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Reduction of waste generated in Chennai city using Black Soldier Fly Larvae (BSFL)-A Proposal

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***Abstract*:- Waste generation and management is a serious problem that has to be dealt with caution. Though several procedures are available for waste management, it has not been effectively utilized. According to the study conducted by The Times of India in 2014, it has been reported that Chennai generates the highest waste in the country i.e 0.7 kg/person/day. The survey also reported that 60% of the total waste was organic waste. This paper aims to provide a solution for reducing the waste by more than 50%. This figure can be achieved by focussing on completely eliminating the organic waste using BSFL. These larvae are very efficient in organic waste decomposition as they do not have any adverse effects on humans nor the environment.**

Keywords : Black Solider Fly Larvae, Organic waste, Circular economy, Optimum temperature

I. INTRODCTION

Urbanisation has caused a rapid increase in environmental problems and one such major issues is waste generation. We are in need of finding a sustainable approach towards waste management such as a circular economy. One such solution to organic waste management are the Black Soldier Fly Larvae. Currently, the garbage generated in Chennai is dumped at two land fill sites that are located in the North and South of the city, namely Kodingayur and Perungudi dump sites. The average waste generated in Chennai per day is 6404 tonnes out of which 60% (3842.4 tonnes per day) is organic waste. Our aim is to reduce the organic waste generated. The total waste must be segregated in a methodical manner. There must be separate bins (indicated by different colours) for organic and inorganic waste. The minor waste which includes the recyclable waste(25%) and hazardous waste (10%) can be minimised by segregation and incineration. Total waste tha can be reduced is 85% out of which 60% organic waste is reduced by our proposed method using the Black Soldier Fly Larvae (BSFL) and 25% inorganic waste can be recycled.

II. THE BLACK SOLDIER FLY (Hermetiaillucens)

The BSFL is an insect which can feed on organic matter up to 2 times of its body mass.The adult stage insects measure about 16 millimeters. The **Fig 1.0** , shows the Black Soldier Fly and the different stages of larvae. This species is found where there is decaying matter where one female fly lays around 500 eggs. Once the eggs are laid it takes 18 days for it form larva and stays in this stage for 18-21 days. After the larva stage it transforms into the pupa stage (14 days) and then to the adult stage (4-9 days). Each larva weighs around 0.1grams.The life cycle of BSFL is shown in **Fig : 1.1**.This species feeds on organic matter during the larval stage. During the adult stage it does not feed on anything as it does not have a digestive system and it thrives on the fat that has been stored due to the food consumption in the larval stage. The pupae contains 43% of protiens and are rich in nutrients and other vitamins which makes it a source of human feed in a few countries. The species usually feeds on organic matter only during the larva stage during which it can feed on all organic material, food waste/scraps, carrion (dead animals) and manure.. There are various advantages of using these flies like they are not attracted to humans and do not spread diseases and do not let other insects to lay eggs in their habitat.

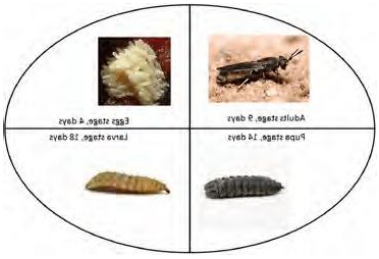

Fig 1.1 : Lifecycle of Black Soldier Fly Larvae

Fig 1.0 : The Black Soldier Fly and Larvae

III. SURVIVAL CONDITIONS FOR BSFL

The minimum and maximum temperature for their survival is 32 degrees Fahrenheitand 113 degrees Fahrenheit respectively while the optimum temperature is 95 degrees Fahrenheit. The larvae develops and works efficiently at 30 to 90% humidity. It cannot work under extreme sun, wet or dry conditions. The sewage conditions in the dump yards in Chennai favour the growth of these insects.

IV. DECOMPOSITION USING BSFL

The study area chosen for our study are the kodingayur and Perungudi dump yards with an area of 200 acres each.Our

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proposal involves two plants in these dump yards, one (PLANT 1-Breeding unit) for breeding the larvae and another (PLANT 2-Digestion unit) where the larvae comes in contact with the waste and digests it. In the second plant, there has to be bed of soil mixed with soil on top of which these larvae should be placed, The organic matter should be poured on top of these larvae so that they have the optimum conditions for breeding.The **Fig 1.2** shows the schematic representation of the plants. These plants can be constructed at a minimal cost near the sewage disposal site in the city. After the eggs are hatched in the breeding unit, the larvae can be transported through trucks or conveyor belts from plant 1 to 2. After it completes the larval stage in the breeding unit, it turns into pupae which can be fed to chickens or used as other animal feed and in aquaculture. As Chennai is rich in pisiculture, the pupa can be used to feed the fishes and are better than the traditional red worms used as fish feed. It can also be dried and processed into feed for used at a later time. A few pupae can be used for further breeding so that more eggs are laid for the process to continue. In the breeding unit, the control of these flies are easy as they have very weak wings.

The calculations enabled us toget a clear understanding on how the BSFL can be used for decomposition of organic waste. Itwas inferred that only 196.04 tonnes of BSFL is required to eliminate a total organic waste of69,163.2 tonnes. In short, 1000 tonnes of organic waste can be decomposed usingapproximately 3 tonnes of BSFL by weight.

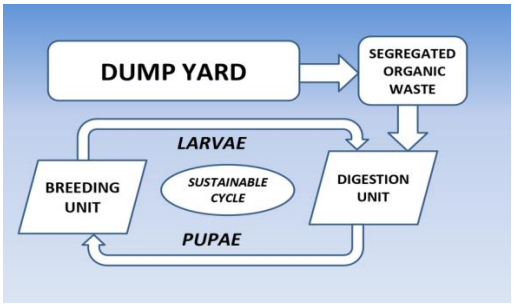

Fig 1.2 : The mechanism of waste disposal using BSFL

V. CALCULATIONSTOESTABLISHTHENUMBER OFLARVAEREQUIREDTO ELIMINATETHE ORGANICWASTE GENERATED

a. Body mass of Black Soldier Fly Larvae:

Weight of 1 larva = 0.1g

Twice the Mass of 1 larva = 0.1*9.8*2
= 0.98g

1 larva can consume twice its body mass on a daily basis.

Therefore, *1 larva can consume 1.96g of organic matter in 11.3 seconds.*

b. Number of larvae required to digest organic waste generated

Percapita waste generation in Chennai = 6404MT/day

60% of the wastes produced are organic wastes = 3842.4 MT/day

(It is inferred from the experiments that the larvae stage lasts for 20 days, after which the blacksoldier transforms into a pupa. Considering a buffer period of 2 days, the larvae can feed onthe organic matter up to 18 days.)

Larvae required to digest 60% of organic matter per day = 196.04 tonnes

Therefore, larvae required to digest the organic matter generated in 18 days = 196.04 tonnes

VI. COST ESTIMATION

As per The Hindu, 09 February, 2019 a total of 7000 crores was invested in solid waste management.

- Cost for setting up of waste disposal plant= Rs. 20 lakhs
- Initial cost for purchasing larvae=Rs.196.04 crores(as per India Mart, 1 larvae=Rs. 10)
- Total cost of initial setup= Rs. 216.04 crores.
- Cost of maintenance= Minimal
- Cost of initial set up at major dump yards in Chennai= Rs. 864.16 crores.

Total estimate for a period of one year = Rs.1000 crores

(Initial set up cost, transportation, electrical expenses in the plant, labour charge, annual maintenance etc,.)

The calculations enables us to get a clear understanding on how the BSFL can be used for decomposition of organic waste. It was inferred that only 196.04 tonnes of BSFL is required to eliminate a total organic waste of 69,163.2 tonnes. In short, 1000 tonnes of organic waste can be decomposed using approximately 3 tonnes of BSFL by weight.

VII. CONCLUSION

1000 tonnes of organic waste can be decomposed using approximately 3 tonnes of BSFL by weight. When compared to the BSFL, mediating recycling, composting releases 70% more carbon into the atmosphere. It has been verified that BSFL grown under these aerobic conditions do not generate significant quantities of CH4 and carbon-dioxide commonly emitted during anaerobic decomposition of organic matter in landfills. According to calculations, every 1000MT of food waste consumed by BSFL would usefully sequester carbon that, if aerobically composted would immediately produce 62.6 tonnes of carbon-dioxide.

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