portable vermicomposting pit at student's place

Fig 2: Vermicomposting pit

6. Conclusion
Vermiculture is a biological process. Vermicompost rich in high quality organic humus is used as organic amendments. The students play important role in increasing awareness about the vermiculture in the society. Therefore, it is essential to give proper training to them and make aware about the importance of recycling the biodegradable waste. In this regard our college is playing significant role to train the students and create awareness among the neighborhood society.

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