Characterization of organic waste generated from student messes in Kota
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ABSTRACT
Kota is the third largest city of the Rajasthan with a population of 1,001,365 (as per census 2011) and well known for engineering & medical entrance exam coaching. Every year about 1.5 Lacs students come to Kota for the preparation of engineering & medical entrance exams from all over India and abroad. For their food requirement (breakfast, lunch, dinner etc) more than 300 small and large scale messes (from 30 students to 1500 students) are in operation in different parts of the city. The aim of this study was to estimate the waste quantity & waste generation rate, characterization of food waste and suggesting appropriate waste to energy technology for the food waste generated by these messes. During this study, samples of food waste was collected from 70 different messes and tested in laboratory for calorific value, pH, chemical & biological content of the waste. The estimated waste generation rate is 140 gm/student/day and waste quantity is 21 tonnes/day. From the experimental results the Moisture content (MC) and ratio of volatile solids to total solids (VS/TS) were found to be 71.85 % and 81.9 % respectively. The gross calorific value of waste was experimentally found to be 1442 Kcal/Kg. The biodegradability of the food waste calculated was 0.72. In this study different method of waste to energy technology is reviewed. Anaerobic digestion and pelletization are the two most suitable technologies for producing the energy from this waste.

Keywords: Food waste, characterization of waste, Kota

INTRODUCTION
Kota city is located in the south eastern parts of Rajasthan State at 23°45’ to 25°53’ North latitudes and 75°9’ to 77°27’ East longitudes at the bank of river Chambal. Kota city generates 653 tonnes of MSW every day (Ranjith Kharvel Annepu, 2012). The waste is collected by municipal corporation Kota and dumped in open area outside of the city. Every year about 1,50,000 students come to Kota for the preparation of engineering & medical entrance exams from all over India and abroad. For their food requirement (breakfast, lunch, dinner etc) more than 300 small and large scale messes (from 30 students to 1500 students) are in operation in different parts of the city. There is no data available about the quantity & characteristics of the waste generated by these messes which can be a source of renewable energy. The purpose of the study is to determine the quantity, generation rate & characteristics of food waste generated from student messes in Kota and suggest the appropriate waste to energy technologies on the basis of waste characteristics. There are different waste to energy technologies such as incineration, gasification; pyrolysis, anaerobic digestion, pelletization and landfilling that are available commercially (Khanjan Ajaybhai Kalyan et. al., 2014).

MATERIALS AND METHODS
Sample collection: The samples are collected from 70 different messes which are selected on the basis of number of students, type of students, mess charges & location of the mess. Every day samples from 10 different messes is collected and this sampling is done for a week with 10 different messes each day. The collected waste is preserved at 4 ºC. The waste generation rate is estimated by weighing the food waste of 10 different messes for a week.

Characterization of waste: Characterization of waste is necessary to access its potential for different waste to energy technologies such as incineration, gasification; pyrolysis, anaerobic digestion and landfilling (Sapna Sethi et al. 2013). In chemical characterization the proximate & ultimate analysis, gross calorific value, metal content and pH is determined in laboratory. The proximate analysis determines the % moisture content, % ash content, % volatile matter content and the calculation of % fixed carbon. The ultimate analysis includes determination of carbon, hydrogen, nitrogen, sulphur and oxygen. Carbon, hydrogen, nitrogen and sulphur are determined by CHNS analyser while oxygen content is determined by difference, knowing the mineral content.

In biological characterization cellulose, protein and lignin content is determined.

RESULTS & DISCUSSION
The rate at which organic waste generate and organic waste quantity per day from the messes in Kota is estimated to be 140 gm/student/day and 21 tonnes respectively.

Chemical characterization: The result of proximate analysis is shown by fig.1 & table 1. The moisture content (MC) in food waste is found to be 71.85 %. The total solid content which is the sum of the volatile solid, fixed carbon and ash content is found to be 28.15 %. The ratio of volatile solids to total solids (VS/TS) is found to be 81.9 %. Fig 2 & table 2 shows the % of carbon, hydrogen, nitrogen, sulphur and oxygen content in the food waste. The carbon to nitrogen ratio (C:N) is estimated to be 25:1. The gross calorific value of the food waste is 1442 Kcal/kg which is evaluated experimentally by bomb calorimeter. The food waste is acidic in nature & having pH 3.55. The Pb, Ni, Na & K is traced in the food waste. The concentration of Pb & Ni is less than 0.01 % while the Na and K is found to be 0.29 % & 1.11 % respectively.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>(%) of wet weight basis</th>
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<tbody>
<tr>
<td>Moisture content</td>
<td>71.85</td>
</tr>
<tr>
<td>Ash content</td>
<td>1.48</td>
</tr>
<tr>
<td>Volatile content</td>
<td>23.08</td>
</tr>
<tr>
<td>Fixed carbon content</td>
<td>3.59</td>
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</tbody>
</table>

Table.1. Results of proximate analysis

Fig.1. Results of proximate analysis (% of wet weight basis)
Biological characterization: Food waste contains 4.37 % of protein, 3.54 % of cellulose & 0.89 % of lignin. The biodegradability of food waste is estimated on the basis of lignin present by the mathematical correlation (chandler et al. 1980) and it is found to be 0.72.

Waste to energy: There are different waste to energy technologies such as incineration, gasification; pyrolysis, anaerobic digestion and landfilling that are available commercially. In incineration, gasification, pyrolysis and pelletization waste is converted into energy by thermal route while in anaerobic digestion the energy is extracted by waste through biological route.

The waste generated by student messes in Kota contains a high amount of moisture so it is not suitable for incineration, gasification & pyrolysis. (Technical EIA guidelines, 2010). The anaerobic digestion is the best suitable technology for the food waste because of high biodegradability of waste, high moisture content and optimum carbon to nitrogen ratio. But pH needs to be adjusted between 7 to 8. Pelletization can be another option because of moderate values of gross calorific value & lignin content but the moisture is to be removed up to a level of 10 % before pelletization.

CONCLUSION

The study indicates that student messes of Kota generate estimated 21 tonnes of organic waste per day at the rate of 140gm/student/day. The waste contains 71.85 % moisture & 28.15 % total solids. The ratio of Volatile solid to Total solid is 81.9 %. The gross calorific value is 1442 Kcal/kg and C:N ratio is 25.1. The biodegradability of food waste is 0.72. The results obtained from the characterization of waste suggests that incineration, gasification and pyrolysis is not suitable for the energy production from food waste because of high moisture content and low gross calorific value of the food waste. Anaerobic digestion could be the best suitable waste to energy technology for the food waste generated by student messes of Kota because of optimum C:N ratio and high biodegradability. Because of moderate calorific value & lignin content, pelletization of waste can also be a good choice to produce a lower grade fuel from food waste. But moisture is to be removed up to a level of 10 % before pelletization (Technical document on MSW organic processing, 2013).

REFERENCES

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