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Conceptual Paper

Plastic Eating Dustbins; A Novel Approach in Degradation of Plastic Waste

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Introduction

Plastic waste is a major problem today. Plastic is a synthetic material used in a variety of different sectors. Plastic is made from a wide range of compounds like vinyl chloride, vinyl acetate, ethylene, etc. The plastic used in bottles, bags, and food packaging is single-use plastics.

The extensive application of plastic has led to various environmental issues. According to the data, single-use plastics (SUP) contain harmful chemicals like bisphenol-A (BPA). This chemical accumulates in humans and animals which leads to cancer and impaired reproductive system. Plastic contains various types of toxic compounds like di- (2-ethylhexyl) phthalate (DEHP), Poly halogenated compounds, and heavy metals. As plastic is not degraded readily in the environment, its disposal has created a considerable pollution problem. Most of the compounds lead to harmful effects on human health. The microplastic particles can penetrate the body and can be eliminated or deposited in the spleen and liver [2,3]. Microplastics made from plastic that has been dumped on land eventually erode and enter the waters, harming marine life. Burning plastic garbage can seriously pollute the air and is harmful to human health as well. Therefore, the safe removal of plastic waste is important [4].

It has been discovered that the super worm known as *Zophobas morio* can survive on polystyrene diets [5] to deal with this problem, a novel product is designed to degrade plastic. This startup project focuses on the degradation of plastic waste by using an innovative approach.

Single-use plastic

These are the plastics that are discarded after being used once. They are used in food packaging, bottles, straws, containers, etc. Annually millions of tons of plastic waste enter the environment [6]. They also represent the largest proportion of manufactured polymers. Single-use plastics (SUP) are used only once and are often discarded on streets and open land. Small particles of plastic are mainly accumulated in water, air, soil, and various living organisms [7]. These plastic fragments do not degrade faster, and release toxic chemicals into the environment. Every year, 300 million tons of plastic are produced worldwide, with single-use items accounting for half of this total. That is almost as much weight as there are people on Earth. Land animals consume plastic waste just like ocean animals. The waste from food packaging, food waste, and plastic waste are eaten by animals, causing digestive problems in them. Animals can also get suffocated by the plastic bags. Animals suffer huge consequences from plastic waste.

Figure 1: Plastic waste dumping.

Our health is harmed by exposure to microplastics and the chemicals added to plastics during processing. Numerous chemicals included in plastics are known endocrine disruptors, and research indicates that human exposure to these substances may have negative effects on health, including hormone abnormalities, reproductive issues like infertility, and even cancer [8].

To deal with this problem, a novel product is designed to degrade plastic. This startup project focuses on the degradation of plastic waste by a novel approach.

Product details

As the name suggests plastic-eating dustbins, really degrade plastic waste by using superworms.

Superworms

Superworms are the larval form of superworm beetle. This insect can degrade.

Scientific classification

Kingdom	*Animalia*
Phylum	*Arthropoda*
Subphyllum	*Mandibulata*
Superclass	*Hexapoda*
Class	*Insecta*
Subclass	*Pterygota*
Order	*Coleoptera*
Suborder	*Polyphaga*
Family	*Tenebrionidae*
Genus	*Amarygmus*
Sp.	*Zophobas morio*

Table 1

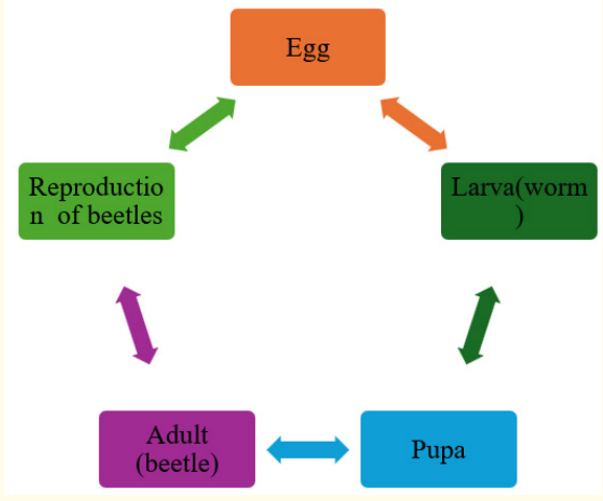

Figure a

- Larva are generally 2.5 cm and adults are 1.25 to 1.8 cm.
- They usually require moist, dark and undisturbed places.
- Mainly found under rocks, logs, in animal waste accumulations, in moist places, and stored grains.

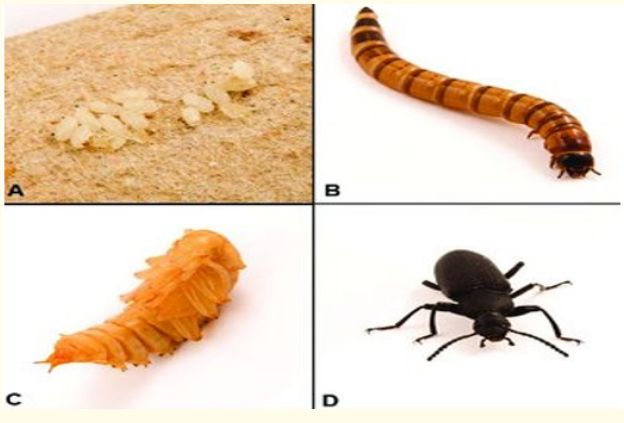

Figure b

This insect has 5 stages of the life cycle

This insect has four distinct stages of life, i.e., egg, larva, pupa, and adult. The time required to go through this cycle will depend on temperature as well as food availability to insects.

- Eggs of this insect are oval with rounded edges. Each female can lay around 1000 eggs in its life span. This will mainly depend upon the female age and adult density.
- Larvae are yellow with dark brown anterior and posterior ends. They have a cylindrical body.

Mechanism of action

This insect (superworm) contains a specific enzyme in saliva that is responsible for polyethylene degradation [9]. They are capable of oxidizing and depolymerizing polyethylene (PE) [9-11]. This effect is seen after a few hours of exposure to plastic at room temperature and under physiological conditions. Within the saliva, 2 different enzymes belong to the phenol oxides family. This fluid is present in the anterior portion of the digestive apparatus.

According to the research, 50 superworms can consume around 2g of plastic in 21 days and in this project, we will take 1200 worms to degrade 48 grams of plastic.

Project Plan-

The Plastic-eating dustbins can be sold to various government organizations, schools, colleges, apartments, and societies. This product will degrade plastic waste.

The bottom of dustbins will contain super worms, of 1-18 days. After the selling of this product, the superworms are then replaced in 10-15 days. Adult superworms are replaced with young superworms. Now the dustbins will contain all young superworms. young superworms will degrade the plastic more effectively. All adult superworms and beetles are transported to the reproduction unit. From the reproduction unit, the young superworms can be used again in these dustbins, to degrade plastic waste.

Figure 2: Superworms Degrading Plastic.

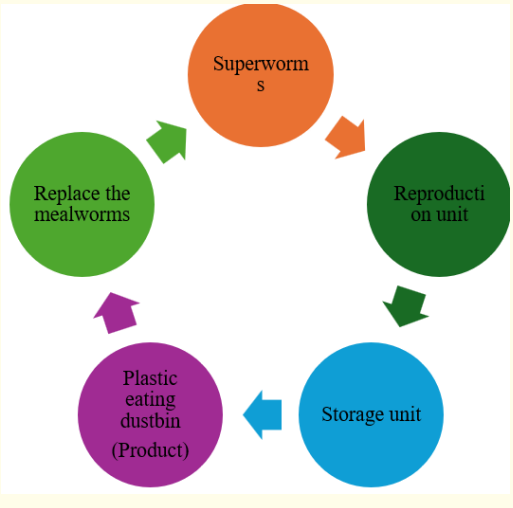

Figure 3: Project plan.

The replaced super worms from the dustbins are used to Reproduce more super worms for the degrading plastic.

Product information

- This Dustbin has three different parts, bottom part, middle part, and upper part.
- The bottom part contains 1200 superworms that will degrade the plastic.

The bottom part will be dark and humid. Bran is used in the bottom part as a base. It is used as nutrition for young super worms.

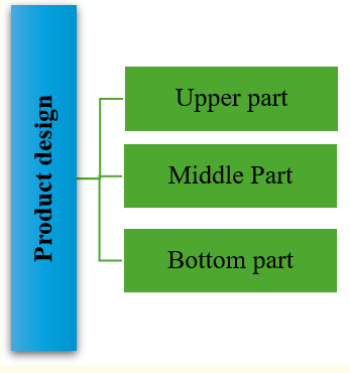

Figure C

The middle part of this will contain a mesh to restrain the worms in the bottom portion. The inner walls of the dustbins will be smooth and slippery so that the worms can't climb up. The holes are maintained at much upper portion of the worms, to maintain ventilation. The upper part of the dustbin contains lead from the container.

Dimensions of a Dustbin

We can keep 2-10 worms/sq inch. If we consider 6 worms in 1 inch, then 1200 worms will require 200/sq inch.

The height of the dustbin should be a minimum of 8 inches. Bedding for the worms is made by using bran, oatmeal, and wheat. The bedding should be 1-2 inches in height.

Reproduction unit

The adult superworms will turn into creamy pupae. These pupae are then converted to beetles. The beetles are capable of reproducing superworms [12].

Figure 4: Lid of Dustbin.

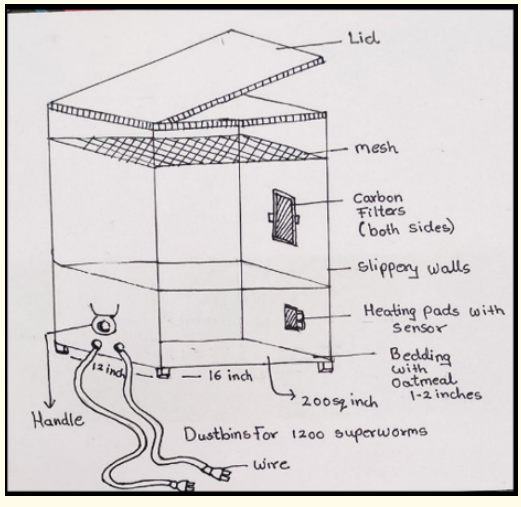

Figure 5: Product design (rough).

Figure 6: Inside Mesh.

Maintenance of reproduction unit

The superworms are easy to care for and have less smell. The temperature should be 20 degrees Celsius.

Storage unit

Structure

The overall form consists of a stackable structure that holds trays. It consists of a climate chamber, where the cooling fan operates. It can increase the airflow within an enclosed environment.

Operational flow

Separating different stages of superworms in different trays controls the temperature in each tray. The airflow is controlled by a centralized system.

The farm is organized as

- The Pupa and Beetle in the top tray pupa are placed on an elevated platform to separate them from beetles to prevent cannibalism.
- Eggs will be located in tray 2 below tray 1 with holes of 2.0 mm in diameter to allow eggs to pass through it.
- Larvae are located in six trays below the beetles. The youngest larvae will be placed just below the beetles and the oldest larvae will be in the bottom tray. As the larvae grow, they develop into pupa and placed in separate trays below the larvae [12].

Heating system

The heating system keeps the body temperature of superworms within its normal range. Heating pads within each tray are required, to maintain temperature approx. 28 degrees Celsius. The superworms bury themselves because they are light-sensitive. Each heat pad is controlled by a microcontroller and is disconnected when the internal temperature is above 28 degrees Celsius.

Ventilation system

The natural ventilation system is provided. Good ventilation is very important to maintain superworms.

Carbon filter and odor Control

To deal with the odor problem carbon filters are placed on the inlet of the fan, which removes volatile organic compounds, odors and gaseous pollutants. The dimensions of the carbon filter will be 10cm x 10cm same as that of the fan.

Sensors

The sensors will be connected to the microcontroller, which detects the temperature. When the temperature is above 28 degrees Celsius it will disconnect the contact.

Tray design

The tray design will involve a removable drawer with a heat pad. The individual will pull the harvesting tray and transfer it to the below one.

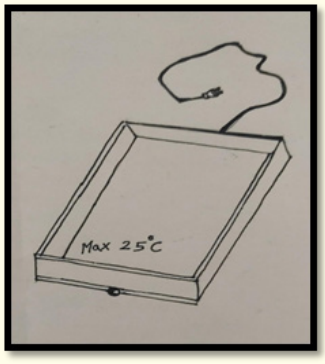

Figure 7: Tray design.

Rational and objective

- To improve the local environment with good mechanisms and offering continuous employment to individuals from socially and employment to individuals from socially and economically disadvantaged groups.
- To protect our environment from pollution and contamination and repair and reduce the damage caused by pollution.
- Reducing the single-use of plastic to an almost zero level so that they should not be dumped under the ground with waste.

Results

According to the research the 1200 Superworms can degrade about 48g of Plastic Waste in 21 days study. These worms are strong and can withstand normal room temperature i.e. 28 degrees Celsius. Superworms are easy to maintain. This concept can be used in many organizations to manage single-use plastic.

Conclusion

The concept of a Plastic Free India is not just a vision, but a necessity. The overwhelming use of plastic is a pressing concern, causing significant harm to our environment, ecosystems, and health. Plastic-free dustbins are used to transition to a plastic-free world.

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