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A Study on Solid Waste Generation of Household and Potential of Resource Recovery in Dhaka, Bangladesh

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Abstract

Rapid population growth in Dhaka has resulted in excess generation of solid waste. Present solid waste management authority of Dhaka City Corporation is struggling to manage this huge amount of waste properly as there is no framework on solid waste management. The purpose of this work is to identify the present waste generation per person (Kg/person/day) in a housing society of Dhaka city and possible resource recovery potential of solid waste of the area so that the correspondent authority can have a scope of finding a framework for effective management of solid waste. The survey was conducted in 100 households of Mirpur Defense Officers' Housing Society, (DOHS) Dhaka. These households were classified into five groups according to monthly income ranging from 60,000 BDT to 160,000 BDT. The total population of the area was around 15,000. Average waste generation was found 0.74 Kg/person/ day. Around 11.10 tons of solid waste was generated per day and major fraction was food waste (on average 69.90%). About 226 Kilograms of solid waste can easily be achievable for using as compost component every day. Possible energy recovery from generated waste was equivalent to 3428.70 Kwh of electricity per day

Keywords: Generation; Components; Recovery; Energy; Electricity

Introduction

Dhaka is one of the most crowded cities in the world having area of 1463.60 square kilometers with population around 12,043,997 [1]. Excessive population generates a lot of waste per day. Solid wastes basically generate from households, supermarkets, factories, food processing plants, hazardous waste from hospitals are major concerns of Dhaka city inhabitants. As the Capital City, Dhaka generates 5340 tons of waste per day with per capita generation of 0.485 Kg/day [2]. Only 50% of this waste is officially collected by Dhaka City Corporation (DCC) whether rest of the waste are dumped openly without planning [3].

Municipal Solid Waste (MSW) contains a lot of different materials of different categories such as food, paper, tin can, hardboard, vegetables etc. [2]. In fact, municipal solid waste contains a 75.9% of waste that is generated from residential area [2]. However, composting organic fraction of municipal solid waste recycles the solid waste as safe and nutrient fraction for soil. [4] On the other hand, combustion, gasification and pyrolysis are the thermal conversion process that is used for thermal treatment of solid waste [5]. In developed countries, it is considering now as a substitute of energy that is generated by burning fossil fuel as fossil fuels' combustion process. The purpose of this work is to figure out how much resource recovery can be achieved from solid waste (Figure 1 and Table 1).

Materials and Methods

Resource recovery of solid waste

Recovery potential: Solid waste contains a significant amount of papers, wrapping bags, food waste, wood, leather and however is a good source of biomass [6]. Biomass is treated as an energy source that can contribute to sustainable development [7]. Biomass resources are available locally and conversion to secondary energy carriers is feasible without staking high capital [8]. Besides, in developing countries, rapid urbanization will eventually put challenge to effective and sustainable management of solid waste and it will become a major issue in local and national level [9]. It will be a wise pick as a source of energy as well as recyclable products in future as the volume of solid waste is increasing day by day. Moreover, it will help to reduce the volume of solid waste and will ultimately ease off the pressure from the correspondent management authority.

Resource recovery practice around the world

Material recovery: National Foundation for Agricultural Research in Crete, Greece and the School of Agricultural Technology of the Technological and Educational Institute of Crete have conducted research jointly for a long time and successfully revolutionized the composting process by including organic fraction of municipal solid waste. The quality of end product is satisfactory and it is enriched with large amount of organic content [10].

At industrial scale, Turkey has habituated the practice of solid waste recovery since 1950s, specially glass and paper recycling [11]. However, after recent investments, almost all types of plastic materials, glass, paper and metals can be recycled at industrial level [12].

Energy recovery: Malaysia has been experiencing tremendous economic growth since last two decades. Such economic growth brings higher population growth with large number of foreign workforce. The national waste generation rate increased from 0.5-0.8 kg/person/day to 1.7 kg/ person/day.

For fruitful waste management in large cities, Malaysia is switching for incineration. Energy potential from an incineration plant based on 1500 tons of municipal solid waste per day with average calorific value of 2200 kcal/kg is nearly 640 KW of electricity per day [13]. Gasification is a process that devolatilizes solid or liquid hydrocarbons, and converts them into a low or medium BTU gas. Over 100 gasification facilities are operating or under construction around the world. Some of them are operating commercially for 5 years (Table 2).

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Group	Income (Taka)	No. of Households	Average Waste Generation (kg/Person/day)	Food content (%)	Paper & Shopping bags	Polythene bags	Cans and metal containers (%)
1	60,000-80,000	25	0.67	67.63	22.12	10.05	0.2
2	80,000-100,000	22	0.7	70.27	17.19	9.05	3.49
3	100,000-120,000	18	0.76	70.62	18.74	7.05	3.59
4	120000-140000	25	0.78	71.24	15.7	11.03	2.03
5	140000 & above	10	0.83	70.21	19.19	8.04	2.56

Table 1: Survey data of 100 households in Mirpur DOHS.

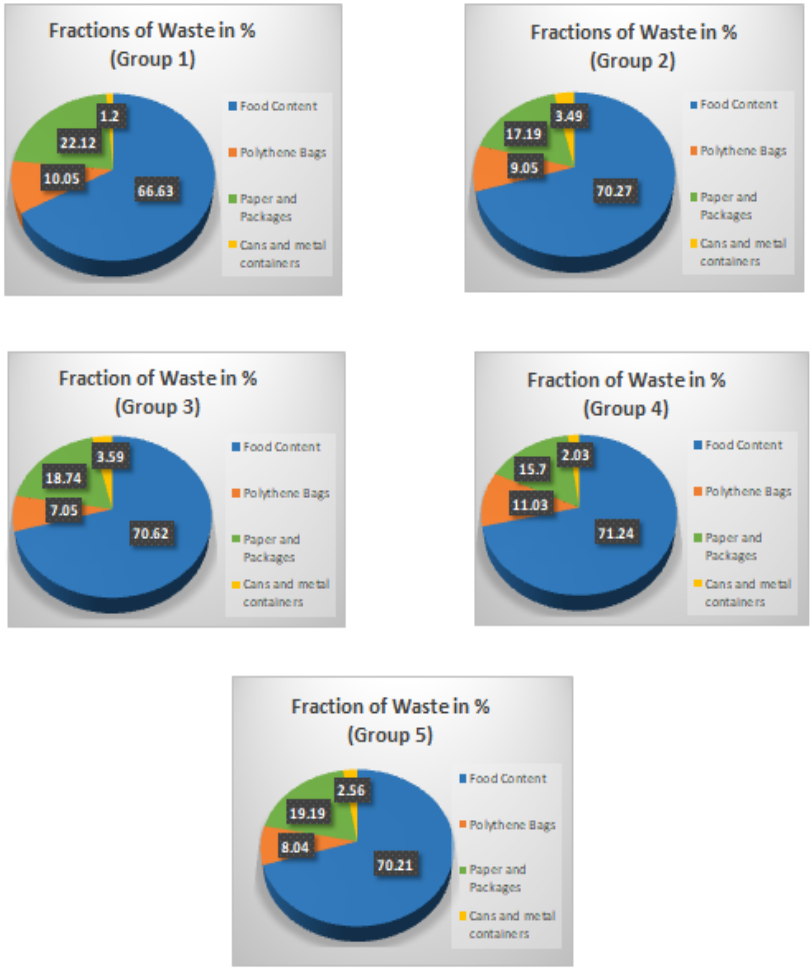

Figure 1: Fraction of different type of solid waste generated from different income group households in Mirpur DOHS.

Research Methodology

Study area profile

Dhaka city consists of 93 wards [1] and Mirpur's Defense Officers Housing Society (DOHS) is the 16th ward. It is situated at north-east part of Dhaka city. This Housing society consists 11 avenues, 1290 plots, 1 gymnasium, 2 mosques, and 2 playing fields. The area covers 138.81 acres of land. However, around 65% of the plots are occupied by households at present, the population is approximately 15,000 thousand.

Questionnaire survey

A questionnaire survey was conducted to 100 households of DOHS based on their income level. The survey was conducted from 20th July 2017 to 27th July 2017. The study was conducted to identify the generation scenario from sources and sub sources of solid waste in the study area. The aim of this survey is to find out the waste generation rate

Components	CV (MJ/kg)	CV (Kcal/Kg)
Medical waste	19-24	4540-5745
Industrial and hazardous waste	22-24	5257-9558
Domestic waste (Without recycling)	7-16	1673-1836
Domestic food (With recycling)	10-14	2389-3345
PVC	41	9797
Dry wood	14.4	3441
Paper	13.5	3226

Table 2: Calorific value of solid waste component [14].

per person per day and contents in the waste. According to income, 100 households were divided into 5 groups.

Results, Analysis and Discussion

Survey data analysis

The survey work brought out lots of significant information and the pattern of waste concentration and generation rate based on income of households. From acquired survey data, it was found that the waste generation per person per day (Kg/person/day) kept rising from lower income group (Group 1) to rest of higher income group (Group 2-Group 5). Per person waste generation varied from 0.67 to 0.83 kg/person/day. Food waste came out to be the major fraction of generated waste. Highest fraction of food waste in generated solid waste was found in Group 4 households (71.24%). Significant amount of paper and shopping bags were disposed as solid waste (15.70 - 22.12%). Besides, generation of polythene bags was (07.05-11.03%). A small amount of cans and containers were found in the generated waste (1.2 - 3.59%).

These data eventually indicate that we can get significant amount of recyclable products and energy. Let us consider that the average waste generation is 0.74 kg/person/day. In the survey period the population was 15,000. So total waste generation in this locality is 11.10 tons/day. Consider 69% of it is food waste, 16.50% paper and shopping bags and scrap metals fraction is 2%. So every day, from 11.10 tons of waste, we can get food waste of 7.65 tons along with 1.83 tons of papers and 0.22 tons of scrap metals.

Possible energy recovery

Food waste have significant amount of calorific value. Not only food waste, but also papers have significant amount of calorific value. Some of solid waste components' calorific value are-

If we consider 50% of food waste and 65% of paper for energy recovery, we can have 3.83 tons of food waste and 1.18 tons of paper. Considering average calorific value for food waste is 12 MJ/kg and for paper 13.5 MJ/Kg, total energy potential in food waste is 45,960 MJ and in paper it is 15,930 MJ from where you can get electricity worth of 12,730.92 Kwh and 4,412.61 Kwh respectively [1 Joule = 0.000277 watt-hour; 1 Mega Joule = 277.77 watt-hour = 0.277 Kwh].

Due to some technical restrains in incinerators, its efficiency on producing electricity from solid waste is 20% [14,15]. So, we can get 2546.18 Kwh electricity from food waste and 882.52 Kwh electricity from paper products. In total, we can easily get 3428.70 Kwh of electricity if we can properly utilize the generated waste of this area.

Re-usable material recovery

We can easily use food waste and paper to produce good quality compost. Using rest 50% of food waste and 35% of papers, in total we can have 4.47 tons of waste products. If we can utilize merely 5% of this waste we can directly convert 223.50 kg of waste as compost component every day which is a significant amount of organic fraction [16].

Conclusion

Although the study area was not significantly large, decent amount of solid waste was found to be generated with high percentage of organic waste. The calorific value of the components are satisfactory enough for energy recovery and looks like this systematic approach has bright future on management of solid waste in Bangladesh. Apart from Bangladesh, there are several countries which has large population that generate huge amount of waste every day (India, China, Indonesia and Brazil). If they separate the waste according to properties and calorific value and develop the energy recovery system to produce electricity, it will eventually help them to save significant amount of resources. Moreover, it will encourage other countries to go for energy recovery as substitute of using fossil fuel where it is feasible.

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