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Household waste reduction efficiency of *Hermetia illucens* larvae#

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Abstract

Waste management with limited resource input under minimum space is the need of the hour. Black Soldier Fly (BSF)/Hermetia illucens is a fly prevailing and flourishing in our tropical climatic condition and is a miracle insect since it can solve a multitude of global problems like waste management, animal feed production and energy production. This fly is highly reputed in converting low quality biomasses in to high protein, high energy larvae meal. In this study we are assessing the quantity of BSF larvae produced from food waste and the waste reduction efficiency of the BSF larvae. Four kilograms of food waste was kept in a modified bin with 6 replicates and the development of the larvae was through natural breeding. The study revealed that from the above said quantity, an average of 0.567kg of BSF larvae can be produced per bin and average waste reduction efficiency was 73.81%.

Keywords: *Black soldier fly, Black soldier fly larvae, food waste, natural breeding, waste reduction efficiency*

Roughly one-third of the edible parts of food produced for human consumption, gets lost or wasted globally, which is about 1.3 billion ton per year (Gustavsson *et al.,* 2011). Poorly managed waste serves as a breeding ground for disease vectors, contributes to global climate change through methane generation, and can even promote urban violence. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported. Usually various techniques like composting, vermicomposting, biogas technology etc. are being adopted for the reduction of waste. The proper and economic disposal of slaughter house wastes is also a big

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problem and organic briquettes using biomass was found to be effective method. (Arun Sankar *et al.,*2022). Nowadays an emerging technology using black soldier fly (BSF) for the waste reduction has attracted the attention of many of the farmers because it differs from all other technology by the production of feed from waste. These insects can be reared on various kinds of organic wastes like vegetable wastes, fruit wastes municipal organic solid wastes (mixed waste of discarded fruits, vegetables, and food scraps produced by households, restaurants, markets, malls, companies, and public institutions), slaughter house waste, millings and brewery side, animal manures and even human faeces (human faeces from source separation toilets, faecal sludge from onsite sanitation technologies) (Lalander *et al.,* 2019). Adult BSF do not feed during their life (Rindhe *et al*., 2019), and is not considered as a pest or a vector. They do not carry pathogens and the larval activity significantly reduced *Escherichia coli* 0157:H7 and *Salmonella enterica* (Van Huis *et al.,* 2013). The annoyance of blood-sucking and biting flies can be reduced by use of illuminated fly traps. (Praveenkumar *et al.,* 2022). Besides, reduced emission of methane during waste decomposition (Dortmans *et al.,* 2017) and prevention of housefly breeding (Bradley and Sheppard, 1984) are the additional benefits. It takes only 18-20 days for the waste reduction. The major benefit along with the waste reduction is the yield of protein and fat rich BSF larvae and fertilizer as by-product. These larvae can be fed to poultry, fishes and pigs and thus can reduce the cost on feed, which constitute around 70-75 per cent of the total expenditure. The optimum energy and lysine levels in feed are important for economic production of meat production in Japanese quails. (Shibi Thomas *et al.,* 2021.)

Thus, these insects have the potential to provide promising solutions to two of modern agriculture's growing problems: the high cost of animal feed and the disposal of large amounts of waste (Givens *et al*., 2013). In the present study we are analysing the yield of the BSF larvae from food waste through natural breeding and waste reduction efficiency of BSF larvae in such natural system.

Materials and methods

The study was conducted at Eco farm, Department of Livestock Production Management, CVAS, Mannuthy. Six modified bins (Fig. 1) were taken for the study and few holes were made at the bottom of the plastic bin to remove the lechate from the bin and another bowl was placed below the bin to collect the lechate. A hole was placed on the lid of the bin and a T shaped PVC pipe was fitted in that hole, so that BSF (Fig. 2) can enter into the bin. One eggie made of cardboard piece was hung from the lid, and another eggie made of two tile pieces rubbered together were also placed in that bin. An arrangement for the larvae to crawl out of food when it reaches the prepupa stage was also made. Initially two kg of waste was put in each bin and all bins were placed in an open area under the shade of trees. The pungent smell of the waste attracted the BSF and they laid eggs on the eggies, near the corrugated surfaces of T shaped PVC pipes and also in the leafy portion of the vegetables in the waste. Eggs (Fig. 3) hatched within 4-5 days and larvae (Fig. 4) fell into the waste (the whole steps from the attraction of the flies till hatching of larvae are mentioned as natural breeding in this article). After 12 day of initial charging another two kg waste was put in each bin and the larvae were harvested on 18th day. Weight of the larvae and weight of the residual waste in each bin were measured. Thus, average quantity of larvae/bin and average waste reduction efficiency was calculated. Weight of the residual food waste after treatment and waste reduction efficiency were calculated by the following formula:

Weight of the residual food waste after treatment = Weight of the bucket with larvae and waste after treatment - (weight of the bucket+ weight of the larvae)

$$\text{Substrate reduction (\%)} = \frac{\text{Total waste added - residual waste after treatment}}{\text{Total waste added}} * 100$$

Results and discussion

Weight of the bucket (A), weight of the bucket with larvae and waste (B), Quantity of larvae produced from each bin (C) weight of

Fig 1. Modified bin with food waste

Fig 2. Black Soldier Fly

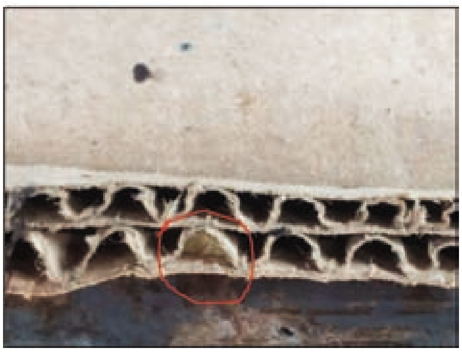

Fig 3. Egg of BSF

Fig 4. Black soldier fly larvae

residual waste after treatment (D) and waste reduction efficiency (E) are enlisted below (Table 1).

Average quantity of BSF larvae produced from each bin =

$$\frac{0.635+0.655+0.675+0.340+0.590+0.505}{6}$$

= 0.567 kg

Average waste reduction efficiency =73.81%

In the present study using a modified bin of 6 replicates and each containing four kg of food waste we could harvest an average of 0.567 kg of BSF larvae/bin. Gligorescu *et al*. (2020) used about 190 kg of food waste to produce 79 kg of BSF larvae by adding young BSF larvae, produced by artificial breeding of BSF to the waste. But in our study natural breeding was opted to allow the larvae to develop in the waste without artificial breeding, which might be the reason for lesser production. In the present study, the waste reduction efficiency was 73.81 per cent. Diener *et al*. (2011) studied the waste reduction and insect biomass produced with different types of wastes by the BSF larvae. It was found that 68 per cent waste reduction and a higher insect biomass yield with municipal organic waste followed by chicken manure (50 per cent reduction) and pig manure (39 per cent reduction). A greater waste reduction efficiency observed in the present study might be due to the difference in the content of the food waste and also due to the natural system of breeding adopted.

Conclusion

Present study revealed an average production of 0.567 kg of BSF larvae/bin from four kg of waste and their average waste reduction efficiency was 73.81 per cent. Though, a number of waste reduction methods do exist, BSF technology is an ideal one for waste reduction in home or in farm, as waste reduction is accompanied by the production of feed and fertilizer. Thus, BSF technology is a promising farmer friendly tool for waste management in animal farms with simultaneous production of a protein and fat rich larvae meal. As a developing country, it is high time that the potential of this fly be extensively utilized for extensive waste management strategies with emphasis on its pathogen inactivation efficiency.

Table 1. Parameters for assessing substrate reduction

	Bin 1	Bin 2	Bin 3	Bin 4	Bin 5	Bin 6
A (kg)	1.470	1.360	1.470	1.360	1.625	1.625
B (kg)	2.425	2.320	3.135	4.295	3.045	3.375
C (kg)	0.635	0.655	0.675	0.340	0.590	0.505
D (kg)	2.425-(1.470+.635) = 0.32	0.305	0.99	2.595	0.83	1.245
E (%)	92.00	92.375	75.25	35.12	79.25	68.87

Conflict of interest

The authors declare that they have no conflict of interest.

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