Potential Reuse of Kitchen Food Waste

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Abstract

Food waste is a biodegradable waste discharged from various sources including food processing industries, households, and hospitality sector. According to FAO, nearly 1.3 billion tones of food including fresh vegetables, fruits, meat, bakery, and dairy products are lost along the food supply chain. The amount of Food Waste has been projected to increase in the next 25 years due to economic and population growth, mainly in the Asian countries. It has been reported that the annual amount of urban Food Waste in Asian countries could rise from 278 to 416 million tones from 2005 to 2025. Disposal of kitchen wastes in open dumps causes the public health hazards and diseases such as malaria, cholera, typhoid. Inadequate management of wastes like uncontrolled dumping bears several adverse consequences. It not only leads to polluting surface and groundwater through leachate and further promotes the breeding of flies, mosquitoes, rats and other disease bearing vectors. Also, it emits unpleasant odor & methane which is a major greenhouse gas contributing to global warming. In this study, an initiative has been taken to chemically characterize food waste and identify possible reuse and disposal techniques. Food waste samples were collected from kitchen of hotel, restaurant and hostel of Bhilwara district of Rajasthan. Collected food waste samples were dried by various methods. It is observed that oven drying method at 105 °C is the optimum temperature for maximum dewatering of collected food waste. The dried samples were further used for chemical composition and calorific value analysis. Lipid analysis of the food waste samples was performed by using fat extraction from sochxlet apparatus. The results obtained from lipid analysis suggest that the kitchen food waste can be an innovative raw material for biodiesel production. Physico-chemical characterization identify considerable amount of calcium (20.36 mg/l), iron (30.84 mg/l), magnesium (3.00 mg/l) and chromium (1.28 mg/l), suggest its reuse in pharmaceutical and agricultural industries after extracting these metals.

Key words : Food Waste, Biodegradable, Global warming, Pharmaceutical, Sochxlet apparatus, Lipid analysis.

Introduction

Food waste (FW) (both precooked and leftover) is a biodegradable waste discharged from various sources including food processing industries, households, and hospitality sector. According to FAO, nearly 1.3 billion tonnes of food including fresh vegetables, fruits, meat, bakery, and dairy products are lost along the food supply chain (FAO, 2012). The amount of FW has been projected to increase in the next 25 years due to economic and population growth, mainly in the Asian countries. It has been reported that the annual amount of urban FW in Asian countries could rise from 278 to 416 million tonnes from 2005 to 2025 (Melikoglu et al., 2013). Approximately 1.4 billion hectares of fertile land (28% of the world's agricultural area) is used annually to produce food that is lost or wasted.

Kitchen food waste can be describe as all waste food, which is generated in household kitchen, restaurants, hotels, canteen, community kitchen, hostels, Messes etc which produce food for human utilization. Within the restaurants, hotels, canteen/catering sector, a huge amount of the food waste produce can be reduced, reused and recycled. The getting rid of large amount of food waste is an environmental problem and its discharge into drain or sewers leads to blockages. If these wastes are dumped on land filled, it creates air pollution problem along with water or soil. There is an urgent need for proper disposal and reuse technique for kitchen food waste.

The objectives of this investigation are to analyze the chemical composition of food waste and identify the potential reuse techniques of kitchen food waste. This paper also identifies possible ways that would help to minimize kitchen waste disposal problem as well as energy crisis problem

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Methodology

Survey

The survey of hotels and restaurant kitchen of Bhilwara city was done for the selection of Kitchens and the waste produce by the same. This study location is chosen for its huge food waste generation and their dumping problem.

The Questionnaire

Use of questionnaires to understand the actual amount of waste generated and the feasibility of utilizing all the kitchens for the project. A questionnaire was design for collecting information about waste generation in all the kitchens. The included were so as to get a basic idea about the two important qualities of the waste generated viz quantity and disposal.

The questionnaire gave the basic idea about the amount of waste generated and characterization of waste based on moisture content, organic matter and calorific value. After giving due consideration, it was decided to use the waste generated from four main hotel and restaurant kitchens. In each sampling about 2.5 kg of food waste is collected for experimental analysis during peak hours i.e., during lunch and dinner when food waste generation is predominant. Total of 15 samples have been collected in air tight plastic containers and brought to the laboratory for further analysis.

Food waste analysis

The collected food wastes from kitchen outlet have been dried by various methods such as oven drying at 55° C for 3 days, 70° C for 3 days, 105° C for 2 days. Dried food waste sample can be used for the analysis of moisture content, proximate composition, lipid extraction, calorific value and at the same time dried food waste can be used for mineral extraction.

Fat

Fat from food is solubilized in petroleum ether and then distilled of completely to estimate the crude fat in the sample. Five grams of moisture free sample was weighed and transferred to a 10 x 10 cm whatman no.41 filter paper. It was folded in such a manner that during extraction the sample does not come out. The packet was placed in the extracting tube of soxhlets apparatus. An empty round bottom flask was weighed and filled to three fourth and then connected with extractor. Flask was heated for about 16 hours for completed extraction of fat. The flask was disconnected, cooled in a dessicator and weighed after ether evaporated. The difference in initial and final weight of the flask calculated to find out the fat content.

$$\text{Fat \%} = \frac{\text{Weight of ether extracted fat}}{\text{Weight of sample (g)}} \times 100$$

Protein

Micro kjeldahl method is commonly used to determine the protein content of food stuff by estimating the nitrogen content of the material multiplying nitrogen value by 6.25. Crude protein was estimated in powdered moisture free sample using Micro kjeldahl method (Kel plus nitrogen estimation unit).

Minerals

Minerals were analyzed using atomic absorption spectrophotometer (ECIL, model AAS 4141). Diluted sample was drawn up in the atomizer burner assembly through a capillary and convert by means of stream of compressed air to a fine spray which after condensation of large droplets was mixed with acetylene and burnt in a long flame at the burner light coming from the hollow cathode lamp, after transversing the flame entered a monochromatic wave set at 324 nm and fell on photomultiplier tube (photocell). The tube converts the light radiation into electrical energy which was measured by galvanometer.

Calorific Value

Calorific value of waste food obtained by experimental method as well as by analysis using the equations (Viz, et al, 2013).

CV=356.248 VM - 6998.497(kJ/kg) (1)

CV= 356.047 VM-118.035FC -5 600.613 (kJ/kg) (2)

Benton: CV=4.2*(44.75 VM-5.85 W + 21.2) (3)
where,
CV- calorific value in kJ/kg
VM- Volatile Matter in percentage
FC- Fixed Carbon content
W- Moisture Content

Data analysis

The statistical analysis was carried out using SPSS 16.0 for windows. Data were compared at 5 per cent level of significance

Result and discussions

Composition of food waste

Food waste mainly consists of carbohydrates, proteins, lipids, and traces of inorganic compounds. The composition varies in accordance with the type of food waste and its constituents. Food waste consisting of rice and vegetables is abundant in carbohydrates while food waste consisting of meat and eggs has high quantity of proteins and lipids. Table 1.1 summarizes the composition of food waste studied in different parts of the globe.

Table: 1.1 Comparison of Composition of Food Waste in present study and reported in various literatures

Moisture	Total solid	Volatile solid	Carbohydrate	Lipid	Protein	Ash	References
81.5	18.5	94.1	55	14	16.9	2.8	Present Study
75.9	24.1	NR	42.3	NR	3.9	1.3	Tang et al.,2008
80.3	19.7	95.4	59.8	15.7	21.8	1.9	Wang et al.,2008
82.8	17.2	89.1	62.7	18.1	15.6	NR	Uncu et al.,2011
75.2	24.8	NR	50.2	18.1	15.6	2.3	He et al.,2012
85.7	14.3	98.2	42.3	NR	17.8	NR	Vavouraki et al.,2013
82.8	17.2	85	62.7	19	15.8	NR	Zhang et al., 2012
61.3	38.7	NR	69	6.4	4.4	1.2	Paritosh et al.,2017
81.7	18.3	87.5	35.5	24.1	14.4	NR	Spiker et al.,2017

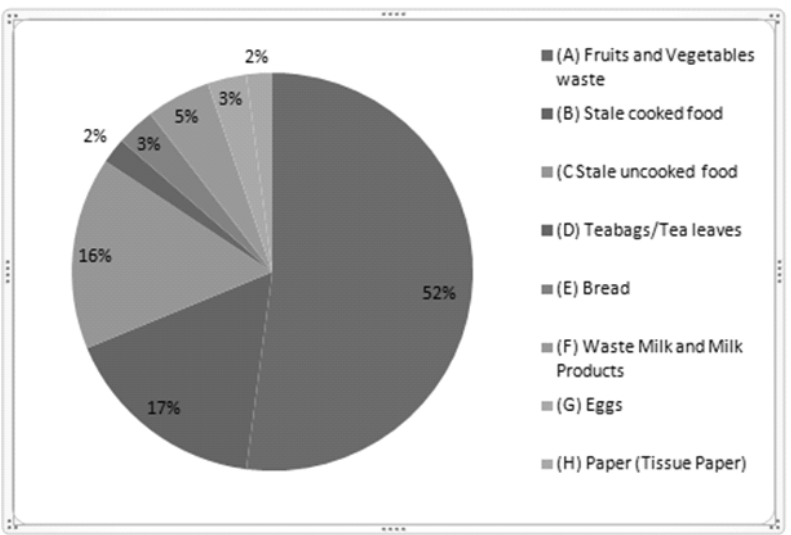

Figure:1. Food Composition of kitchen food waste

Table 1.2 Calorific value of food waste

Food Waste	Moisture Content (% ww)	Calorific Value (Kcal/dry Kg)	Calorific Value Kj/dry Kg
Uncooked meat	73%	5707±0.78	23894
Cooked meat	45%	6051±0.92	25335
Cooked pasta	79%	3955±0.56	16557
Vegetables	94%	3494±0.39	14627
Fruits	85%	3661±0.39	15327
Raw meat fat	55%	7132±4.5	29861

Treatment options for food waste

The possible disposal/treatment alternatives for food waste are several, including technologies such as landfill, incineration, aerobic and anaerobic digestion, gasification and refining, i.e., animal feed production.

Composting

Composting is simply the aerobic treatment process of breaking down the organic matter (food waste) in the presence of air and water, using micro organism and small insects present in nature. The end product is called compost which is rich in readily usable plant nutrients forming a part of healthy soil.

Anaerobic digestion or biogas technology

Kitchen waste is the best alternative for biogas production in a community level biogas plant. It is produced when bacteria degrade organic matter in the absence of air. Biogas contains around 55-65% of methane, 30-40% of carbon dioxide. The calorific value of biogas is appreciably high (around 4700 kcal or 20 MJ at around 55% methane content). 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 (Agrahari and Tiwari, 2013).

Anaerobic digestion is a multistep biological and chemical process that is beneficial in not only waste management but also energy creation. There are four fundamental steps of anaerobic digestion that include hydrolysis, acidogenesis, acetogenesis, and methanogenesis. Throughout this entire process, large organic polymers that make up Biomass are broken down into smaller molecules by chemicals and microorganisms. Upon completion of the anaerobic digestion process, the Biomass is converted into Biogas, namely carbon dioxide and methane, as well as digestate and wastewater (Biarnes , 2014).

Pharmaceutical use of extracted minerals from food waste

Pharmaceutical industry can extract heavy metals by using chemical and physical technologies such as precipitation, solvent extraction, ion exchanger, reverse osmosis, oxidation/reduction, sedimentation, filtration, electrochemical techniques, cation surfactant, etc. Also, biosorption methods can be used for extraction of heavy metals using algae, bacteria, fungi and yeast. Electrokinetic remediation and bioleaching technology can also be used for removing heavy metals (Barik and paul, 2017).

- Iron for preparing iron tablets.
- Calcium and magnesium to prepare multivitamin tablets.
- In human nutrition, chromium is used as a nutritional supplement recommended in impaired carbohydrate metabolism characterized by reduced glucose tolerance and impaired insulin action, weight reduction, etc.
- Zinc, selenium, manganese, copper etc and vitamin are used to prepare multivitamin tablets .

Conclusion

Food waste is a zero cost material and non-edible resource. This study investigated and confirmed that kitchen food waste has a great potential to be used for extraction of nutrient and lipid. The extracted lipid is found to have significant potential for biodiesel production. Other than biodiesel production, kitchen food waste can also be reused for agricultural and pharmaceutical purposes. Recycling of food waste is environment friendly that increases energy production and minimizes space requirement for landfill. It also minimizes waste disposal problem. This study can be helpful for pollution control by reducing leachate generation. It will also reduce environmental problem like foul odor and fly nuisance. Thus, this study is an innovative approach to reuse kitchen food waste for biogas production to overcome energy crisis problem by replacing biogas and biodiesel with petro-diesel and helps to minimize handling and disposal problem of kitchen food waste.

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