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Innovative Approach towards Solid Waste Management on Agonda Beach in Goa

Shriraj N. Naik[1], Mr. Amar A. Katkar[2]

[1]*PG student, Department of Environmental Engineering, Kolhapur Institute of Technology's College of Engineering, Kolhapur, Maharashtra, India*
[2]*Assistant Professor, Department of Environmental engineering, Kolhapur Institute of Technology's College of Engineering, Kolhapur, Maharashtra, India*

Abstract - *The main aim of this study is to tackle the problem of solid waste management at Agonda beach, Goa. A questionnaire survey was carried out to collect respective information about Solid waste such as generation rate, composition, mode of present disposal practice etc. It was found that the restaurants on an average are generating 20kg of waste daily, which is around 84.53% of the total solid waste generated. Black Soldier Fly Larvae (BSFL) composting technique was adopted to treat the organic waste. A prototype model was prepared and studies on volume reduction and BSFL life cycle were carried out. The cost economic study of the solid waste was carried out and chemical testing of the end product i.e., the compost was carried out.*

1. INTRODUCTION

Goa is one of the famous tourist destinations in India. Huge number of tourists visit Goa during the peak tourism season i.e., from October to May. Most of these tourists are attracted towards the coastal areas. Some of the famous beaches in Goa like Baga, Agonda, Colva, Benaulim etc come under Panchayat. In Goa majority stress regarding Solid waste is given in municipal areas and the areas which come under the panchayat are generally neglected. Areas under the panchayat, mostly the coastal regions lack proper disposal methods and transportation systems are also absent.

Fig 1: Open dumping of waste at Colva beach entrance

Solid wastes are posing serious problems as the available technologies are not adequate for their safe disposal [3]. Proper segregation, collection, recovery and systematic disposal are very rarely followed in India, particularly in rural areas [4]. This leads to open dumping of waste which cause nuisance in the coastal areas. To tackle these problems Decentralized waste management techniques should be adopted. Many Decentralized techniques such as Bio methanation, Vermicomposting and composting are available in the market. For the present study we have adopted Black Soldier Fly Larvae (BSFL) composting technique.

Currently it is one of the latest and innovative technique present in the market. We can yield multiple benefits from this technique; As it decomposes waste at rapid rate also it produces the compost and the larvae can be used as animal feed [8]. In the present study scientific study has been done on a prototype model. Studies such as organic waste reduction rate and life cycle analysis of BSFL has been done. The cost economic study related to BSFL composting unit has been carried out during this study. Furthermore, the compost which we got from the unit was chemically tested for parameters like Nitrogen, Phosphorous, potassium (NPK), Organic carbon and C:N ratio.

1.1 Study Area

Agonda beach is one of the famous beaches in Asia and it is also facing problems related to Solid waste disposal therefore Agonda beach was selected as the study area. Agonda is located in Canacona in South Goa, India. The beach also serves as nesting ground for Olive ridley sea turtles in the month of September. It is one of the famous beaches in Goa which comes under panchayat region.

Proper transportation and treatment of waste is not carried out in this region. Around 50 Restaurants/ Shacks are located on its coast. With this many number of restaurants, the need for a proper treatment facility is a

must. Also, there are resorts and residential buildings in the vicinity adding to the need of proper treatment facility.

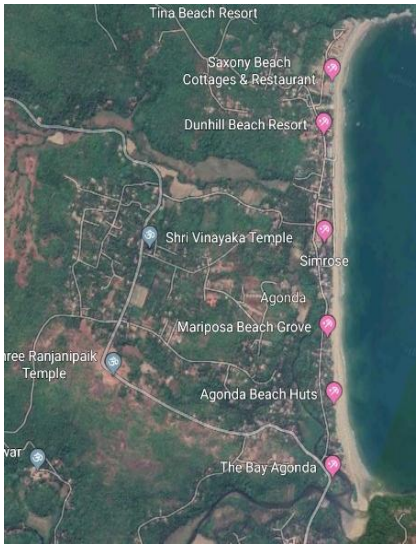

Fig 2: Agonda Beach

2. METHODOLOGY

2.1 Data collection:

Proper quantification and characterization are essential for successful solid waste management [4]. A Questionnaire was prepared for collecting data like composition and quantification of Solid waste. The composition was done and the waste was categorized into following categories; Food waste, Paper waste, Plastic waste, Glass waste and metal waste [9]. Paper, glass and metal waste are stored separately and are recycled. Two types of questionnaire were prepared, one for the restaurants and resorts and the other for the households. The first survey was conducted in 20 restaurants and resorts on Agonda beach. The household survey was conducted in 20 houses which are in the near vicinity.

The data from the questionnaire survey led to a conclusion that the majority of the waste generated in the area under study is food waste. Each Restaurant/shack/resort generated 20kg/day of vegetable leftovers, cooked food waste. This data helped us in calculating the capacity of the BSFL composting unit. Along with the data properties of waste like pH and density were found out while conducting the survey. The average pH value of the food waste was found to be 7.5 and the density of the food waste was found to be 453.46 kg/m^{3}. Data regarding the current collection and disposal practices was also collected from the local panchayat authorities. In the present study an attempt is made to suggest best disposal practice for the people of Agonda.

NAME: Date:

1. Number of Households
2. Annual income of the family (approx.)
3. Approximately kilograms of solid waste accumulated daily in the home
4. Distance of waste collection bin from home
5. In how many days do you dispose your waste in the waste collection bin?
6. How does the Municipality/Panchayat collect the waste?
7. How many times does the Municipality/Panchayat collect the waste weekly?
8. Do you throw the following items in the waste bin?

   Paper waste Glass items Plastic items
9. If not, then how do you use them?
10. How much organic waste is produced in home?
11. At what time of the year the waste generation is more?
12. When you are outside/travelling somewhere do you use the dustbin?
13. What type of disposal technique do you use?

Fig 3: Questionnaire for Restaurants and resorts

Table 1: Composition of solid waste from Restaurants and Resorts

Waste type	Total Weight
Food Waste	326.1(84.53%) kg/day
Paper Waste	36(9.33%) kg/week
Plastic Waste	20(5.18%) kg/week
Glass Waste	2.2(0.57%) kg/week
Metal Waste	1.45(0.37%) kg/week

NAME: Date:

1. What is your Business?
2. What kind of Waste is generated at your place?
3. Approximately kilograms of waste collected daily
4. Distance of nearest waste collection bin
5. In how many days do you dispose your waste in the waste collection bins?
6. How does the Municipality/Panchayat collect the waste?
7. How many times does the Municipality/Panchayat collect the waste weekly?
8. At what time of the year the waste generation is more?
9. What type of facilities would you love in future to tackle the waste management problems?

Fig 4: Questionnaire for Households

Table 2: Composition of solid waste from Households

Waste type	Total Weight
Food Waste	31.69(82.33%) kg/day
Paper Waste	3(7.79%) kg/week
Plastic Waste	3.8(9.8%) kg/week
Glass Waste	–
Metal Waste	–

2.2 Model preparation:

A prototype model of size 40 X 35 X 60 cm was prepared for the present study. A GI metal sheet was used for the fabrication of the prototype model. The model was provided with a vent pipe to prevent anaerobic conditions inside the unit. A valve at the bottom was provided for collection of leachate. An outlet is provided for the larvae to crawl out of the unit when they attain the pupal stage. Few corrugated sheets are provided inside the unit for the adult fly to lay eggs. The model was then painted with anti-rust paint to prevent the rusting of the metal. The model was placed at an elevated level to prevent the entry of pests. Around the unit a water barrier was created to prevent the entry of ants.

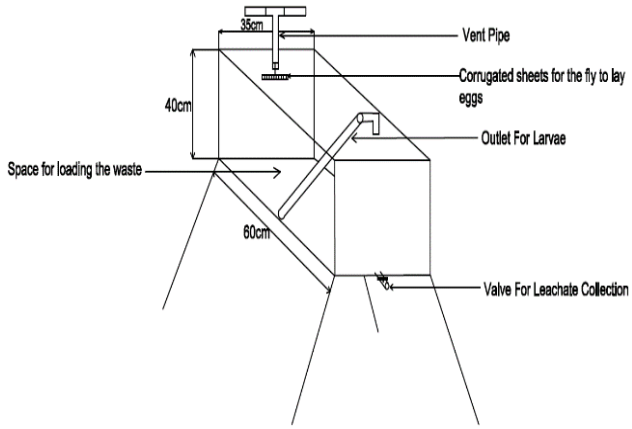

Fig 5: Design of Prototype model

Actual Volume of composting unit = 0.60 x 0.40 x 0.35

$=0.084 m^3$

Density of the Food waste is found to be 453.46 kg/m^3

Therefore, the total capacity of unit = 0.084 x 453.46

Total capacity = 38 kg of waste

1kg of waste was added in the composting unit for a period of 30 days

After the 30 days no waste was inside the unit.

The compost was kept inside the unit for a period of 20 days for maturation.

After 20 days the compost was removed from the unit and kept for dewatering.

Fig6: Prototype model

Fig7: Model placed on site

3. RESULTS AND DISCUSSION:

3.1 Life cycle study of BSFL:

Studies on the prototype model were done for a period of 40 days. At the initial stage of the study few black soldier fly larvae 5-6 days old were introduced inside the composting unit. Also, some larvae at their pupal stage were brought and kept aside for hatching. The pupal stage larvae were placed inside a net cage also termed as 'love cage' so that after hatching the fly can reproduce faster and lay eggs. Some corrugated sheets were kept inside the cage for the fly to lay eggs. A female black soldier fly lays around 500-600 eggs at a time.

For a period of 30 days 1kg of daily Food waste was applied inside the composting unit. The eggs laid by the black soldier fly took around 4 days to hatch. It took 15-16 days for the larvae to fully grow and go into prepupal stage. Prepupal stage lasts for around a week. After this stage they attain the pupal stage and crawl out of the composting unit. Larvae at the pupal stage has a lifespan of 10-20 days before they hatch into a fly.

These larvae at the pupal stage can be sold as feedstuff for animals and fishes. The adult fly has a lifespan of 5-6 days within which it reproduces and lays eggs.

Fig 8: BSF while laying eggs

Fig 9: Eggs of BSF

Fig 10: Larvae after 6 days of feeding waste

Fig 11: Larvae after 12 days of feeding waste

Fig 12: Larvae at the prepupal stage (after 16 days of feeding)

Fig 13: Larvae at the Pupal stage

3.2 Volume Reduction Calculation:

Actual Volume of composting unit = 0.60 x 0.40 x 0.35

$=0.084m^3$

Density of the organic waste is found to be 453.46 kg/m^3

Therefore, the total capacity of unit = 0.084 x 453.46

Total capacity = 38 kg of waste

1kg of waste was added in the composting unit for a period of 30 days

Therefore, now the volume for 30kg capacity will be $0.0662m^3$

The volume after 30 days was found to be $0.036m^3$

Volume reduction = {(0.0662-0.036)/0.0662} X100

= 48.7%

From the survey we found that each restaurant/ shack/ resort on Agonda beach, Goa generated 20kg/day of food waste. From the prototype model study, we found out that we get a volume reduction of about 48.7%. therefore, for each restaurant /shack /resort we can provide two units each of $0.5m^3$ capacity. One running and one standby.

3.3 Cost Economic study of BSFL Composting unit:

- From the present study it is found that after feeding 1kg of waste daily for a period of 30 days we get 8 kg of compost.
- Therefore, for 20kg of daily waste generated by the shacks/ restaurants, we will get 150kg of compost per month.
- Price of 1kg of compost = Rs 30
- Therefore, price for 150kg compost = 150 X 30

  = Rs 4,500 per month.
- For the present study, after 30 days around 500-600 larvae were harvested from the composting unit.
- Therefore, for a $0.5m^3$ unit with a 20kg feed daily one will be able to harvest around 10,000 larvae per month.

- Price of larvae: 1 unit = Rs 2
- Therefore, for 10,000 units = 10000 X 2 = Rs 20,000

Table 3: Total cost Estimation for Black Soldier Fly Larvae Composting Unit

Sr no	Particulars	Amount (Rs)
	Capital investment	
1	Cost of BSFL composting unit	10,460
	O&M per month	
1	Labour Salary	3000
2	Hand tools for labour	1900
3	Lump sum	2000
	Total per month O&M	6900
	Per Annual O&M	82,800
1	Total Annual Revenue	2,94,000

3.4 Testing of Compost

The compost obtained from the BSFL composting unit was kept for maturation for a period of 15 days. After maturation the compost was kept for dewatering for 6 days and then dried for 2 days. Then it was sent for its chemical testing. It was tested for parameters like NPK, organic carbon and C:N ratio. All the parameters analyzed are within the required limits which allows the use of the compost as organic fertilizers according to The Fertilizer Control Order 1985 (Amended 2006) Schedule IV, Part-D

Table 4: Parameter analysis of compost

Sr. No	Parameter	Results
1	Nitrogen	4.27 %
2	Phosphorous as P_2O_5	2.46 %
3	Potassium as K_2O	3.36 %
4	C:N ratio	4.54:1
5	Organic carbon	19.40 %

4. CONCLUSIONS

Black Soldier Fly thrive good in tropical conditions and since Goa witness similar climate, BSFL composting technique is best suited for Goa. From BSFL composting we can obtain twin benefits and problems like foul smell are absent. This technique also requires less O&M cost. Hence it is the best suited wet waste disposal technique for restaurants and resorts at Agonda beach Goa.

REFERENCES

[1] D. Sarpong, S. Oduro-Kwarteng, S. F. Gyasi, R. Boamah, E. Donkor, E. Awuah, M. K. Baah, May 2019. "Biodegradation by composting of municipal organic solid waste into organic fertilizer using the black soldier fly larvae" International Journal of Recycling of Organic Waste in Agriculture (2019) 8 (Suppl 1):S45–S54 https://doi.org/10.1007/s40093-019-0268-4

[2] S.N. Rindhe, Kumar Manish Chatli, R.V. Wagh, Kaur Amanpreet, Mehta Nitin, Kumar Pavan and O.P. Malav, November 2019. "Black Soldier Fly: A New Vista for Waste Management and Animal Feed" International Journal of Current Microbiology and Applied Sciences, Volume 8.

[3] Mohammed Yaseen, S. Suresh, Aravinda H.B, January 2017. "Quantification of solid waste and management of Davanagere city" Open access international journal of science and engineering Volume 2, Issue 8.

[4] V. Ramakrishna, Ch. N. Subrahmanyam, S. Bhanuchand, B. Someswara Rao and A.N.V., kumar Arun, October 2016. "Municipal Solid Waste Quantification, Characterization and Management in Mylavaram" IOSR Journal of Mechanical and Civil Engineering Volume 13, Issue 5, Ver. IV.

[5] Singh Rozita, April 2015. "Exploring the potential of decentralized solid waste management in New Delhi" https://www.researchgate.net/publication/275645551 DOI: 10.13140/RG.2.1.5118.6088

[6] Kokate B. Vishvajit, V.V. Sasane, March 2014. "Decentralised Approach for Municipal Solid Waste Management Using Vermitechnology" International journal of innovative research in science, engineering and technology Vol. 3, Issue 3.

[7] Singh Satpal, July 2013. "Decentralized solid waste management in India: A perspective on Technological options" Cities - the 21st century India.

[8] Diener Stefan, Zurbrügg Christian, Roa Floria Gutiérrez, Dang Hong Nguyen, Morel Antoine, Koottatep Thammarat, Tockner Klement, January 2011. "Black soldier fly larvae for organic waste treatment - prospects and constraints" Proceedings of the WasteSafe 2011 – 2nd International Conference on Solid Waste Management in the Developing Countries.

[9] M. Rafee Majid and Owee Boon Hwee, December 2007. "Sustainable solid waste management for island resorts: potential for perhentian island, terengganu." Research paper presented at the 1st International Conference on Built Environment in Developing Countries.

[10] Singh Gurudeep, Siddiqui Tauseef Zia and Jain Anshul , January 2007. "Sustainable Development through Integrated Municipal Solid Waste Management (MSWM) Approach – A Case Study of Indian School of Mines Campus". Proceedings of the International Conference on Sustainable Solid Waste Management.

[11] Unnikrishnan Hita, Gowrav Brunda and Jathanha Sabrina, 2006. "Sustainable Decentralized Model for Solid Waste Management in Urban India".