Quantitative assessment of biodegradable kitchen waste generation from three star hotels in Chandigarh and its potential for composting

Simranjit Kaur, Dinesh Goyal, Randeep Singh Saini

***Abstract*— Due to the expansion of business profile, Chandigarh city has become a hot spot for hospitality sector, which is one of the major sources for generation of biodegradable kitchen waste. The present study was conducted to assess the quantum of biodegradable kitchen waste generation from three star hotels in Chandigarh, waste management practices being followed and potential of biodegradable waste for composting. The study involved survey in 11 three star hotels of Chandigarh (India) out of 70 three star hotels located in the province. A questionnaire was used to collect the data from hotel staff. The biodegradable waste generated was quantified and composted using a lab scale mechanical composter. The results have shown that the waste generation rate varies from 40-80 Kg/day/hotel. Segregation of waste at source is being partly implemented as vegetables peelings are mixed in dry waste and used tissues in wet waste. The dry waste is picked by municipal workers from all the hotels and is dumped at the landfill site however the wet waste is being given to piggeries by most of the hotels on daily basis. Out of the total waste generated, 38-44% of waste generated is biodegradable kitchen waste which can be composted to get a compost of C/N ratio 22.79 ± 4.43. This compost can be used as soil amending agent in gardening. Thus the kitchen waste generated from hotels has a good potential for composting which can done on a small scale through a suitable decentralized system. This will help in decreasing the ultimate load on landfill and will assure environmentally sound disposal of biodegradable waste.**

***Index Terms*— composting, decentralized system, hotels in Chandigarh, kitchen waste.**

I. INTRODUCTION

With the expansion of industrial and business profile, Chandigarh, India, has turned into a major corporate destination thus making it an excellent option for hospitality chains. As the hospitality sector is expected to see significant rates of growth in the next few years [1] [2] [3], Chandigarh will also witness this growth as many new hospitality chains are coming up which would lead to an increase in waste generation by the sector [4].

Large and small business organizations are facing the pressure of environmental performance [5] and hotels all over the world are struggling with the appropriate management of various types of waste however problem is more prevalent in the developing countries. In addition inadequate waste minimization practices tremendously increase the environmental problems in Asia [6].The education on solid waste minimization is neglected in the tourism sector as compared to the education on industrial waste minimization in industries. The impacts of waste can affect the public image and environmental performance of the hotel [7] thus it is important for hotel sector to understand the need and benefits of waste management. It has been observed in Europe hotel industry that despite its importance, environmental stewardship is not always the top priority [8]. There is an urgent need for proper management of solid waste in the hotels along with engineering solution, education and compliance by everyone who deals with the hotel waste [9].

Not much literature is available on waste management in the hospitality industry. For example, a 2012 review of environment related research articles published in major hospitality journals accounted for only 58 articles in the period from 2000 to 2010 [10]. These articles were not only exclusively focused on waste management, but also discussed other types of environment-related issues and relevant research. Likewise, a 2013 review paper accounted for publications from all over the world on food waste prevention in the food supply chain and has mentioned only one publication about cafeterias in Brazil [11], two publications about the hospitality sector in general (one with reference to the UK and the other with reference to the Nordic countries) and one publication about hotel restaurants in Norway [12] [13] [14]. When resources can be found which discuss environmental management in the hospitality sector, they tend to lack the focus on the waste management aspect of environmental management [15]. These resources do discuss waste management in detail; however they are in the form of reports covering different strategies as recommendations; only with few having shown the effects of carrying out such strategies. Moreover, reports concerning waste in the hospitality industry tend to lack data specifically on food waste [13].

The World Health Organization (WHO) defines Waste as "something which the owner no longer wants at a given time." Therefore this line of thought requires a broad based approach towards the classification of what constitutes waste. Even though methods, procedures and policies are mandated to reuse and recycle, there exists significant gap when it comes to practical reality. In this article, we present and discuss the results of a survey on waste generated from 11 of 70 three star hotels of the Chandigarh province in India, the current practices of waste management and potential for composting.

To undertake this study about the waste generation and handling in hotels, a questionnaire was used to collect data. The use of questionnaires provides more responses and

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requires fewer skills to administer [16]. This also enables researchers to collect data on people's values and knowledge [17].

Sorting and weighing of waste was also implemented. The biodegradable kitchen waste was composted using a lab scale mechanical composter and the compost thus prepared, was analyzed for various physico-chemical parameters to assess its suitability as soil amending agent.

II. Materials and Methods

Chandigarh has approximate 70 three star hotels. In the present study 11 hotels were assessed for quantity of biodegradable kitchen waste generation and its present management technique. Three star hotels were selected as they have higher occupancy and are there in large number in the city. Managers of the hotels who look after the overall operations of the hotel as well as person responsible for handling environmental issues were interviewed. A questionnaire was designed taking into consideration number of rooms, number of restaurants as well as number of banquet halls in the hotels. During interviewing the managers/person responsible, the questionnaires were filled as well as process of collection and disposal of wastes was observed. The waste was sorted into biodegradable as well as nonbiodegradable waste and quantity was measured using weighing balance. The data was recorded and analyzed. Biodegradable kitchen waste was collected and composted using lab scale mechanical composter and microbial consortium "BioN". The compost was prepared after 14 days which was further analyzed for various physico-chemical parameters for assessing its use as a soil amending agent.

III. Results and Discussion

A. Location and capacity of hotels

All hotels covered in the study are located in Sector 43, Sector 35 and Sector 22 of Chandigarh city which is referral centre for the hospitality services not only for the residents of Chandigarh but also for the tourists visiting Chandigarh. The total number of rooms in these hotels is 232. The number of banquet halls, conference rooms and restaurants provided in these hotels varies from 1-3, 1 and 1-2 respectively. The details are given in Table I.

B. Waste generation

Waste generation is considered to be one of the most noticeable effects that the hospitality sector has on the environment [18]. Waste is generated from various activities performed in the hotels and is mainly related to food preparations, occupied rooms and administrative departments as well as landscaping. The waste from hotels consists of paper, cardboard, plastics, wood, organic waste, glass, metal, household waste. Out of this, the organic waste and household waste consists of food/kitchen waste, food preparations, leftover food, discarded material etc. [19] [20] [4]. The amount of waste generated from the hotels depends upon various factors such as number of rooms, banquet halls and restaurants. The detail of waste generation from these hotels is given in Table II. The waste generation rate varies from 40 Kg/day/hotel to 80 Kg/day/hotel. Out of which biodegradable waste varies from 38% to 44.07%. However in a study done in Kathmandu, Nepal it was found that 113.3 kg/facility/day of waste is generated from hotels out of which 57.8% is organic waste [21].

C. Segregation of waste and waste containers

The waste generated from hotels is segregated into dry and wet waste in all hotels covered under the study. The wet waste consists of the leftover food, rotten vegetables, vegetable peelings etc. along with tissues and poly bags due to improper segregation. Thus the wet waste is not completely the biodegradable waste. The dry waste consists of recyclables, paper waste, sweeping waste, packing's etc. Separate containers are provided for collection and storage of wet and dry waste in the kitchen area. However the wet waste from rooms is generally mixed with the dry waste.

D. On site transportation and temporary storage area

The waste in collected manually from all the rooms, restaurants, banquet halls etc. Then it is shifted manually to a temporary collection bin where all the dry waste is stored till the same is picked by the Municipal workers. The wet waste bin is provided in the kitchens from where it is given to piggeries. Both dry and wet waste is picked once in a day between 8 AM to 11 AM.

E. Biodegradable kitchen waste management

The wet waste from all the hotels is temporarily stored at site in collection bin from where it is daily picked by the piggeries. The parts of tissues, poly bags etc. which are mixed with the wet waste are removed by the piggery owners on their own before feeding to animals.

No facility for treatment of biodegradable waste within the premises is provided or proposed. Segregation of waste being done is also not proper.

F. Offsite transportation of waste

The wet waste is collected by individual piggery owners from the hotels and transported using a two wheeler or a four wheeler vehicle to their piggery farm.

The dry waste is picked by the municipal workers using a cycle cart and disposed to the sehaj safai Kendra of the Sector. Sehaj Safai Kendra's have been provided in 35 out of the 56 sectors for primarily storage before getting transported to the dumping site [22]. Waste is brought to this community Sehaj Safai Kendra's with the help of handcarts during primary collection and is emptied in storage containers. Segregation of waste is carried out by rag pickers and sweepers in informal way in these Kendra's [23] [24]. Trucks or dumpers can also enter these Sehaj Safai Kendra's and they pick up the waste from these storage sites to the disposal site. As per CDPR, 2010, maximum budget of Municipal Corporation, Chandigarh is used in collection and transportation of waste [25].

G. Final disposal of waste

The food waste acts as a food for the pigs in the piggery farm and is eaten by them.

The dry waste from the sehaj safai kendras is picked by trucks and disposed off to the open dumping site at Dadu majra. Part of the waste of whole city is converted to RDF at the plant installed by JP Group at Dadu Majra. Although 90 metric tonnes of waste generated daily from hotels, vegetable markets, drainage pipes and so on is not taken by the plant and is directly disposed to the landfill site [26].

H. Biodegradable kitchen waste – potential for composting

The biodegradable kitchen waste was collected from hotels and was composted at Eco Laboratories and Consultants Pvt. Ltd, Sector 74, Mohali using lab scale mechanical composter and microbial consortium "BioN".

BioN - is a liquid concentrate containing consortium of naturally occurring (not genetically altered in any way) beneficial microorganisms isolated and selected for desirable properties for treatment of biodegradable solid or liquid wastes. The stock solution is a mix of *Paenibacillus sp.* (x 106 cfu/ml); *Trichoderma reesei* (x 106 spores/ml); *Bacillus sp.* (x 106 cfu/ml); *Saccharomyces sp*. (x 106 cells/ml). The culture has been developed under mutual agreement between Science & Technology Entrepreneur's Park (STEP) Thapar University, Patiala and Eco Laboratories & Consultants Pvt. Ltd., E-207, Sector-74, SAS Nagar. BioN is free of pathogens as reported under Test Certificate No. PBTI/FAO/230913/17629/1919 dated 4.10.13, PBTI/FAO/300713/17251/1681 dated 13.8.13, and AES-60-290713-05 dated 5.8.13.

Mechanical Composter – The key features of Mechanical Composter are described below:

- Designed to handle 25 Kg of waste per batch.
- Thermal Jacket in outer body provided to control temperature.
- Digital moisture indicator.
- Waste inlet point and compost outlet point provided.
- Internal cylinder with central shaft having impellers and cutters.
- Material of construction is stainless steel.
- Control panel with temperature controller cum indicator provided.

The waste was mixed and grinded in the composter at 40°C and saw dust @ 15% was added to this mixture. The material was allowed to mix in the composter for 30 min and was thereafter taken out for maturing. After maturing the compost for 14 days, it is ready for use. The input material as well as compost prepared was analyzed for various physico-chemical parameters and details are given in Table III.

The compost prepared has a C/N ratio of 22.79 ± 4.43. In general, the C/N ratio of completely decomposed compost should be from 16 to 20 [27]. However another study says that C/N ratio of 10 - 20 generally indicates the maturity of compost; although the higher ratio cannot be concluded as not mature enough, as this can be because, C is not in an available form [28]. It is also said that the ideal compost feedstock mixtures should have an initial C:N ratio of about 30:1 [29], decreasing to less than 20:1 as composting process proceeds. However a study on municipal solid waste characterization from 59 Indian cities indicated quite high C:N ratio (>50) in several cities [30].

As per Municipal solid waste (management & handling) rules, 2000[31], compost should have a C/N ratio of 20-40 however compost with higher C/N ratio can be utilized for purposes other than growing food crops. Thus the compost prepared from kitchen waste is suitable for use on food crops as well as can be used in green areas within the hotels.

I. Hotel staff

The hotel staff is not much concerned about the possibilities available for solid waste management as they are more focused on getting the wet waste picked from the hotel. Companies do face this challenge to align the thinking of their business managers with their environmental managers to get everyone on the same page [32] for implementing environmentally sound waste management practices.

J. Waste management regulations

The Municipal solid waste (management & handling) rules came up in India in the year 2000 and gave emphasis on the composting of the biodegradable waste [31]. These rules have been amended on 8th April 2016 and are now called the Solid Waste Management Rules 2016 which makes it mandatory for all hotels to treat the biodegradable waste within the premises through composting or bio-methanation [33]. But there is a lack of enforcement of these rules [34] and despite these regulations waste collected is dumped in unscientific manner which adversely affects the environment and human health [35] [36] [37] [38] [39].

IV. Conclusion

In conclusion the following concerns have been identified:

1. There is a lack of awareness in the hospitality sector about the solid waste management techniques available in the market.

. As there is no legal obligation for implementing the rules and composting biodegradable waste at site thus everyone is focused on getting rid of the waste and is least bothered about its environmentally safe disposal.

Thus there is a need to sensitize people about their duty towards environment. It is also suggested that the management of biodegradable kitchen waste should be done on small scale by using a suitable decentralized system for handling of biodegradable kitchen waste so that the ultimate load on landfill can be reduced and the waste generated is handled in an environmentally sound manner. Same has also been emphasized in the Municipal solid waste manual, 2016, by central public health and environmental engineering organization (CPHEEO) [40]. To implement these waste management practices, the adjoining hotels can work collectively towards common target.

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Table I: Capacity of three star hotels covered under survey, Chandigarh, India

S.No.	Capacity of Hotels			
	No. of Rooms	No. of Banquet Halls / Capacity	No. of Conference Rooms / Capacity	No. of Restaurants / Capacity
1.	14	NP	NP	1 / 75
2.	12	1 / 100	NP	1 / 40
3.	20	NP	NP	2 / 50, 100
4.	30	2 / 300, 200	1 / 50	2 / 60, 100
5.	17	2 / 150, 250	NP	1 / 50
6.	29	NP	1 / 50	2 / 50, 75
7.	26	2/ 100, 150	NP	1/50
8.	17	1 / 125	NP	1 / 50
9.	26	3 / 50, 60, 150	NP	1 / 50
10.	16	1 / 150	NP	1 / 50
11.	25	3 / 20, 25, 70	NP	1 / 40

NP: Facility Not Provided in Hotel

Table II: Rate of waste generation from three star hotels in Chandigarh, India

S.No.	Waste Generation (Kg/day)		
	Biodegradable Kitchen Waste	Non Biodegradable Waste	Total
1.	15 ±0.5	25 ±0.4	40 ±0.9
2.	32 ±1.0	48 ±0.6	80 ±0.4
3.	23 ±0.3	32 ±0.2	55 ±0.5
4.	26 ±0.4	34 ±0.4	60 ±0.1
5.	29 ±0.2	36 ±0.2	65 ±0.4
6.	24 ±1.0	36 ±0.6	60 ±1.5
7.	29 ±0.2	46 ±0.7	75 ±0.9
8.	29 ±0.2	41 ±0.5	70 ±0.7
9.	33 ±0.2	47 ±0.3	80 ±0.3
10.	25 ±0.2	35 ±0.7	60 ±0.8
11.	29 ±0.4	41 ±0.3	70 ±0.8

Table 3: Characteristics of waste and compost

S.No.	Parameters	Waste Characteristics	Compost Characteristics
1.	pH	5.9 ± 0.22	6.98 ± 0.18
2.	Conductivity (mmho/cm)	0.48 ± 0.03	0.82 ± 0.05
3.	Moisture content (%)	65.27 ± 2.05	35.09 ± 3.18
4.	Organic Matter (%)	97.35 ± 1.31	53.32 ± 5.70
5.	Organic Carbon (%)	56.60 ± 0.76	31.00 ± 3.32
6.	Nitrogen (%)	0.97 ± 0.04	1.39 ± 0.20
7.	Phosphorus (%)	0.24 ± 0.05	0.33 ± 0.06
8.	Potassium (%)	0.01 ± 0.003	0.04 ± 0.01
9.	C/N ratio	58.09 ± 2.63	22.79 ± 4.43