APPLICATION OF KITCHEN WASTE IN BIOGAS SYSTEM: A SOLUTION FOR SOLID WASTE MANAGEMENT IN CHITTAGONG

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ABSTRACT
Bangladesh, a developing country, having a population over 170 million produces almost 2200-2400 ton waste per day per city. In this rapid growth in population and demand, it's becoming a challenging task to manage waste that are being produced daily by the authorities. It is estimated that solid waste generation will be 30 thousand tons/day by the year 2020 in Bangladesh. Solid waste can be a potential source of energy in the biogas plant that produces natural gas as well as electric power. In this paper implementation of kitchen waste in biogas plant is discussed to promote a well-established waste management system in this country. We conducted a study for appropriateness of kitchen waste for biogas plant in Chittagong and its potential as alternative energy source. In Bangladesh, kitchen waste contributes to about 50% of the total solid waste in urban area. Under Chittagong City Corporation, around 40 million people generate daily 80 to 85 MT organic wastes from kitchen waste. Biogas potential from these huge wastes approximates to 5100 to 5300 m^3 which can eventually use as cooking gas and also used for power generation. Utilizing kitchen waste in the biogas plant may reduce the burden of solid waste and could be one of the potential sources of renewable energy in Bangladesh.

Keywords: Solid waste management; kitchen waste; biogas; Chittagong

INTRODUCTION
Chittagong port city is not only the second largest metropolis city but also the commercial capital and economic gateway of Bangladesh and is expanding rapidly as well as experiencing huge increase in solid waste. City corporations are unable to carry out a desired level of service with the existing solid waste management system in Bangladesh. Chittagong city contributes about 15% of the total waste. It is estimated that solid waste generation will be 30 thousand tons/day by the year 2020 in Bangladesh. This incapability is managing the excess load of waste produced is creating a threat to the overall sanitation. Biogas is one of the most effective solution to get rid of the problems such as waste management, sanitation problem, excess demand of gas etc.
Biogas is produced by bacteria through the bio-degradation of organic material under anaerobic conditions. Biogas contains around 55-65% of methane, 30-40% of carbon dioxide (Gautam et al., 2008). The calorific value of biogas is appreciably high (around 4700 kcal or 20 MJ at around 55% methane content) (Ravi et al., 2013). The gas can effectively be utilized for generation of power through a biogas based power-generation system after dewatering and cleaning of the gas. In addition, the slurry produced in the process provides valuable organic manure for farming and sustaining the soil fertility (Ziana et al., 2015).Kitchen waste is the best alternative for biogas production which contains organic material having the high calorific value and nutritive value to microbes, that's why efficiency of methane production can be increased by several order of magnitude. Also in most of cities and places, kitchen waste is disposed in landfill or discarded which causes the public health hazards and diseases.

Methodology

The study was conducted at five different residential areas (Chadgaon Residential Area, Eastern Refinery Colony, Jamal Khan Area, GEC Area and Tigerpass Area) under Chittagong City Corporation (CCC) of Bangladesh. The study was conducted from April to August 2016, to understand the quantitative and qualitative aspects of residential solid waste generation. The methodology adapted in this study is a combination of empirical and case study method. This study involved a review of the related literature, design of the survey plan, and implementation of the personal interview survey. A structured questionnaire was designed, pre-tested, and modified to collect household level data on socioeconomic and daily solid waste traits. Data were also collected through both direct observations and interviews with household members to find out the amount of kitchen waste generated in Chittagong city and also find out the composition of kitchen waste generated from a selected areas in Chittagong city. Adequate calculation also has been done to find out the amount of biogas produced from these waste and also the amount of LPG gas that can be reduce by using biogas.

Result and Discussion

Household waste mainly consists of kitchen waste. It can be divided into food leftovers and peelings or pieces of vegetables and fruits. The food leftovers consisted of rice, pieces of meat, vegetable, potato chips, and fish residue. Orange and banana peelings were also merged into the food remains. Fruit and vegetable waste was also obtained during the waste collection period. A Map of the selected residential areas is given below.

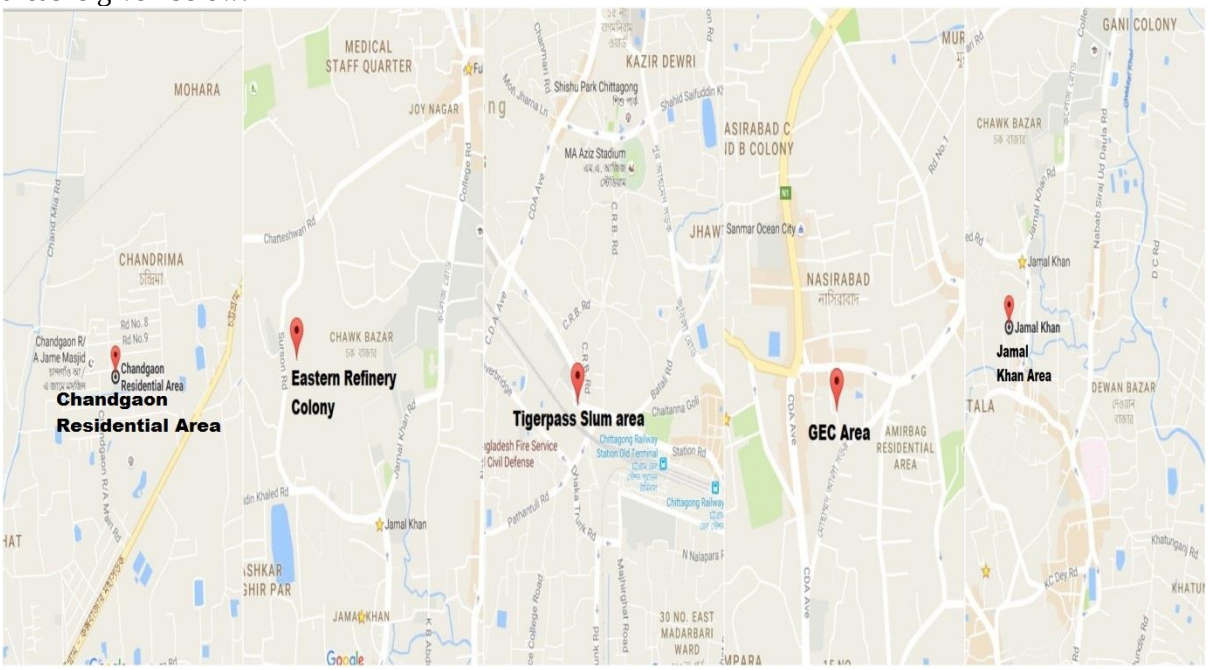

Fig.1: Selected study area

Obtained kitchen waste generation in different types of residential areas and composition of kitchen waste is listed in the Table 1 and Fig.2.

Table 1: Kitchen waste generation rate in Chittagong City Corporation

Sample area Type	Locations	Population	Mass (kg)	Generation Rate (kg/c/day)
Residential Area	Chadgaon Residential Area	51	15	0.29
Colony	Eastern Refinery Colony	459	112.16	0.24
Apartment	Jamal Khan Area	53	16.4	0.31
Unit Family Dwelling	GEC Area	16	5.6	0.35
Slum	Tigerpass Area	10	2.3	0.23

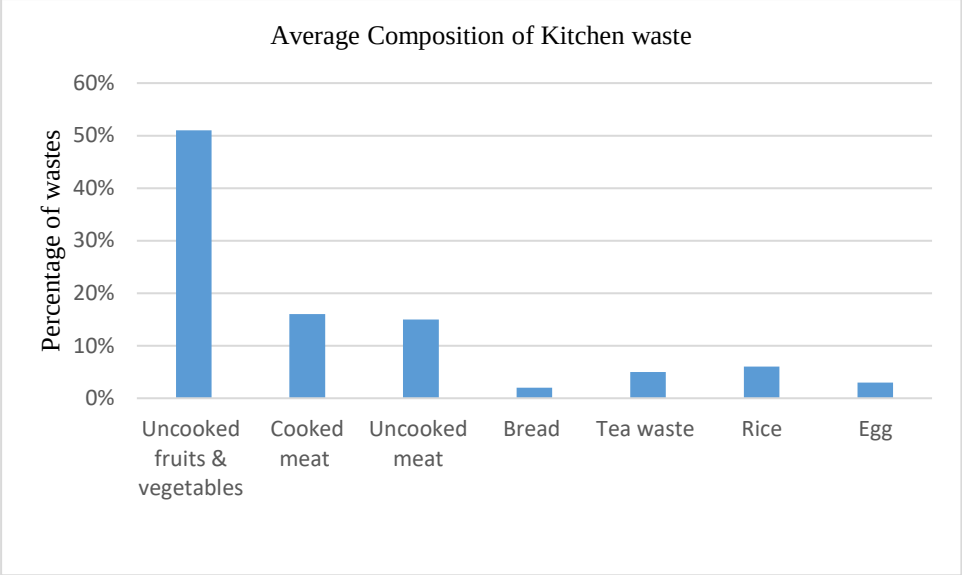

Fig. 2: Average composition of kitchen waste

In this study modified ARTI technology has been used for further calculation of biogas production. Modified ARTI is a compact biogas plant which uses kitchen waste as feeding material (Agrahari,et al., 2013). The slurry of feeding materials goes to the anaerobic decomposition to biogas for cooking, replacing Liquid Petroleum Gas (LPG) or Kerosene. It is a floating drum biogas plant. It consists of 1000 L capacity digester of simple water storage tank and 750 L capacity of gasholder which is placed upside down in the digester. When gas starts to generate, the gasholder rises to a certain limit. It then falls down to the lower limit after burning all gases present in the gasholder. Kitchen waste can be useful under community level biogas program, where LPG gas can be saved. In this study, we have taken of kitchen waste and water in ratio of 1:1.4.

Table 2: Elements of biogas production from kitchen waste

Characters	Quantity
Ratio (Kitchen Waste: Water)	1:1.4
pH	7-7.8
Amount of kitchen waste	10 kg
Amount of water	14 kg
Total biogas production	0.12785 m^3

From the chart we can say that for 10 kg kitchen waste production of biogas is 0.12785 m^3. Therefore, 1 kg kitchen waste can produce 0.012785 m^3 biogas. From Table. 1 if we consider Chadgaon Residential Area with 51 people producing 15 kg kitchen waste then biogas production will be 0.1918 m^3. As all the waste components will not produce biogas in the same rate so we can consider 60% of the total biogas can be used for cooking purpose. Therefore the production of biogas from kitchen waste will be 0.115 m^3 or 115 kg which is equivalent to 29 kg LPG gas per day.
It will be an efficient way to use kitchen waste in production of biogas, as it can possibly reduce the demand of gas and also help to maintain a sustainable environment.

CONCLUSIONS

The concept of kitchen waste for biogas production offers an effective waste management and resource development solutions with positive measures for the economy and sustained energy security. This study helps to the management of an organic waste generation in urban areas as well as saves the consumption of LPG gas and money in the long term. The relevance of biogas technology in Bangladesh lies in the fact that it makes the best possible utilization of various organic wastes as a renewable and perpetual source of clean energy in the rural and provides environmental sanitation. The objectives of the study were largely met, giving what may be considered as baseline data on the kitchen waste generation and management in the residential areas of Bangladesh.

ACKNOWLEDGMENTS
In the name of God, the most gracious, for giving us the courage and determination to complete this study. We are also thankful to Port City International University Chittagong.

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