An Analysis of Municipal Solid Waste Reduction Using Housefly Maggot

(Musca Domestica)

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Abstract: In India, 90 million t of solid wastes are generated annually as byproducts of industrial, mining, municipal, agricultural and other processes. The amount of MSW generated per capita is estimated to increase at a rate of 1–1.33% annually. To reduce municipal waste, house fly maggots were used. The experiments were conducted in trays. The size of tray was 1mx1mx9inches and which is locally available in the market. Two trials were conducted to observe the growth of larva in specific intervals viz., 1stday, 3rd day, 5thday and 7thday. The moisture content, pH, total hardness and waste reduction index were calculated. The study concluded that the using of housefly maggot reduces the municipal waste efficiently at micro level. The major obstacles associated with the production of housefly larvae from municipal waste on large scale seems to be technological aspects of scaling up the production capacity. Therefore, the municipal solid waste can be reduced commercially by having knowledge on housefly characteristics.

Key words: MSW, Housefly maggot, Waste reduction, pH, Total hardness

I. INTRODUCTION

Municipal Solid Waste (MSW) is commonly known as trash or garbage in the United States and rubbish in Britain, is a waste type consisting of everyday items that are discarded by the public. Garbage can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately.

In the European Union, the semantic definition is 'mixed municipal waste,' given waste code 20 03 01 in the European Waste Catalogue. There are many categories of MSW such as food waste, rubbish, commercial waste, institutional waste, street sweeping waste, industrial waste, construction and demolition waste, and sanitation waste. MSW contains recyclables (paper, plastic, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines), compostable organic matter (fruit and vegetable peels), food waste and soiled waste (blood stained cotton, sanitary napkins, disposable syringes) (Jha et al., 2003; Reddy and Galab, 1998; Khan, 1994). The quantity of MSW generated depends on a number of factors such as food habits, standard of living, degree of commercial activities and seasons. Data on quantity variation and generation are useful in planning for collection and disposal systems. With increasing urbanization and changing life styles, Indian cities now generate eight times more MSW than they did in 1947.

MSW in India

Presently, about 90 million t of solid wastes are generated annually as byproducts of industrial, mining, municipal, agricultural and other processes. The amount of MSW generated per capita is estimated to increase at a rate of 1–1.33% annually (Pappu et al., 2007; Shekdar, 1999; Bhide and Shekdar, 1998). A host of researchers (Siddiqui et al., 2006; Sharholy et al., 2005; CPCB, 2004; Kansal, 2002; Singh and Singh, 1998; Kansal et al., 1998; Bhide and Shekdar, 1998; Dayal, 1994; Khan, 1994; Rao and Shantaram, 1993) have reported that the MSW generation rates in small towns are lower than those of metro cities, and the per capita generation rate of MSW in India ranges from 0.2 to 0.5 kg/ day. It is also estimated that the total MSW generated by

217 million people living in urban areas was 23.86 million t/yr in 1991, and more than 39 million t in 2001. The quantity of MSW generated (CPCB, 2000) and the per capita generation rate of MSW (CPCB, 2004) are shown in Table 1. It can be seen from Table 1 that the per capita generation rate is high in some states (Gujrat, Delhi and Tamil Nadu) and cities (Madras, Kanpur, Lucknow and Ahmedabad). This may be due to the high living standards, the rapid economic growth and the high level of urbanization in these states and cities. However, the per capita generation rate is observed to be low in other states (Meghalaya, Assam, Manipur and Tripura) and cities (Nagpur, Pune and Indore).**CPCB 2000**

Table.1 Municipal solid waste generation rates in different states in India

S.No	Name of State	No. of cities	Municipal Population	Municipal Solid Waste(t/day)	Per Capita generated (kg/day)
1.	Tamil Nadu	25	10,745,773	5021	0.467
2.	Gujrat	21	8,443,962	3805	0.451
3.	Himachal Pradesh	1	82,054	35	0.427
4.	Kerala	146	3,107,358	1220	0.393
5.	Uttar Pradesh	41	14,480,479	5515	0.381
6.	Maharashtra	27	22,727,186	8589	0.378
7.	Karnataka	21	8,283,498	3118	0.376
8.	Orissa	7	1,766,021	646	0.366
9.	Andhra Pradesh	32	10,845,907	3943	0.364
10.	Rajasthan	14	4,979,301	1768	0.355
11.	West Bengal	23	13,943,445	4475	0.321
12.	Madhya Pradesh	23	7,225,833	2286	0.316
13.	Bihar	17	5,278,361	1479	0.280
14.	Haryana	12	2,254,353	623	0.276
15.	Assam	4	878,310	196	0.223
16.	Manipur	1	198,535	40	0.201

Source: Status of MSW generation, collection, treatment and disposal in class-I cities (CPCB, 2000).

Urban solid waste management is considered one of the most immediate and serious environmental problems confronting urban governments in low- and middle-income countries. The severity of this challenge will increase in the future given the trends of rapid urbanisation and growth in urban population. Using an alternative method, waste biomass is converted into larvae and residue. The larvae consist of 35% protein and 30% crude fat. This insect protein is of high quality and is an important feed resource for chicken and fish farmers.

Feeding waste to larvae has been shown to inactivate disease transmitting bacteria, such as Salmonella sp. This implies that the risk of disease transmission between animals and humans is reduced when using this technology at farm level or when treating waste of animal origin in general (e.g. chicken manure or slaughterhouse waste). However, risk reduction is achieved mainly through waste reduction (80%) rather than through pathogen inactivation. If treatment is applied at the source of bio waste generation, the costs for waste transport and space requirements for landfills can, thus, be reduced drastically. Such organic waste treatment could furthermore reduce open dumping, which is still an unfortunate reality in low- and middle-income settings. The residue, a substance similar to compost, contains nutrients and organic matter and, when used in agriculture, helps to reduce soil depletion.

Maggot

A maggot is the larva of a fly (order Diptera), it is applied in particular to the larvae of Brachycera flies, such as houseflies, cheese flies, and blowflies, rather than larvae of the Nematocera, such as mosquitoes and Crane flies. Maggot is not a technical term and should not be taken as such; in many standard textbooks of entomology it does not appear in the index at all. In many non-technical texts the term is used for insect larvae in general. Maggot-like fly larvae are of wide importance in ecology and medicine; among other roles, various species are prominent in recycling carrion and garbage, attacking crops and foodstuffs, spreading microbial infections, and causing myiasis (Willis, 2008).

II. RESEARCH METHODOLOGY

Materials needed for the experiment and method of analysis were discussed in the following different sections.

Collection of Sample

The house fly maggots were collected. The initial wet weight of each larvae was approximately 5mg because a larva with a weight below 5mg is difficult to handle and to observe changes. The age of larvae was 4-5 days after egg hatching (Newton.et.al., 2005 and Jack et.al., 2017).

Experimental Setup

The experiments were conducted in trays. The size of tray was 1mx1mx9inches and which is locally available in the market. Two trials were conducted to observe the growth of larva in specific intervals viz., 1stday, 3rd day, 5thday and 7thday. The following analyses were taken-up to identify the various parameters.

Moisture Content

Sampling and feeding were performed every two to three days. Added solid waste amounts were calculated. While sampling and feeding, larvae were transferred into another tray. Residual material of the previous tray was dried for atleast 24hours at 105^{o} C to determine its dry mass. At each transfer, five randomly selected larvae were removed for further analysis. The selected larvae were weighed (wet mass). The samples were then dried. The weight of the dry material was then recorded, and the moisture content was obtained using the equation

$$\text{Moisture content } [\%] = [(\text{wet weight} - \text{dry weight}) / \text{wet weight}] \times 100$$

pH

Activities of acid producing bacterial communities have been considerably affected by pH of the system. Hence pH is an important parameter affecting the growth of house fly. Ma.et.al.,2008 examined the effect of initial pH of substrates on survival and growth of BSF and found a significant increase in BSF weight at a pH of 6.0, 7.0 and 10.0. No growth was observed below a pH of 1.8 and the lowest growth was observed at a pH of 2.0 and 4.0 (Ma.et.al., 2018).

Total Hardness

The hardness in the organic waste (vegetable) was tested in laboratory. The hardness was identified by titration method using EDTA(Ethylene Demine Tetra Acidic Acid) solution in burette and Ammonia as buffer solution Erichrome black T as indicator. The titration was conducted for two trials and for two times. The average value was taken as hardness of waste.

Waste Reduction Index

To take into account not only the overall material reduction but also the time the larva require to reduce the amount of solid waste, the waste reduction index was calculated using the overall degradation (D), divided by the number of days the larvae fed on the material

WRI = (D/t)x100

D = (W-R)/(W).

Where W is the total amount of solid waste applied during the time 't' and 'R' is the residue after time 't'. The factor (100) is used to give the index a practical value. High 'WRI' values indicate the good reduction efficiency.

III. RESULTS AND DISCUSSION

The experiment was conducted under aerobic condition. The size of both tray are same i.e.,1meter X 1meter X 9inches as length, breadth and height. In the first tray, 15 maggots of housefly (Musca domestica) were added along with waste of three kilogram. In the second tray, 10 maggots were added with the same weight of waste. Before adding, the weight and size were measured. Initially, it was two millimetres in size and average weight was 0.113grams. The weight of maggot was increased from 0.113 to 0.148grams at seventh day i.e., 31 per cent. The size of maggot was increased by three mm i.e., at the seventh day size was five mm.

The results of the experiment are furnished in Table-2 and pictorial representation is given for pH, moisture and total hardness from Fig.1 to Fig.3

It could be seen from the table that the moisture of waste was initially 56 per cent and that was decreased to 52 per cent at seventh day. The result revealed that the growth of maggot was found to be optimum in the range of 52 to 56 per cent of moisture. But in the trial two, initially the moisture was 59 per cent and it was reduced to 53 per cent. Hence, it was found that 52 to 55 per cent of moisture would be suitable for the growth of maggots.

Initial pH of waste was identified as 3.27 and 3.30 in trial one and trial two respectively. At seventh day of experiment, pH in trial one was observed as 6.69 and in trial two it was 6.72. It was found that there was very meagre difference in pH of both trials. According to Beulah Gnana Ananthi and Partheeban (2001), the optimum pH for growth of maggot was 6.0 to 7.5. The present study confirmed that the growth of maggot was identified as the most advantageous condition i.e., the growth of maggots was optimum in the alkaline condition of waste.

Initial total hardness of waste was identified as 720mg per litre in both trials. It was decreased to 120mg per litre in 3rd day and again it was increased to 162mg per litre at the end in trial one. But in the case of trial two, the initial hardness was decreased to 240mg per litre in 7th day. This might be due to decrease of carbon-dioxide level in municipal waste and increasing level of pH.

In 7th day, the weight of residue was 1.8kg and the total degradation was worked out using the formula given in method of analysis and it was 0.40. Therefore, the waste reduction index was calculated as 5.7per cent.

Table-2 Results of Experiment

S.No	Parameters	Days							
		Initial		3rd day		5th day		7th day	
		T1	T2	T1	T2	T1	T2	T1	T2
1.	Maggot weight(gm)	0.113	0.123	0.124	0.130	0.132	0138	0.148	0.150
2.	pH	3.27	3.30	6.39	6.50	6.60	6.65	6.69	6.72
3.	Chloride(mg/l)	500	500	120	140	132	180	150	170
4.	Total Hardness(mg/l)	720	720	120	200	140	200	162	240

IV. CONCLUSION

The study concluded that the using of housefly maggot reduces the municipal waste efficiently at micro level. The major obstacles associated with the production of housefly larvae from municipal waste on large scale seems to be technological aspects of scaling up the production capacity. Therefore, the municipal solid waste can be reduced commercially by having knowledge on housefly characteristics.

V. REFERENCES

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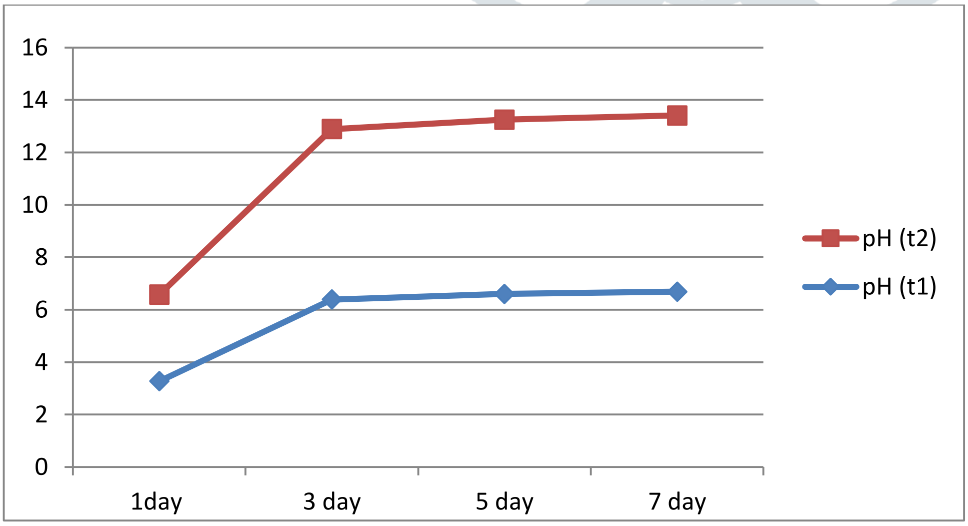

FIG-1 pH

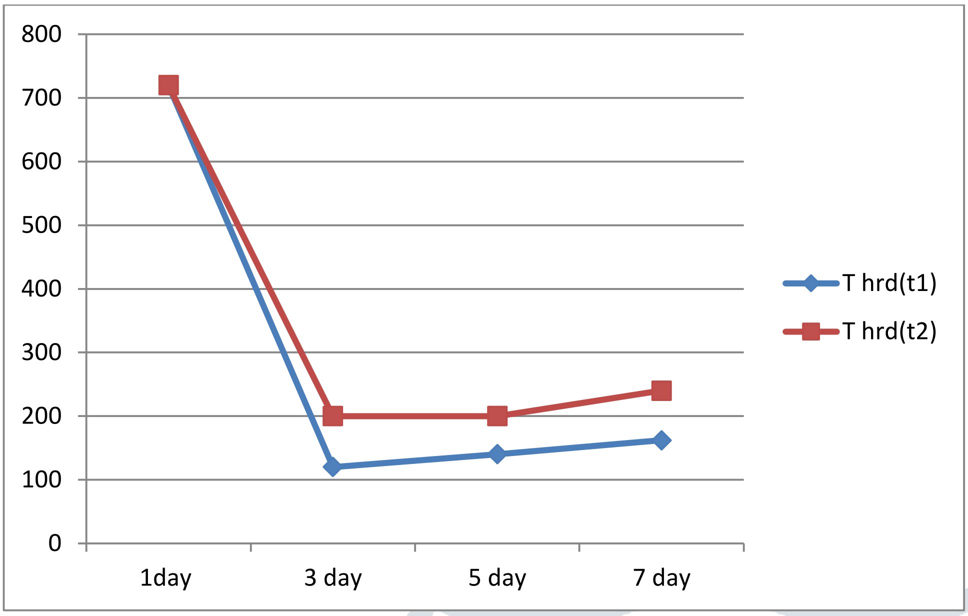

FIG-2 Total Hardness

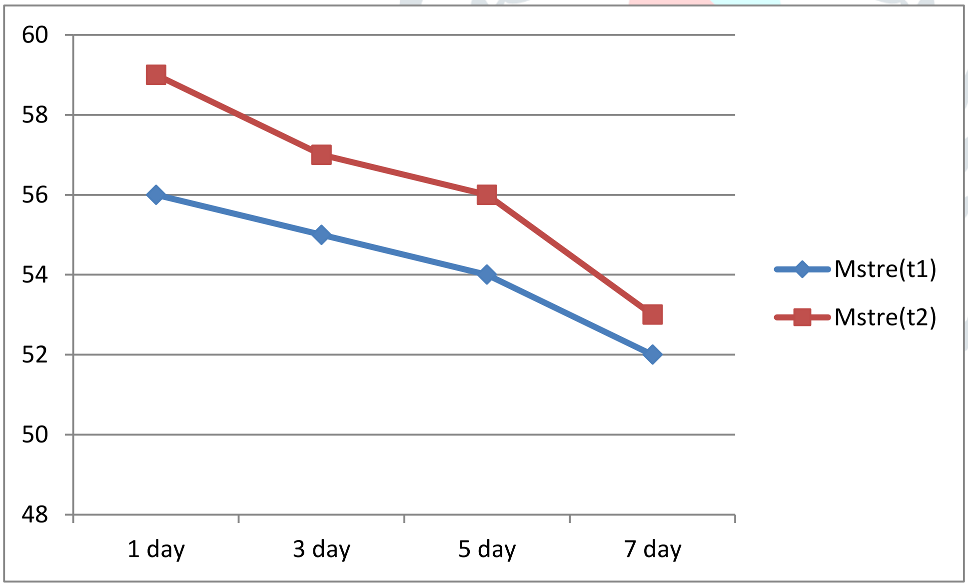

FIG – 3 Moisture Content