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AEROBIC BACTERIAL DEGRADATION OF KITCHEN WASTE: A REVIEW

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ABSTRACT

Kitchen waste contain easily degradable an organic biomolecules substances as feedstock for aerobic bio-reactor which works as aerobic digester system to produce highly simple organic and inorganic matters containing biomass as biofertilizers. To create an excellent biomass used as biofertilizers source which will be more valuable and an effective, eco-friendly, cut down on landfill waste, generates a high-quality biomass and reduces CH_4, CO_2 emissions & controlled global warming effect. Therefore these bio-fertilizers contain beneficial & active bacterial communities which involved in the regulation of soil properties on the basis of their biological activity. In the presence of oxygen, aerobic microbes play a major role in the degradation of complex organic materials into mainly to simple biomass & CO_2 production. Aerobic treatment has favourable effects like removal of higher organic concentration, various pathogenic bacteria removal and also produces a stable biomass. The bio-digester requires addition of sodium hydroxide (NaOH) to maintain the alkalinity and pH to 7. For this reactor we have prepared an excellent bacterial community which applied into mixture of kitchen waste slurry along with other biowaste in aerobic bioreactor for biomass as humus production in large quantity and therefore, may be controlled of environmental pollution. A combination of these mixed an excellent bacterial community is used for biomass production at different temperature in laboratory.

Keywords: Aerobic degradation, Waste Treatment, Biomass as biofertilizers & CO_2

INTRODUCTION

India is rich agricultural resources, accounts for 50 million tons of vegetable waste, which is about 30 % of its total production (**Verma *et al.*, 2011**). Food waste is an unwanted raw or cooked food throw away during or after food preparation that is no longer fit for consumption or desirable (**Jean *et al*, 2009**). As food waste has high moisture content and can be decomposed rapidly, many unpleasant environmental consequences can arise during its storage, collection and transportation (**Choi and Park, 1998**). Microbial population of activated sludge is capable of degrading simple chemical structures from municipal wastewater, e.g. carbohydrates, short-chain fatty acids, simple alcohols, proteins and amino acids (**Pike, 1975**). Management and removal of such pollutants are facing a crucial state, due to the unavailability of suitable strategies for the treatment and waste disposal. Unscientific disposal can cause an adverse impact on all components of the environment and human health (**Rathi, 2006; Gupta *et al.*, 1998**).
Asian countries alone spent about 25 billion US dollars on solid waste management during the year 1990, which was expected to rise up to 50 billion US dollars per annum by 2025 (**Hoornweg and Thomas, 1999**). About 135.5 million tones/year of municipal solid waste is generated in India and it is consist of 30-40% of food waste (**Kashyap *et al.*, 2003**). Human societies generate large amounts of waste (**Taylor *et al.*, 2002**).

Table 1 Total production of municipal solid waste (MSW), industrial and agricultural waste in million tons/year. (Source: **Kashyap *et al.*, 2003**)

Waste	India	Brazil	Sudan	USA	Sweden
Municipal Solid Waste	135.5	44.0	2.3	148.0	5.3
Sewage	44.9	8.02	1.4	16.0	0.6
Manure	653.0	470.0	68.0	306.0	13.2
Agricultural residues	200.0	47.0	8.1	573.0	12.6
Biomass	140.0	496.8	192.3	427.0	14.0

Although organic matter can also be decomposed under anaerobic condition, the degradation is slow and less efficient, and produces less heat and more undesirable products, including CH_4 and N_2O, which are greenhouse gases contributing to global warming (**Hao *et al.*, 2001**).
In comparison, aerobic composting is accepted as an eco-friendly an option for handling food waste, because the predominant aerobic environment can help mitigate methane generation. Thus, composting is presently gaining more and more attention in treating food waste (**Droffner and Brinton, 1995; Elwell *et al.*, 1996; Donahue *et al.*, 1998; Laos *et al.*, 1998; Faucette *et al.*, 2001; Seymour *et al.*, 2001; Tomati *et al.*, 2001; Filippi *et al.*, 2002; Das *et al.*, 2003; Cekmecelioglul *et al.*, 2005; Chang *et al.*, 2005a**). Pathogenic microorganisms and harmful chemicals in solid waste can be contaminated into the environment when the waste is not properly managed (**Wai-Ogosu, 2004; Ogbonna and Igbenijie, 2006**). Waste can contaminate surface water, ground water, soil and air which cause more problems for humans, other species, and ecosystems (**Obire *et al.*, 2002**).

KITCHEN WASTE SOURCES

In Municipal Solid Waste, food and organic waste mostly consist of uneaten food and food waste generated to especially from residences (School, hospitals, universities, offices), and commercial (from restaurants, cafeteria, hotels, markets and industry) sources known as kitchen waste (**Village, 1998**).

COMPOSITION OF KITCHEN WASTE

Kitchen waste is characterized by a high organic content containing soluble sugars, starch, lipids, proteins, cellulose, and other compounds that are readily biodegradable, and generally contain few compounds that inhibit bacteria (**Wang *et al.*, 2003b**).

MICROORGANISMS INVOLVED

Macdonald *et al.* (1981) noted that the composting process is brought about by several organisms such as bacteria, fungi, actinomycetes and protozoa and may also involve invertebrates such as nematodes, pot worms, earthworms, mites and various other organisms.

BIODEGRADATION OF KITCHEN WASTE

Composting is considered one of the most suitable approaches for disposing of solid waste and for increasing the amount of organic matter that can be used to restore and preserve the environment (**Stentiford, 1987**). Aerobic composting involves a process of biological decomposition and stabilization of organic substrates under conditions that allow multiplication and activity of thermophilic microorganisms as a result of biologically produced heat, to produce a final product that is stable, free of pathogens, pests and plant seeds, useful in agriculture and forestry as manure (**Balasundaran *et al*., 1999; Saravannan *et al*., 2003**).
Donahue *et al*. (1998) demonstrated a successful composting of food waste with sawdust and mulch chip in an in-vessel system within 14 days. Composting reduced the amount of disposed garbage, recycled the organic resources and produced the organic fertilizer for organic farming. However, the variation of compost quality is huge due to differences of raw materials, operation conditions, micro flora, and composting methods (**Aoshima *et al*., 2001; Tsai *et al*., 2002**). There will be an advantage if the kitchen waste with high fraction of organic content can be utilized as a high value of carbon resource. So far, the recovery energy from methane fermentation and the production of organic fertilizers by composting using kitchen waste has been implemented (**Wang *et al*., 2001**). These organic wastes also have been used for organic acids production. An organic acids production from kitchen waste, not only can eliminate waste pollution problem but also reduce the production cost of organic acids (**Wang *et al*., 2003b**). Lactic acid could be stably accumulated during kitchen waste fermentation by controlling some fermentation parameters such as temperature, pH etc (**Sakai *et al*., 2000; Wang *et al*., 2002**). Lactic acid was found to be the main fermentation products for kitchen wastes (**Wang *et al*., 2001; Wang *et al*., 2003b**).
In recent years, composting has attracted much attention and has come to be regarded as an environmentally friendly and sustainable alternative for the management and recycling of organic wastes (**Saebo and Ferrini, 2006**). Composting is being widely employed for the treatment of sewage sludge, yard waste, food waste, forestry industry waste, municipal solid waste, and agricultural waste (**Liang, 2000**). Composting is a thermogenic, solid state fermentation process, carried out by a succession of microbial populations beginning with mesophilic bacteria, actinomycetes and fungi followed by thermophiles and ending again with mesophiles (**Johri *et al*., 1999**). Composting process creates stable, soil-enriching humus and concentrates the Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca) and Magnesium (Mg) contents (**Eneji *et al*., 2001**). Composting is useful in avoiding green house gas (GHG) emissions, as it is an aerobic process. Composting with sufficient aeration generates biogenic CO_2 instead of CH_4 from the degradation of organic materials. It also reduces emissions from organic waste by a significant amount, compared to land filling without energy recovery (1.2 t CO_2 e/t for food wastes and 0.7 t CO_2 e/t for yard trimmings) (**Mohareb *et al*., 2004**). Moreover, composting produces a useful byproduct that can be used as a soil conditioner.
Composting converts various components in organic wastes into relatively stable substances that can be used as a soil amendment or organic fertilizer. However, composting can also impact negatively on the environment, namely through the generation of odorous gaseous emissions (**Pagans *et al*., 2006**). Consequently, the problems of odor emission in composting plants require immediate attention if composting is to become a viable option for the industrial scale recycling of food waste. More than 100 kinds of odorous gases are emitted from composting processes, of which the nitrogen-containing compounds, sulfur-containing compounds, and short-chain fatty acids have attracted the most attention due to their low threshold limits (**Curties, 1981**).
According to **Verrier *et al*., (1987**) and **Raynal *et al*., (1998**) the organic fraction of the waste includes about 75% sugars and hemicelluloses, 9% cellulose, and 5% lignin, carbohydrates, amino acids, fatty acids and their esters. The use of bioremediation technologies for removing these contaminants provides a safe and economic alternative to commonly used physical-chemical treatment. The exploitation of the metabolic versatility of microorganisms is advantageous in bioremediation but the actual number of degraders of a target compound may only 5-10% of the total microbial community (**Chandrakant and Rao, 2011**).
Vegetable waste provides good amount of nutrients for inhabiting microbes, they are neither pathogens nor concerned with human health. However they are prone to strong odors during decomposition. The high moisture contain of vegetable waste causes expensive to dispose it off. The vegetable waste containing lettuce and onion waste has high amounts of sulfur 0.2% and 0.7% respectively and their moisture content is of 96.2% and 91.1% respectively (**McGuckin *et al*., 1999**).
Bio-fertilizer are commonly contains living microorganisms and their activities will promote soil ecosystem and produce supplementary substance for the plants (**Parr *et al*., 2002**). The microorganisms and the nutrients occur in the raw materials which are helpful in improving of soil health. There are different types of bio-fertilizers available that their differences are mainly the raw materials used, forms of utilization and the sources of microorganisms (**Svensson *et al*., 2004**).

ROLE OF MICROBIAL ENZYMES IN COMPOSTING

Bacterial extracellular enzyme mediated activity is the major process involved in the hydrolysis of organic pollutants. Bacterial communities contain a broad range of genetic information to build up specific enzymes for the biodegradation. Extracellular hydrolytic enzymes thus produced can disrupt major chemical bonds in the toxic molecules and results in the reduction of their toxicity (**Sharma and Shah, 2005; Lal and Saxena, 1982**). Microorganisms are the key factor in nutrient transformation. Microorganisms that involve in composting process excrete several extra-cellular enzymes include lignocelluloses, proteases, lipases and other enzymes that contribute in degradation of macro-molecules of organic wastes. Therefore inoculation of suitable microbial strains in initial organic wastes resulted in enrichment in the nutrient status of composts (**Lei and Vander Gheynst, 2000**).
Lipase are serine hydrolases of considerable physiological significance and industrial potential that can catalyze numerous reactions such as hydrolysis, inter-esterification, esterification, alcoholysis and aminolysis (**Jaeger and Eggert, 2002**). Biodegradation is breakdown of organic contaminants occurring due to production of extracellular enzymes by microorganisms. These contaminants can be considered as the substrate or microbial food source (**Maier *et al*., 2000**). Biological treatment of municipal wastewater is successful when performed with activated sludge (**Grady and Lim, 1980; Eckenfelder, 1985**).
The microbial source of amylase is preferred to other sources because of its plasticity and vast availability. Microbial amylase has almost surpassed the synthetic sources in different industries (**Pandey *et al*., 2000**). Amylases can be obtained from several sources such as plant, animal and microbes (**Kathiresan and Manivannan, 2006**). Starch degrading amylolytic enzymes are most important in the biotechnology industries with huge application in food, fermentation, textile and paper (**Pandey *et al*., 2000**). Unusual bacterial amylases are found in acidophilic, alkalophilic and thermoacidophilic bacteria (**Boyer and Ingle, 1972**). In 2003, Windrow and aerated pile composting of sewage sludge and food waste could enhance the stability of these wastes and ensure the inactivation of pathogens and parasites (**Furhacker and Haberl, 1995; Rantala *et al*. 2000; Krogmann, 2001**).

FACTORS AFFECTING OF KITCHEN WASTE DEGRADATION

These factors are involved in the composting of kitchen wastes, which are discussed given below. Such as the composition of raw material, temperature, oxygen concentration, pH and water of the composting process-all influence the concentrations of gases produced (**Wang *et al*., 2002**). The major advantage of aerobic composting over anaerobic composting is that it is fast and the decomposition process is completed within eight to twelve weeks and foul smelling gases are not produced. There are many factors that affect the composting process, such as the microbial diversity, proportions of the mixture, temperature, the aeration rate, oxygen consumption rates, compost recycling, moisture content, pH and C/N, and so on (**Yanjun *et al*., 2009; Boulter *et al*., 2000**).

THE COMPOSITION OF RAW MATERIAL

Where the amount of readily degradable compounds (sugars, carbohydrates, hemicelluloses and cellulose) is adequate, and the compost pile is well aerated and insulated, the pile temperature will generally rise within several days to the mesophilic and then to the thermophilic phase (40^o to 70^oC), reflecting a vigorous microbial activity and a rapid rate of organic compounds degradation. The degradation by thermophilic bacteria at the thermophilic phase is critical for pathogen control and killing of fly larvae, weed seeds if the high temperature is maintained three or more days. The composting rates decrease when the temperature reaches 60^oC or above (**Boch *et al*., 1984**). The temperature of the composting pile can be controlled by several strategies including configuration of the compost heap (its size and shape), by turning and watering, or by temperature feedback controlled ventilation (**de Bertoldi *et al*., 1985**).

C/N RATIO

Carbon to nitrogen ratio of compost is the ratio between carbon and nitrogen content in compost. It is an important parameter of composting because its show about the compost quality. The composting may be more effective when C/N ratio between 30 to 40% (**Chang and Chen, 2010**). Some studies have shown that C/N ratio at lower than 20 is also effective (**Kumar *et al*. 2010; Zhu, 2007**). As aerobic composting is based on microbial respiration, so microorganisms require food, energy and habitat. They need C as their energy source in order to manufacture enzymes for complex carbohydrates degradation into simpler forms which are then being used by these microorganisms (**Hamdy, 2005**). These nutrients are the basic building blocks of life and allow microbes to create the necessary enzymes which help them in the breakdown of contaminants. Carbon is the most basic element of living forms which is needed in greater quantities to microbes than other elements. Microbial cells constitute about 95% of hydrogen, oxygen, and nitrogen of the weight of cells. Phosphorous and sulfur contribute with 70%. The nutritional requirement of C/N ratio is 10:1, and carbon to phosphorous is 30:1. (**Vidali, 2001**).

TEMPERATURE

Temperature rises when sufficient heat is trapped within the compost pile. Composting can generally be divided into three stages based on the temperature in the composting pile. The rise in temperature and the rate of CO_2 release from the compost are directly related to O_2 consumption rate (**Epstein, 1996**). Actinomycetes tend to be common in the later stages of composting and can exhibit extensive growth. Bacteria are by far the most important decomposers during the most active stages of composting due to rapid growing ability on soluble substrates and tolerant of high temperatures. Thermophilic bacteria are dominant species at temperatures above 55^{o}C, which kill pathogens (**Strom, 1985**).

According to Cooney and Emerson, (1964) thermophilic microorganisms require a maximum temperature for growth at or above 50^{0}C and a minimum temperature for growth at or above 20^{0}C. Thermophiles are reported to contain proteins which are thermostable and resist denaturation and proteolysis (**Kumar and Nussinov, 2001**). Specialized proteins known as chaperones are produced by these organisms, which help, after their denaturation to refold the proteins to their native form and restore their functions (**Everly and Alberto, 2000**). The cell membrane of thermophiles is made up of saturated fatty acids, which provides a hydrophobic environment for the cell and keeps the cell rigid enough to live at elevated temperatures (**Herbert & Sharp, 1992**).

MOISTURE

Moisture is also a very important parameter of composting it can maintain the rate of biodegradation of materials. The moisture content in access amount can be negative for composting process. Bulking agents like sawdust, rice husk, cotton waste and maize straw can control the moisture content of composting materials (**Adhikari *et al*., 2008; Paredes *et al.*, 1996; Zorpas and Loizidou, 2008)**. When the moisture content between 55% to 65% the composting will more effective (**Chang and Chen, 2010)**. Water is the media for nutrient transportation and metabolic reactions. The availability of nutrients and contaminants to microorganisms is affected by the water content in their micro-environment especially in the thin liquid layers on the surfaces of particles. The optimum moisture content is in the range of 50- 70%. If too much water fills the voids, the pore space that allows air diffusion would be limited (Gajalakshmi and Abbasi, 2008).

OXYGEN CONCENTRATION

The oxygen requirement for decomposition of food wastes was estimated to be 5.0 g O_2 g^{-1} dry weight of food wastes. In this slurry-phase decomposition, suspended solids in the reactor disappeared at a maximum rate of 7.9 g dry weight L^{-1} day^{-1} (**Yun *et al*., 2000**). The use of aerobic thermophilic treatment to convert a mixture of sewage sludge and food waste into fertilizer has been reported previously (**Wang *et al.*, 2003a, b**). Theoretically, the water content of the compost could reach 100% without causing harmful effects itself. However, as water content increases, the rate of O_2 diffusion decreases. As O_2 becomes insufficient to meet the metabolic demand, the composting process slows down and become anaerobic. The upper limit of water content is between 60 and 80%, depending on the composting materials (**Golueke *et al.*, 1991**). **Nakasaki *et al.*, (1990**) revealed that the supply of oxygen is essential for the escalation/ growth of composting process.

pH

The pH is a very important factor in composting and vermicomposting. It can increase and decrease the rate of biodegradation. Composting is a biological process of microbial activities and microbes survives at specific pH. Bulking agents like sawdust, cow dung and rice husk etc can control the pH value of composting (**Chang and Chen, 2010; Adhikari *et al*., 2008; Singh and Kalamdhad, 2012**). For the better biodegradation of composting materials the pH value should not very basic and very acidic it should be between the range of 6-8 (**Chang and Chen, 2010; Gea *et al*., 2007; Alburquerque *et al*., 2006**).

Actinomycetes prefer moist but aerobic conditions with neutral or slightly alkaline pH. But reducing pH to reduce NH_3 volatilization by adjusting the pH of the compost to or below is possible, but low pH interferes with the transition of mesophilic degradation to thermophilic degradation (**Sundberg *et al.*, 2004**). The volatilization of organic acids (e.g., acetic acid), or odor, is reduced when the compost pile pH is raised to pH 5 or above (**Brinton, 1997**).

Although microbes are the real agents responsible for composting, their type and population size rarely are a limiting factor (**Golueke, 1989**). Bacilli predominated beyond the initial mesophilic phase. Compost turning or aeration is critical for a rapid degradation and high quality compost particularly for the food waste composting (**Illmer and Schinner, 1997**). A moisture level of 40 to 60% by weight should be maintained throughout the composting period (**The U.S. Composting Council, 1997**). Bacillus species are generally industrial importance since they have the ability to produce extracellular enzymes (proteases, amylases, cellulases, lipases, pectinases, and xylanases) that are active and stable at high pH values (**Martens *et al*., 2001**).

WATER

Water is a critical factor in composting system. Microbial cells have a physiological need for water. In addition, water can function as a solvent of substrates and salts, a major heat storage medium due to its high specific heat capacity, and as temperature adjusting substances through evaporation. Theoretically, the water content of the compost could reach 100% without causing harmful effects itself. However, as water content increases, the rate of O_2 diffusion decreases. As O_2 becomes insufficient to meet the metabolic demand, the composting process slows down and become anaerobic. The upper limit of water content is between 60 and 80%, depending on the composting materials (**Golueke *et al.*, 1991**).

AERATION

Aeration or air supply is the major factor in the composting rate. It can highly affect the composting process and rate (**Chang and Chen, 2010**). Air supply should be proper in the compost materials for better and fast biodegradation of materials (**Barrington *et al.*, 2003**). Food waste is an easily degradable material under aerobic conditions. A 91% reduction of food wastes was achieved during treatment in the slurry phase at 30°C with the addition of a mixture of micro-organisms used in composting (**Yun *et al*., 2000**). The maximum content of microorganisms was 5×10^{10} cells ml^{-1} at the 20^{th} day (**Park *et al.*, 2002**). The effect of aeration rate was considered to be a major factor affecting the slurry-phase decomposition of food wastes (**Park *et al*., 2001**).

In recent study, an attempt is made to enhance the aerobic composting through bio-stimulation by the addition of nutrients in order to enhance the efficacy of microorganisms (**Martinez *et al.*, 2008**). Urea and tri super phosphate (TSP) are used as nutrient source. Indigenous microorganisms are stimulated by injecting these trace nutrients to waste system to increase the activity of microorganisms (**Koenigsberg *et al.*, 2005**). In low-income countries, the solid waste generation rate is average only 0.4 to 0.6 kg/person/day, as opposed to 0.7 to 1.8 kg/person/day in fully industrialized countries (**Cointreau, 1982; Blight and Mbande, 1996**). In urban areas, solid waste has a very high organic content that ranged from 70- 85 %. Thus, under proper conditions this biodegradable fraction could be composed or co-composted for beneficial use as soil conditioners and bio-fertilizers (**Parr and Hornick, 1992**). The microbial population of soils is made up of five major groups including bacteria, actinomycetes, fungi, algae and protozoa, and among these groups, bacteria are the most abundant group (**Alexander, 1961**) and the most important microbe for decomposing waste.

Various composters are currently commercially available or several types of in-vessel composting systems have been developed for installation in food service establishments to manage food waste as a recyclable resource. It is difficult to maintain steady degradation due to the instability of the micro flora within the composter due to the raw material, pH, temperature and other environmental conditions (**Miller, 1959; Summerell and Burgoss, 1989**). Composting is a microbial decomposition process in which easily degradable and putrescent organic waste materials are converted into a stable material, compost (**Gray *et al.*, 1971**). It has been thought that the micro-organisms contributing to organic matter decomposition will change as composting progresses, since temperature, pH, moisture content, the quality and quantity of organic materials also change during composting (**Gray *et al.*, 1971; Golueke, 1977; Finstein and Morris, 1975; de Bertoldi *et al*., 1983**).

Under anaerobic condition, microorganisms break down those materials into small molecules, produce organically reduced sulfur compounds, such as H_2S (**Rapper and Muller, 2005**), acids (**Wu, *et al.*, 2010**), ammonia (**Kim *et al.*, 2009**; **Vijaya *et al.*, 2010**) and amines ($R-NH_2$) (**Rapper and Muller, 2005**) which are the most likely source of malodor (**Rosenfeld *et al.*, 2000**). Bacteria use wastes for their own metabolism and finally they produce some simple and useful compounds which are important for soil health, plant growing and over all to keep well balance of natural ecosystem. Bacteria along with saprobic fungi are an important contributor to optimal agricultural and kitchen wastes bioconversion (**Rahman *et al.*, 2009**). It contains mostly organic wastes which can be decomposed by composting process (**Raimbault *et al.*, 1998**). During the process, part of organic C is released as CO_2, part incorporated into microbial cells and part humified. The organic nitrogen primarily as protein prior to composting is mineralized to inorganic N (NH_4-N and NO_3-N), which is then re-

synthesized into other forms of organic N in microbial biomass and humic substances during the composting process.
Degradation of organic C during composting is carried out by bacteria, fungi, and actinomycetes, depending on the stage of degradation, the characteristics of materials, and temperature (**Epstein *et al*., 1996; USDA, 2000**). There are many thermophilic actinomycetes, which can tolerate composting temperatures in the 50°C and low 60°C. In some countries, before 1980's, the soil fertility was maintained mainly by the use of organic fertilizers such as farmyard, manure, compost, green manure, straw and organic wastes. At the present, low soil organic matter content on arable lands has made them become less fertile (**Yang *et al.*, 1997**).
In composting, a large number of microorganisms such as fungi, actinomycetes and bacteria, which at the same time attack the organic residues, use a portion of them to form their cellular material and produced carbon dioxide (**Deporter *et al.*, 1998**). In addition, a variety of organic metabolites and water are produced. As the process reaches at its mature stage, a lower concentration of carbon dioxide is given off since microbial utilization of carbon source render the labile compounds less accessible due to diminution in the residues (**Wang *et al.*, 2004**). Furthermore, composting is an economic, hygienic and ecological system of managing municipal as well as industrial solid wastes constituting biodegradable residues, both by aerobic and anaerobic process (**Nakasaki *et al.*, 1985**). In general, composting is practiced in open piles or windrows (**Gaur, 1982**).

METHODS OF KITCHEN WASTE TREATMENT:-

COMPOSTING

An aerobic, biological process of degradation of biodegradable organic matter, Composting also leads to reduction in odour and the removal of pathogens. The wastes from wholesale fruit and vegetable markets, supermarkets and food processing are the best materials for composting (**Sharma *et al*., 1997**). Other reports describe the application of composts from different food wastes such as leaf compost (M**aynard and Hill, 2000**) and compost from agro-industrial wastes (**Garcia-Gomez *et al.*, 2002**) which improve the physical properties of the soil and the produced crops. The optimal conditions for composting of food waste are: moisture content of the composting material must be at least 65%; pH near neutral; the C/N ratio of the material must be between 25: 1 and 35: 1. Additional aeration can improve the process; a temperature of 60°C must be kept for optimal thermophilic composting (**Haug, 1993**). Another aerobic technology for the treatment of food waste is a slurry technology which leads to a complete high rate decomposition of food waste to inorganic carbon (**Park *et al*., 2001**)

INCINERATION

A process of combustion designed to recover energy and reduce the volume of waste going to disposal. In its dry form, sewage sludge could be considered a special type of renewable fuel, due to the high quantity of organics of sufficiently high calorific value, similar to that of brown coal (**Werther and Ogada, 1999; Spliethoff, 2010; Garcia, *et al.*, 2013**). There is therefore increased interest in utilisation of sewage sludge, resulting also from limited reserves of fossil fuels (and limited global security of energy supplies) and environmental and climatic regulations on CO_2 emissions. There are several thermal technologies for utilising municipal sewage sludge to obtain useful forms of energy, such as pyrolysis, gasification, combustion, and co-combustion processes (**Manara and Zabaniotou, 2012; Calvo *et al.*, 2013; Chun *et al.*, 2011; Judex, *et al.*, 2012; Rushidi *et al.*, 2013**). The advantages of thermal processes are the large reduction in volume, the thermal destruction of toxic organics and the recovery of the energy of organic sources in the sludge. One of the most promising options is combustion. Combustion characteristics of sewage sludge have been widely studied using thermo-analytical techniques. The influence of temperature and atmosphere has been investigated by thermal analytical techniques (**Viana *et al.*, 2011; Varol *et al.*, 2010; Magdziarz and Wilk, 2013; Otero *et al*., 2007; Wu *et al*., 2012**). Thermogravimetric analysis of the kinetics of combustion processes has been performed by **Scott *et al.*, 2006; Lee and Bae, 2009; Magdziarz, and Wilk, 2013**). Landfill causes ground water contamination while in case of incineration; there is a problem of green house gas emissions, leading to the environmental degradation (**Tsai *et al.*, 2007; Lee *et al*., 2009**).

LANDFILL

The deposition of waste in a specially designated area, which in modern sites consists of a pre-constructed 'cell' lined with an impermeable layer (man-made or natural) and with controls to minimize emissions (**Rushton, 2003**). High-quality compost is produced by interaction of many organisms that have suitable properties for the composting processes. Nevertheless, little information has been reported about in situ functions and roles of individual microbes in the composting processes, because many microbes related to composting are difficult to isolate and are characterized by conventional cultivation methods (**Atkinson *et al.*, 1996; Gautam *et al.*, 2009**).

RECYCLING

The recovery of materials from products after they have been used by consumers, Recycling of food wastes can be benefits to the environment by reducing the amount of garbage disposed, promoting the fertility of soil and improving the physical and chemical properties of soil (**Park *et al.*, 2002**). Furthermore, recycling of food wastes reduce the unpleasant odors of garbage, benefits the sanitation of the environment, and decreases garbage collection-related spending. Food waste is less harmful to the environment than industrial waste. Thus, composting of food waste is attracting considerable attention because it would significantly reduce the amount of waste and the product can be used as compost or bio-fertilizer which can be handled, stored, transported and applied to the field without adversely affecting the environment (**Debosz *et al.*, 2002**).

SEWAGE TREATMENT

Process of treating raw sewage to produce non-toxic liquid effluent which is discharged to rivers or sea and a semi-solid sludge, which is used as a soil amendment on land, incinerated or disposed in a landfill. Wastes include solids, liquids and gases, among them solid or semi solid forms are called "solid waste". Kitchen waste sewage (the liquid portion of kitchen food waste) contains carbohydrates, proteins, fats, and cellulose etc.; those are the source of nutrition for microbial metabolism (**Wang *et al*., 2003**). Kitchen waste has high moisture content (about 70%), malodor, high oil and grease levels as well as salt. If treated inadequately by land filling, the unpleasant odors, and ground-water pollution may cause residents to protest (**Chen *et al.*, 2008**). This bio-reactor need not add any chemicals, operates easily, and almost every household can apply this cheap bio-reactor to treat their own kitchen sewage. This kind of household treatment can reduce kitchen waste weight about 40% for easier garbage truck collection. The cyanobacteria can decay organic pollutants and decreases water pollution (**Cheunbarn and Peerapornpisal, 2010**).

CONCLUSIONS

Based on the literature survey, it can be concluded that kitchen waste is very useful and very harmful to our day life in different conditions. It can be used for biogas, an organic acids, biofertilizers, and biomass production as humus which contain biological activity and associated with many major roles for fixation of environmental parts. Due to its degradation is becoming a great challenge because kitchen waste made up of biological polymer substances which provide nutritional substances for growing pathogenic microorganisms. Various treatment methods are available in the literature but the cheapest, eco-friendly and acceptable method is aerobic degradation (composting) by aerobic microbes. The anaerobic microbes release the extracellular enzymes such as hydrolytic enzymes involve in degradation of kitchen waste in anaerobic conditions and produces methane gas act as a global warming factor. So composting methods is a suitable for controlling of methane and global warming effect in environment.

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