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Liquid Fertilizer from Food Waste - A Sustainable Approach

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Abstract

Food waste actually has a good potential if it is processed into organic liquid fertilizer rather throwing away. The present research study deals with conversion of food waste generated from restaurants, marriage halls and hotels into organic liquid fertilizer through anaerobic process in the Cherlapally Industrial Area for improving service level benchmarks as designed by the Ministry of Environment and Forest. The food waste was processed in a closed container along with addition of molasses in anaerobic conditions where after 72 hours the food waste started converting into organic liquid fertilizer and a by-product as pulp. The NPK values were analyzed in the liquid fertilizer which showed N-1.15 %, P-0.308% and K- 0.7% and in pulp N-0.39%, P-0.159% and K-0.51%. Pot culture experiments in triplicate were conducted to test the toxicity of the organic liquid fertilizer for seed germination. Liquid fertilizer has many advantages because of easy process, inexpensive and no side effects. The resulting benefits are very likely to fertilize crops, to maintain the stability of nutrient elements in the soil and reducing the bad impacts of chemical fertilizers. In addition to a liquid fertilizer that can be sold in the market, liquid fertilizer can be used for agriculture purpose or in the premises for plantation.

Keywords: Food waste, liquid fertilizer, service level benchmarks, manure.

Introduction

The increased food waste generation is a global problem. The food waste generation has several facets, which is understood by its quantity and nature of food waste generated across all phases of the food production and consumption cycle. Majority of the stakeholders are concerned about the impact of food waste which has on generation of methane and carbon dioxide which are green house gases [1].

The leftover food waste it smells bad and attracts rodents and insects which has significant impact on public health. The major cost of municipal waste management range from 75% to 80% of a municipal waste budget and additional 30% cost for landfilling. During land filling the green house gases are generated and energy value along with soil nutrient value is lost during landfilling. Segregation of food waste at source has the potential to decrease greenhouse gas emission and there will be no adverse impact on public health [2].

Presently the food waste is disposed of at landfill along with other municipal solid waste. The earlier data reveals that in 2012 nearly 9,278 tonnes of municipal solid waste was disposed at landfills each day, where about 3,337 tonnes is only food waste[3]. Nearly 809 tonnes of food waste was generated from restaurants, hotels, wet markets, food production and processing industries on the daily basis. The food waste is rich in organic content, but the current practice of disposing food waste at landfill is not environmentally friendly and sustainable. The ladfill practice is reducing land space, creating odor, leachate generation and green house gases emission [4].

Out of total municipal solid waste generated nearly on average 20 to 30% remains uncollected which creates health hazards. Due to increase environmental concern more emphasis is laid on recycling and reuse of waste. Due to the high cost involved the municipalities and corporations are unable to manage the municipal waste in integrated manner. Whereas, the non-government organizations and other private agencies has come forward to provide services for municipal solid waste management through public private partnership (PPP). The NGOs are providing these services towards collection, segregation, recycling, composting and bio-gas generation [5].

As part of the reform the Ministry of Environment and Forest has initiated Municipal solid waste management and handling rules 2000 aiming at standardization and enforcement of solid waste in urban areas. The rules highlights that every municipal corporation and municipalities are responsible for the implementation of rules for proper collection, segregation, processing and disposal of waste[6].

The present study is depended on the anaerobic digestion process in which microbes breakdown organic matter in the absence of oxygen. The anaerobic digestion starts with bacterial hydrolysis with initial organic matter where in-soluble polymers, such as carbohydrates are broken down to soluble derivatives that become avialble to other bacteria. The acidogenic bacteria converts the amino acids and sugars into carbon dioxide, hydrogen, ammonia and organic acids, further the methanogenic bacteria converts these products into methane

and carbondioxide[7]. The present research study highlights the preparation of liquid fertilizer and pulp (compost) from food waste generated from hotels and restaurants. In order to ensure that liquid fertilizer and pulp are safe for land use seed germination technique was used to evaluate the liquid fertilizer and pulp (compost) phytotoxicity.

Material and Methods

Study Area: Cherlapalli Industrial Area is in Greater Hyderabad Municipal Corporation (GHMC) with 2000 population, 800 small, medium and large industries spread over in 1200 acres divided into 7 sectors. The industries are into manufacture of plastic products, bore well equipment, electrical and electronics, fabrication and heavy engineering, forging and casting, pharmaceuticals, printing and packaging, wood and furniture products etc., and has around 30 commercial establishments like hotels, tea stalls, and around 300 dwellings located in industrial units meant for security people and workers.

Sample Collection: The food waste was collected from the restaurants and hotels in plastic containers with sealed caps from the Cherlapally Industrial Area.

Fermentation Solution: One litre of molasses was added to three litre of groundwater.

Anaerobic Digestion: 5kg of food waste was collected from restaurants, hotels and marriage halls from the vicinity of Cherlapalli Industrial Area. 4 litre of fermentation solution prepared with molasses was added to the food waste. The food waste was placed in the gunny bag and was tightly closed and placed in the plastic container for anaerobic digestion. After 3 days the liquid fertilizer was collected where 1 to 1.5 liter was collected within a week. To the concenrtated liquid fertilizer 10 liter of groundwater was added for dilution. The process of preparing liquid fertilizer from food waste is depicted in figure-1. The nitrogen, phosphorous and potassium (NPK %) [8] was analyzed in the liquid fertilizer and the pulp. The chemical characteristics of the liquid fertilizer and pulp are given in table-1.

Table-1
Characteristic of Liquid Fertilizer and Pulp

Parameters (%)	Liquid Fertilizer (%)	Pulp (%)
Nitrogen	1.15	0.39
Phosphorous	0.308	0.159
Potassium	0.77	0.51

Toxicity Test: The final liquid fertilizer and pulp was used to evaluate the toxicity on plants depicted in figure-1. From the liquid fertilizer various dilutions were prepared by adding the distilled water. The various concentrations from lower concentration to higher concentration were prepared along with control. The concentrations were prepared by adding liquid fertilizer of various concentrations 0.57 ml, 1.14 ml, 2.28 ml and 4.56 ml and 30 ml of distilled water was added to all the concentrations equally.500 ml capacity plastic pots were used, each having 10 mustard seeds distributed in pots at compatible diameter in relation to the superior part of pot. Seedlings were grown, under an aerated system, adding the various concentrations of liquid fertilizer. Seed germination was observed after 3 days, later the length of the plant was measured by using a ruler. Toxicity test experiment was performed in triplicate.

Figure-1
Steps Involved in the Preparation of Liquid Fertilizer and Pulp from Food Waste and Toxicity Test

Results and Discussion

The results reveal that the liquid fertilizer from anaerobic process is rich in nutrients and is a great source of organic fertilizer. It can be either recycled to farm land as a liquid or alternatively it is dewatered to produce a solid cake which can be is used as a fertilizer. Anaerobic digestion treatment is an alternative to landfill which can prevent carbon dioxide between 0.5 to 1.0 % entering into the atmosphere[9]. The results reveal that characteristic values of NPK produced from liquid fertilizer which is depicted in table-1[10].

Digestate is nitrogen rich bio-fertiliser which is spread to land as a replacement for mineral fertilisers. Its use ensures that vital nutrients in the food waste are recycled and returned to the ground. The resulting benefits from liquid fertilizer are very much like to fertilize crops, to maintain the stability of nutrient elements in soil and can reduce the impact of organic waste in the neighborhood. Reusing and diverting of food waste will reduce the landfill space and reduces the green house gases. The landfills generate methane which is potent greenhouse gas having warming potential 21 times that of carbon dioxide[11]. The toxicity results revealed that the mustard seed germination and length of the plant was good when liquid fertilizer was used in various concentrations. The increase concentration of liquid fertilizer has no adverse effect on seed germination. The toxicity test with all concentrations has shown seed germination greater than 90 percent.

The rising prices of fertilizer in market looking for an idea to force someone else to meet the needs of the crops they planted[12]. In addition, chemical fertilizer if used continuously can made microorganism in the soil becomes dead and causing the soil to be infertile[13]. Utilization of organic food waste as a liquid fertilizer is expected to solve these problems and can help increasing the economy by farmers and housewives in the village. Urea prices Rs 1600 per kg, SP-36 Rs 2000 per kg, ZA Rs 1400 per kg, NPK Rs 2300 per kg. Not only are the prices continued to rise but the resulting impact if used continuously may damage soil quality. In contrast to the organic liquid fertilizer that is environmentally friendly and very safe. The financial cost to prepare the liquid fertilizer is given in table-2, which is economical and viable for farmers without any environmental impact[14].

Table-2
Financial Details for Preparing Liquid Fertilizer from Food Waste

Tools and Materials	Quantity	Prices (Rs)
Jute bag old	1 No	-
Food waste	5 kg	-
molasses	1 lit	1000
groundwater	3 lit	-
Plastic container old	1	-
Total		1000

Conclusion

Food waste actually has a good potential if it processed into organic liquid fertilizer. Organic liquid fertilizer is expected to help the economy of farmers or just used in their own farm. The present study reveals that the nutrient value of ordinary food waste are converted into two highly useful products which are liquid fertilizer and pulp without producing any further environmentally damaging outputs. This technique can empower and is expected to slightly ease the burden on the farmers and could get even more revenue from this organic liquid fertilizer. Organic liquid fertilizer is very affordable and if calculated from the total expenditure to be incurred during the manufacture of organic fertilizers is economical.

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