A REVIEW ON RECYCLING OF BIODEGRADABLE WASTE AND CONVERT TO ENERGY BY USING COMPOSTING TECHNIQUE AND METHODS

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Abstract – In this review we are going to see how the biodegradable waste is increasing with increase in population growth and what will be the impacts of recycling different bio-waste materials. And to convert waste-energy by using methods like incineration, anaerobic digestion, pyrolysis/gasification and recycling the bio-waste using composting as a technique.

Using composting as a technique to recycle household biodegradable waste. By decomposing them under a controlled environmental condition, mixtures of organic materials that are components of biodegradable waste were recycled. Waste-to-energy has now become a type of utilization of renewable energy that can bring environmental and economic benefits to the world.

For easy turning, the compost mixture was scaled down to half of its quantity. With an optimal moisture content environmental condition (50 percent), an adequate proportion of both dry and wet material to meet the required carbon / nitrogen (C / N) ratio, and an adequate volume of air was initiated in the compost pile pore spaces and microbial decomposition. Emissions from greenhouse gas (GHG) and fossil fuel consumption were estimated from the improved biodegradable waste utilization system and both were found to be reduced. The aim of the study was to highlight the use of biodegradable waste in developing countries as a clean source of energy. At the end of the decomposition, a stabilized organic matter that horticulturalists, landscapers, orchardists, farmers, etc. can use as a fertilizer supplement was obtained.

Keywords: Biodegradable waste, Composting, Organic materials, Aeration, Environment condition, Moisture content, greenhouse gas emission, renewable energy source, incineration, pyrolysis/gasification.

I.INTRODUCTION

Composting, recycling organic waste such as vegetation and food waste reduces the amount of waste that goes to landfill, making it a rapidly growing sector. Residual compost has been described as the stable, sanitized and humus-like material rich in organic matter and free of offensive odors resulting from the composting process of separating collected bio-waste. waste has become a local and global issue related to society, wild species, and the environment. Waste generation in developing countries has been increasing along with the growing population, increasing per capita waste generation and economic growth. Without an effective and efficient solid waste management program, the Waste generated from a variety of human activities, both industrial and domestic, can lead to health hazards and adversely affect the environment. Recycling is widely assumed to be environmentally beneficial due to the negative environmental and economic impact of allowing organic waste to decline in landfills (Table 1)

Material	% of household waste	Energy	Emissions	Raw material save/tonne recycled
Paper	18	28-70% less	95% less air pollutants	
Glass	7	18% less	30% less	1.2
plastic	7	up to 66% less		1.8
Cans (Fe)	3	70% less	86% less	2
Can (Al)	3	95% less	95% less	4

Table 1 impact of recycling for different materials.

since the urban population in most Asian developing countries in 2012 might be increased by around 50% in 2025. Since waste generation rates are closely related to the population and per capita waste generation of a country, the Asian developing countries might have significantly increased waste generation rates during 2012–2025. (fig 1)

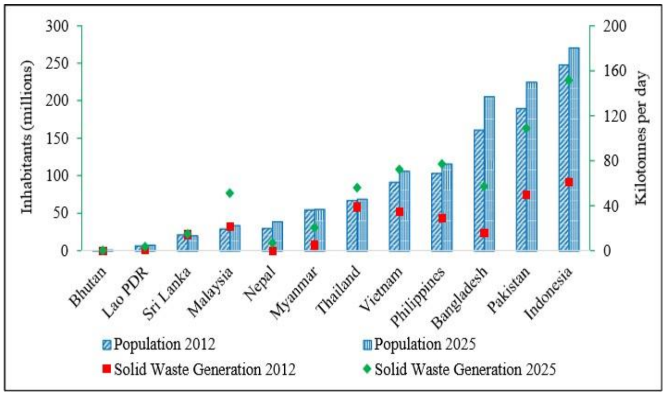

Figure 1 Total population and solid waste generation in the selected developing Asian countries during 2012–2025.

II. DESCRIPTION

The variety of composting technologies is extensive as composting to advanced, highly technological centralized plants can be performed in private garden (home composting). The most suitable composting method depends on the availability of land, the nature and quantity of biodegradable waste to be treated, financial considerations and available workforce, the desired quality of the end product and the amount of time available for processing Different methods for household waste composting include static piles, windrow, in-vessel, vermicomposting,


Figure 2: Vermicomposting

Composting is the microbial degradation of organic solid material involving aerobic respiration and involving a thermophilic stage in general (Feinstein and Morris, 1975). Home composting (HC) is traditionally considered a horticultural recreational activity, but more recently it has been identified as a potential major opportunity to manage part of the domestic, biodegradable waste stream, minimize the quantity of waste collected for landfill disposal and thus contribute to achieving compliance with reductions in biodegradable waste disposal on the road. The biodegradable waste materials are aerobically digested at a stabilized organic fraction that can be recycled for agricultural uses (Fehr, 2009).

According to the 2012 World Bank Report, the amount of municipal solid waste (MSW) from cities around the world could reach 2.2 billion tons per year by 2025 and the rate of waste generation in developing countries could double over the next two decades. Consumption patterns, educational and living standards, household income, and economic development mainly influence the country-specific waste composition. Generally speaking, most developing countries have larger organic fractions of their MSW composition compared to developed countries, accounting for more than 50% of the total. Figure 2 shows the World Bank 2012 comparison of waste composition, collection efficiency and waste generation per capita in Asian developing countries. MSW is found to consist mainly of organic waste in most Asian developing countries, with an average of around 55 %, followed by other (16 %), paper (17 %), plastic (11 %), and glass and metal (1 %). These developing countries' collection efficiency and per capita waste generation is lower than 70% and 1.5 kg per capita.

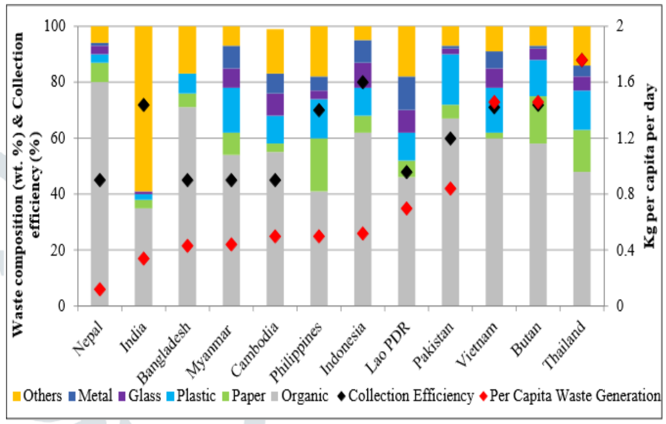

Figure 3 Comparison of waste composition, collection efficiency and per capita waste generation in Asian developing countries.

Thermal waste treatment is not suitable for energy recovery without additional fuel supply in developing countries due to the higher organic fraction and higher moisture content of the MSW. Moreover, due to the high investment costs associated with waste-to-energy technologies, developing countries commonly use open dumping and landfilling as their main methods of disposal. Negative impacts of waste disposal at open dumpsites and landfills, however, have a significant impact on the environment and public health due to pollution caused by greenhouse gas emissions from anaerobic digestion of biodegradable waste into the atmosphere and landfill leachate impacts on groundwater hygiene issues for waste service workers and residents nearby Renewable energy sources, including biomass, are increasingly being used because of environmental concerns about fossil fuel consumption. Biofuel production from renewable sources is currently a major research challenge. Methods have been developed to generate hydrogen from waste products. Despite their disadvantages, MSW incineration plants have been beneficial to developed countries for recovering energy and reducing the mass and volume of initial bulk waste. When incinerated, waste stands at 95–96 percent by volume by 80–85 percent by weight. Ideally, however, waste fuel should have a high heating value and low moisture and ash content. MSW drying therefore aims to modify the characteristics of the waste in order to increase its low heating value and make it easier to remove glass, metals and other inert materials. Therefore, energy-oriented conversion technologies for improving waste quality through drying could potentially increase the heating values of raw waste materials as well as decrease the bulk volume of waste and waste odor and facilitate storage and transport. Furthermore, dried waste materials could offer other significant benefits such as reduced fossil fuel dependency, reduced landfill environmental impacts, and mitigation of global warming. Therefore, in developing countries with higher solar radiation and availability of reliable energy sources from industries such as waste heat, a drying process could likely become a future potential waste pre-treatment option with environmental and economic benefits. Among the developing countries in Asia, Myanmar has been chosen as a representative country to enhance the use of biodegradable waste as a clean source of energy their quality.

This was because most Myanmar cities generally divide waste into two categories— bio-solid waste (dry waste) and biodegradable waste (wet waste). Separating the biodegradable wastes from the generated wastes could easily make it possible to separately improve the quality of the biodegradable wastes by drying for use as a potential future source of energy.

III. AIM FOR RECYCLING

The main objective of recycling biodegradable waste from households using composting as a technique and specific goals is

i. Determine the biological and chemical processes and management factors that control the efficacy of biodegradable household waste composting in small compost bins

ii. Assess the material's end-use as a soil conditioner and fertilizer and as an alternative to peat.

IV. MATERIALS AND METHODS

Compost mixtures consist of household waste such as tomatoes, leaves of pumpkin, oranges, peppers, onions, rice husk, woodchips, and sawdust. In order for composting to occur in an optimal manner, five key factors need to be controlled, temperature, moisture content, oxygen content, material particle size and the nature of the feedstock with special carbon over nitrogen ratio (C: N) (Pace et al., 1995; Evans, 2001; Last, 2006). In a structural roof, the compost stack was sheltered. Shovel was used to turn the compost to achieve aeration. Nose mask and hand gloves were won for the purposes of protection during the turning. For composting, the combination of the turned windrow and the methods of aeration static pile was used. This is a passive system where feed stocks are mixed with bulking agents to provide a composter-friendly mixture. The mixture was formed into a concave pile, which increased compost materials ' water retention and aeration. In turning the compost material with a shovel, Figure 3 to Figure 5, aeration was achieved. Under proper conditions of adequate oxygen supply, the pile begins to decompose at a temperature of (44.7 °) at an initial moisture content of 50 %, particle size of approximately 1 8 to 2 inches in diameter and carbon to nitrogen ratio of 20:1 to 40:1 respectively (Rink et al., 1992). In general, green and moist materials tend to be high in nitrogen, while brown and dry materials are high in carbon. Tomatoes, oranges, pumpkin leaves, onions, and peppers are the high nitrogen materials, while compost materials are the high carbon materials Sawdust, Woodchips, and Rice husks. The resulting mixture's moisture content is one of the critical factors in the ratios of different materials to be mixed to form the compost. The equation below was used to design the initial mixture to achieve suitable moisture level for the optimal composting.

$$M_n = [(W_w - W_d)/W_w] \, X \, 100$$

Where, Mn = Moisture content of the Material (%)Mw = Wet Weight of the Material (g) Wd = Weight of the Material after drying (g)

Oxygen movement in the compost pile was facilitated by turning the pile at regular intervals with the shovel, this was done when the compost temperature exceeded normal, and this was observed by noticing a rotten odor of hydrogen sulfide gas emissions from the compost material. Compost heat has been produced as a by-product of organic material's microbial breakdown. Due to the replenished oxygen supply and the exposure of organic matter not yet completely decomposed, turning the pile will result in an increase in temperature to peak as the compost begins to cool. After the thermophilic phase, the compost temperature drops and is not restored by turning or mixing. At this point, decomposition takes over mesophilic microbes through a long healing process in which chemical reactions continue to occur, making the remaining organic matter more stable and suitable for use in plants.

Figure 4: Compost Materials after Ten (10) Days

Figure 5: Compost Materials at Final Stage

COLLECTION OF THE SAMPLES

Data were collected from the World Bank 2012 Reports on waste generation and waste composition. MSW's average composition in Myanmar accounted for 54% organic waste, 16% plastic waste, 8% paper, 7% glass, 8% metal, and 7%

more. Wet waste and dry waste are collected separately in Myanmar, mainly in Yangon. Yangon's wet waste accounts for organic waste, consisting of food waste and green leaves, while dry waste includes plastics, paper, glass, metals, and so on. Of these, this study considered wet waste (mostly food waste and green leaves) for drying to optimize the quality of biodegradable waste.

METHODS

i. Evaluation of the moisture content of the samples

Mettle Toledo HG63 Halogen Moisture Analyzer (Type: HG63) evaluated the moisture content of the samples. Standard drying was used to dry the samples, with one milligram per 50 s switch off criterion and 105C drying temperature.

ii. Moisture reduction assessment, weight reduction, volume reduction and heating value increase of the samples

The samples were dried by binding laboratory heating and drying in the oven at a drying temperature of 105 C for 5 h at an air fan speed of 80 %. The drying temperature of 105c. was selected in conjunction with five hours of drying time to efficiently evaluate changes in the quality of various samples during the drying. The moisture reduction, weight reduction, and volume reduction of the samples were recorded at different times. The initial lower heating values and final lower heating values of the samples were approximately estimated based on the following Equations (1) and (2)

$$LHV_{initial} = \sum_{i=1}^{n}\left(\frac{W_i}{D_{avg}} \times \frac{(100 - MC_i)}{100} \times E_i\right)$$

$$LHV_{final} = LHV_{initial} \times \frac{\sum_{j=1}^{n}\left(\frac{W_j}{D_{avg}} \times \frac{(100-MC_j)}{100}\right)}{\sum_{i=1}^{n}\left(\frac{W_i}{D_{avg}} \times \frac{(100-MC_i)}{100}\right)}$$

iii. GHG Emissions and Avoidance from Anaerobic Digestion of the Biodegradable Wastes

Based on the IGES GHG calculation methods, the GHG emissions and avoidance from anaerobic digestion were estimated as described in the Equation (3)

$$\begin{aligned} NGHG_{AD} &= AD_{emission} - AD_{avoidance} \\ &= \left[(E_{CH4} \times DM \times 1000 \times GWP_{CH4})\right] - \left[\begin{matrix}(C_{Biogas} \times P_{CH4} \times EC_{CH4} \times EF_{CO2}) \\ +(GHG_{LFavoidance})\end{matrix}\right] \end{aligned}$$

iv. GHG Emission Avoidance from Avoiding Waste Disposal at Open Dumpsites

The GHG emission avoidance from the biodegradable waste disposal at open dumpsites could occur when all the biodegradable wastes are assumed to be theoretically used as a clean energy source without any disposal at open dumpsites. Thus, the GHG emission avoidance from avoiding the biodegradable waste disposal at open dumpsites is approximately estimated to equal the amount of GHG emissions from landfilling the equivalent amount of waste.

V. GHG Emission Prevention of Biodegradable Waste Use

The avoidance of GHG emissions from the use of biodegradable waste could occur when the equivalent amount of fossil fuel energy could be avoided by using the equivalent amount of energy from enhanced biodegradable waste. Consequently, the amount of GHG emission avoidance from the use of biodegradable waste is estimated approximately equal to the amount of GHG emissions from the fossil fuel consumption equivalent.

V. METHODS TO MANAGE BIODEGRADABLE WASTE

By the segregation of bio waste at the source.

By composting process.

By landfill method.

By Anaerobic digestion.

Figure 6: Anaerobic digestion.

Figure 7: Incineration.

Figure 8: Gasification/Pyrolysis

ADVANTAGE:

Biodegradable waste can be used for

- Composting.
- A resource for heat.
- Electricity and fuel by means of incineration or anaerobic digestion.

DISADVANTAGE:

Climate change impacts: -The main environmental threat from biodegradable waste is the production of methane and other greenhouse gases.

CONCLUSION

With advances in technology, biodegradable waste can be recycled very easily and can be used to produce energy out of it. There are more efficient methods that can be used to generate the energy without damaging the environmental health. There are many projects in most of the districts in India to generate energy from waste. Because of the growing population the waste generation is increasing to prevent this government of India came up with an idea to segregate the wastes at households its self and can be recycled at the source itself the most efficient method of recycling the bio-waste is composting it can be done at home itself. Segregation of the waste at the source is one of the best method of managing the biodegradable waste.

By decomposing them under a controlled environmental condition, mixtures of organic materials that are components of biodegradable waste were recycled. However, compared to other composting processes, the thermal profile and losses of organic matter were lower. A stabilized organic matter was obtained at the end of the decomposition process that can be used as a fertilizer supplement for horticulturalists, landscapers, orchards, farmers, etc. It is also possible to use this stabilized organic matter to control soil erosion. The high variability of most important local compost parameters, as suggested by Al-Turki (2010), suggests an urgent need to develop local compost quality standards to ensure good quality for land use, environment and public health. This study was carried out to know the importance of recycling the biodegradable waste and converting the waste into energy using various methods.

Due to the increasing population the waste generation is also increasing to control this we need to recycle the bio-waste at the generation itself. Composting is a very efficient technique in recycling the bio degradable waste. Anaerobic digestion is non thermal method/technique which is used to produce bio methane gas from bio waste.

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