Generation rate, proportion of combustible and non combustible materials and management of municipal solid waste in District Shopian, J&K, India.

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Abstract

The present investigation is an attempt to explore the composition, characteristics, and generation rate of municipal solid waste in the Shopian (J&K) by selecting five different sites with an aim to provide baseline information for the development of an efficient solid waste management system. The study revealed that the average residential municipal waste generation rates differed among sites. Daily, Site II recorded highest amount of waste generation 170.3 kg/day and minimum of 48.56 kg/day was recorded at SV. The rate of waste generation per capita varied, ranging from 0.521 kg/capita/day (SII) to 0.3455 kg/capita/day (SV). The study also revealed that the proportion of flammable material in municipal solid trash ranged from 95% at SII to 83 % at SIII, whereas the percentage of non-combustible material in municipal solid waste ranged from 18% at SIII to 5% at SII. Analysis of variance showed significant variation in % of combustible and non-combustible material content across different sites (F=3.76, P=0.003).

"Keywords": *Municipal Solid Waste (MSW), Management, Composition, District, Shopian.*

Introduction

Municipal solid waste concerns in India and throughout the world are inextricably tied to global climate change and human health. As a result, Solid Waste Management is crucial in achieving the health and sustainability aims of the Millennium Development Goals. While waste management infrastructure and services are vital to improving the health, ecology, and overall quality of life for all urban residents, they are also costly and difficult to implement (Singh and Pandey, 2001). In India, 80 to 90% of municipal waste is disposed of in open landfills without proper management or open burning, contaminating the air, water, and soil (Joshi and Ahmed, 2016; Ahluwalia and Patel, 2018). Daily, India generates around 143, 449 metric tonnes of waste, of which 111, 000 metric tonnes are collected and 35, 602 metric tonnes are handled (Kumar et al., 2017). The amount of solid trash produced is determined by economic status, business operations, eating habits, as well as geographic and meteorological factors (Kumar and Agrawal, 2020). India now generates around 147 million tonnes of trash per year, with 300 million tonnes predicted by 2047 (CPCB, 2016). The composition of municipal waste has a big influence on waste management practices (Sharma and Agrawal, 2020). Indian municipal solid waste (5 percent) typically contain food trash and grass clippings (50 percent), building and demolition debris (29 percent), glass/metal (5 percent), plastic (4 percent), cloth (7 percent), and paper (5 percent) (Ahluwalia and Patel, 2018). In India, the land area required for waste dumping has climbed from 1200 square kilometers in 2012 to 1400 square kilometers in 2021 and is expected to reach 1800 square kilometers in 2051 (Joshi and Ahmed, 2016).The quantity of municipal solid waste generated by 1018 wards in Jammu and Kashmir is 1489 metric tonnes per day (MoHUA, 2020).All houses in 137 wards of Jammu and Kashmir have embraced source segregation, and 809 wards have successfully implemented 100 percent door-to-door collection under the Swachh Bharat Mission (MoHUA, 2020). Under the Swachh Bharat Mission, Jammu and Kashmir process 16 percent of all garbage generated (MoHUA, 2020).

Study Objectives

- The present study was carried out under the following objectives:-
- To evaluate the composition and characterization of waste.
- To determine per household and daily per capita generation rate.
- To analyze the seasonal variation in waste generation among the sites.
- To develop base line data for management of solid wastes.
- To suggest effective solid waste management strategies to the concerned authorities.

Study area

Shopian or Shupiyan is a hill district in Jammu and Kashmir's Union Territory, with Shopian as its administrative unit. It is situated on the historic Mughal Road, and most of the land is covered in trees. The Pir Panjal Range runs through Shopian, making it quite frigid in the winter. In March 2007, Shopian was granted district status by the Government of Jammu and Kashmir. The Shopian district has a population of 265,960 people, according to the 2011 census (Census of India, 2011). This places the Shopian district in 577th place in India (out of a total of 640). The population density of the district is 852 people per square kilometer (2,210 people per square mile). Its population grew at a rate of 25.85% between 2001 and 2011. The sex ratio of Shopian is 951 females per 1000 males, with a literacy rate of 62.49 percent (Census of India, 2011).

Sampling Procedure

The fieldwork of the entire district was carried out to visualize the existing scenario of solid waste collection and disposal by the Shopian Municipal Committee. Several sites of the district were randomly selected. These sites were selected in consultation with the help of secondary data and suggestions provided by the authorized person of the Shopian Municipal Committee. In the present study, selection of suitable sites for municipal solid waste collection and analysis was carried out based on distance from road, habitation, and urbanization.

Materials and Methods

Sampling of solid waste in the Shopian district of Jammu and Kashmir, India was carried out on monthly basis from 2019 and 2020. Monthly waste data was converted into seasonal data by averaging over three consecutive months of a particular season. Sampling of solid waste was done at each selected site of the study area by the following methods.

Solid waste samples were collected from dustbins and open dumping sites located at five different wards of the Shopian Municipal Committee. Every month, at the end of the day, samples were collected from dustbins and dumping sites and placed in 5-kilogram polybags. Weighing of waste was carried out by using a digital balance/spring balance to estimate the amount of solid waste generated. The compositional study was carried out after the total waste generated at each location was estimated independently. Spreading, hand sorting, and segregation of samples on the ground into distinct waste components were used to determine the mean composition of waste. The total weight of each waste component/constituent was recorded after each component/constituent was weighed individually. Finally, the components identified were classified as biodegradable or non-biodegradable (Gaxiola, 1995; Rampal et al., 2002; Benitez et al., 2003).

- **Generation rate:-** A weight–volume analysis was used to determine the generation rate (GR, the weight of waste produced by a person per unit time).

$$\mathrm{GR} = \frac{\text{Weight of Solid Waste (g)}}{\text{Population} * \text{ Duration (day)}}$$

The purpose of GR measurement is to collect information that may be used to calculate the overall amount of trash that has to be handled. Weight volume data obtained by weighing and measuring each load will almost certainly provide further information on the density of different types of solid waste at a specific place. The data will be calculated as a weighted average for the entire municipality, based on the population of various areas.

- **Combustible and non-combustible substances**:- The weight percent of combustible and non-combustible substances are computed as follows. Standard methods were followed (Ahmed Bhat, 2007; US EPA, 2008).

Combustible material (%) = Plastic (%) + Paper (%) + Textile (%)

Incombustible material (%) = Metal (%) + Glass (%)

- **Net weight composition (%):-** Net weight composition (%) of constituents was calculated by using formula as:

$$\text{Net weight composition (\%)} = \frac{\text{Weight of constituent of solid waste}}{\text{Total weight of constituents}} \times 100$$

- **Moisture content (%):-** Moisture content (%) was determined by weighing the entire sample of a specific category; this is called wet weight (W_W). It is then dried in an oven at 105°C till its mass becomes constant. In the case of combustible material, the temperature shall not exceed 70 to 75°C. After drying the dry weight (W_d) is measured.

$$\text{Moisture content} = \frac{(W_w - W_d)}{W_w} \times 100$$

- **Net weight (kg) or dried weight (kg):-** Net weight (kg) or dried weight (kg) was also calculated by using the following formula as;

$$\text{Net weight (kg)} = W_{w\,-}\ \frac{(\text{Moisture content} \times W_w)}{100}$$

Results and Discussion

Consumer trends, eating habits, traditional practices of people, lifestyles, climate, topography, and economic status all influence the characteristics of MSW collected from every area. With the increased usage of packaging materials and plastics, the composition of MSW is changing.

Field measurements, observations, and conclusions were used to estimate total MSW production, which was then augmented with technical experience. Domestic waste accounts for over 70%–80% of total MSW produced, according to estimates. Non-household trash accounts for 20% of non-household waste in the studied municipality, which has a significant scale inter-and intra-district mobility of inhabitants for economic and commercial operations. Below are some details on the computation of per capita MSW generation at each location within the Shopian municipality. Based on per capita per day generation and total population (26 626 people), the total quantity of municipal solid waste produced within the municipal limits of Shopian is approximately 14000 kg/day (14 tons/day). The average residential municipal waste generation rates differed among sites (Figure 1). Daily, Site II recorded highest amount of waste generation 170.3 kg/day and minimum of 48.56 kg/day was recorded at SV. The rate of waste generation per capita varied, ranging from 0.521 kg/capita/day (SII) to 0.3455 kg/capita/day (SV) (Figure 2). SII has greater per capita waste production, which is due to the area's rapid urban expansion and economic development, which has accelerated consumption rates, resulting in higher waste generation rates.

According to the findings of this study, the average per capita trash production on a geographical scale is 0.03376 kg/capita/day, and the average per capita waste production on a temporal scale is 0.01796 kg/capita/day. The average daily waste created per person is 0.85 kilograms, according to the CPCB (CPCB India, 2018). Even though several studies on waste characterization have been published, there are only a few studies on seasonal MSW fluctuations. In 2005, the MSW generation of Srinagar city was 428 Mt/day, and prior research has revealed that MSW output has been increasing. The explanation for this might be that the town's economy has grown as a consequence of greater population and higher incomes, which has raised MSW generation rates, while people's lifestyles and eating habits have changed dramatically in recent years (TPOK, 2019). Kumar et al. (2009) found that cities with populations of 1–2 million create MSW at rates ranging from 0.19 to 0.53 kg capita1 day^{-1} across major Indian metropolitan cities, while another research found that MSW generation rates in South Asian nations average 0.52 kg capita1 day^{-1} (Kaza et al., 2018). Population density, economic position, the amount of business activity, culture, and city/region impact waste generation rates. Jammu & Kashmir, Bihar, Jharkhand, Chhattisgarh, Orissa, Goa, Assam, Arunachal Pradesh, Meghalaya, Tripura, Nagaland, and Manipur have lower waste output (less than 3841 tonnes per day) (Kumar et al., 2017). Given the high percentage of biodegradable wastes in municipal solid waste researched from Shopian Municipality, composting and biomethanation may be explored as ways to transform trash into energy. The average weight of waste created per resident per day is 0.197 kg at the time. The study found that waste output and collection were growing year after year, possibly due to population growth (Dasgupta et al., 2013; Mushtaq et al., 2020).

Table.1. The average and per capita per day municipal waste generation rate at different sites.

Shopian Municipality	Average MSW (kg/day)	Average per capita HH waste (kg/capita/day)
SI	0.21409375	0.038926136
SII	0.2521875	0.04203125
SIII	0.18765625	0.026063368
SIV	0.1936875	0.037247596
SV	0.139	0.024558304

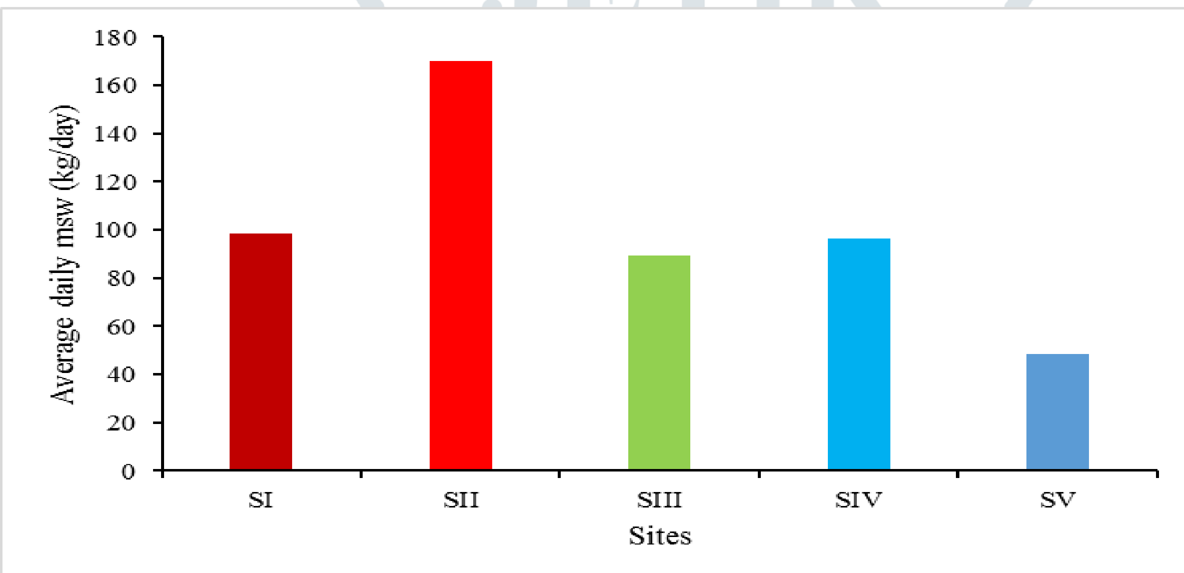

Figure 1. The average municipal waste generation rate at different sites.

Figure 2. The average daily per capita (kg) municipal waste generation rate at different sites.

The percentage of combustible and non-combustible material in municipal solid waste is one of the most essential properties. The proportion of flammable material in municipal solid trash ranged from 95% at SII to 83 percent at SIII, whereas the percentage of non-combustible material in municipal solid waste ranged from 18% at SIII to 5% at SII. The graph (Figure 3) shows the comparison of the Combustible and Non-combustible proportion (%) of the waste types at different sites. Analysis of variance showed significant variation in % of combustible and non-combustible material content across sites (F=3.76, P=0.003).

The combustible content of the municipal solid waste collected for this investigation ranged from 95 % at SII to 83% at SIII. One of the most critical factors in defining a material's burning properties is its combustible content. The higher amount of combustible content provides an opportunity for energy recovery and generation. It has been reported that 60% of municipal solid waste is carbonaceous, comprising of biodegradable material that can be converted into methane or incinerated to generate utilizable energy (Abbasi, 2018). Municipal solid waste also comprises several recyclable components like glass and metal scraps, which can be reused or recycled, thereby helping in achieving energy conservation (Moyna, 2012; Abbasi, 2018). Incineration is the most common and prevalent technology being used for the generation of energy from municipal solid waste (Chen and Christensen, 2010). Incineration techniques have the advantage of reducing the volume of municipal solid waste from 70-90% for landfilling and killing disease-causing organisms (pathogens) (Zhang, 2012).

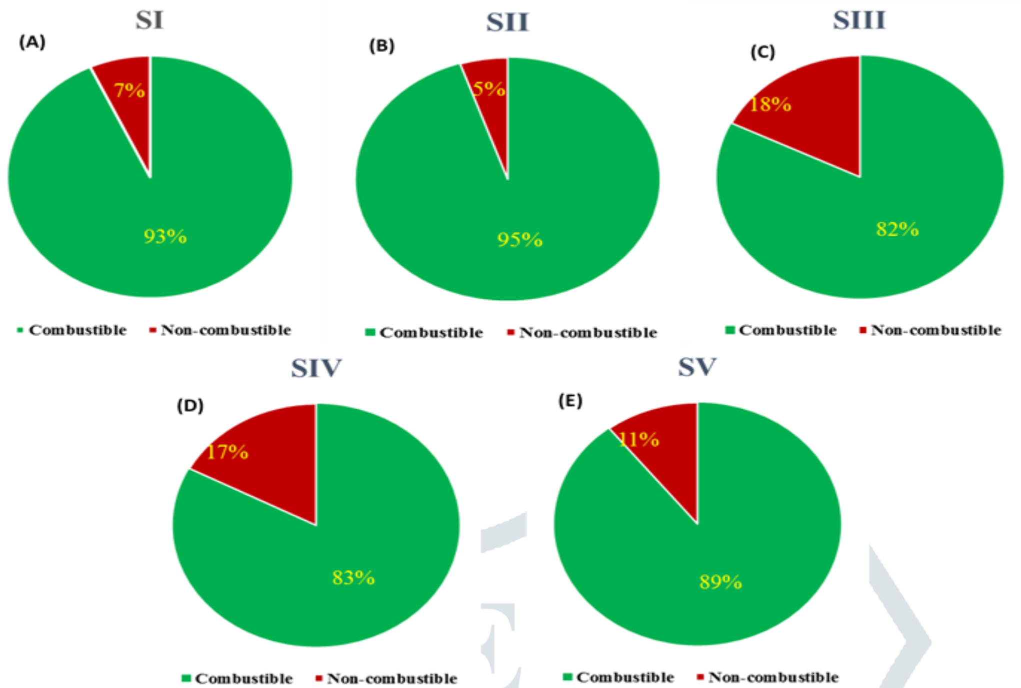

Figure 3. Composition of (%) combustible and non-combustible material in municipal solid waste at five different sites.

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