A Review on Technological Approach for Obtaining Nutrient from Solid Waste

A. Karthika, R. Seenivasagan, and M. Vasanthy

Abstract Globally the huge amount of solid waste creates the ecological and technical problems. As the human population increases, there is simultaneously increase in waste generation. Hence waste management strategies are considered most important in gaining organic nutrients from it. Farmyard manure, biochar, poultry manure, vermicompost, biogas digest, and urban compost are rich sources of vitamins, growth-promoting substances, macro-, and micro-nutrients. Numerous technologies are followed nowadays to recover organic nutrients and utilize them for the agricultural field to retain the soil fertility, improved tillage, reduce irrigation of soil, obtain high porosity, better aeration, water holding capacity, and plant growth-promoting factor, etc. Among them composting, vermicomposting technologies, and aerobic digestion play major roles. These processes are able to collect microbes, macro-nutrients, and all micro nutrients from the waste degradation. At the end of process, compost and digestate obtained are eco-friendly and cost-effective compare to other bio products. This chapter deliberates the methods followed in managing solid waste and their importance in gaining nutrients. This could also substantiate the significance of micro- and macroorganism helpful in increasing the rate of degradation. Other new technologies such as biochar, osmosis, and electro-dialysis are also discussed. This chapter summarizes over all case studies and key publications regarding solid waste management and nutrient recovery from organic waste with no further costs.

Keywords Solid waste · Vermicompost · Compost · Organic nutrients

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1 Introduction

The World Bank Report by the year 2020, about 2 billion tonnes of waste would be generated. This could be expected to increase by 3.4 billion tonnes by the year of 2050 (Luis et al., 2019). According to the Associated Chambers of Commerce and Industry (ASSOCHAM), in India about 5.2. million tonnes of waste is estimated to be generated every year. Generation of waste has been categorized into food and green, glass, metals, plastics, paper and cardboard, rubber, wood, and others. In the developed countries, among 34% of waste generation about 16% went for recycling. But in the developing and underdeveloped countries, about 90% of waste are not disposed properly and hence leads to pollution and disasters.

Recently the disposal of organic solid waste creates more attention by collecting and recycling. With increasing population, there would be increase in the generation of waste annually (Vinay et al., 2018). Therefore, managing the solid waste is one of the major needs to avoid the consequences caused by the waste generation. Solid waste management includes activities such as generation, storage, collection, transfer and transport, treatment, and disposal of solid wastes. Due to unavailability of suitable facilities, there is a lack of collection and transportation. Therefore, there is a deposition of waste accumulated in every nook and corner of the city. All this happened due to the unplanned maintenance and poor financial status of the municipal corporation of the country. The MSW management system should involve planning, engineering, organization, administration, financial and legal aspects of activities related with generation, storage, collection, transport, processing, and disposal in an environmentally compatible manner thereby adopting the economy, energy conservation, aesthetics, and opportunities (Sharholy et al., 2008). It should provide maintenance charge for proper infrastructure facilities and requirement needed for all activities.

1.1 Solid Waste Generation

About 2.0 billion metric tons of municipal solid waste (MSW) are produced annually worldwide. According to the World Bank Report, overall waste generation increases up to 3.40 billion metric tons by 2050 (https://www.wastedive.com/news/world-bank-global-waste-generation-2050/533031/). About 13.5% of waste get recycled; 5.5% went on composted; 40% of waste has not been managed properly, and it went on open dumping and burning which pollute soil, water, and air. Among 217 countries worldwide, India influences maximum waste generation. About 62 million tonnes of waste with growth rate of 4% was generated in India. All types of waste including organic waste, plastic waste, and textile waste come under municipal solid waste (MSW). Organic waste is a major contributor to MSW, as organic waste gets decomposed easily and it may also cause harm to environment due to

wild deposition of waste in land without proper treatment. Hence it pollutes soil and ground water and accumulates greenhouse gases (Sisto et al., 2017). Therefore, solid waste management should be necessarily practiced to overcome the problem.

1.2 Amount of Municipal Solid Waste Generation

The quantity of the waste depends up on the influence of food habits, living standards, commercial activities, and seasons of a particular area. An increase in population will increase the waste generation. Currently, it must be higher in comparison to the previous years (Pappu et al., 2007). MSW generation is lower in small towns when compared to metro cities. The solid waste generation in urban area must be 1.15 lakh tonnes; in mega cities, it must be 21,100 tpd; in metro cities, it must be 19,643 tpd; in towns, it must be 42,635.28 tpd, respectively.

1.3 Collection and Generation of MSW in India

According to Planning Commission Report (2014), urban India generates 165 million tons of waste annually and by 2050 it could reach 436 million tons. It requires around 1175 hectare of land per year to dispose waste in a systematic manner (Bhide & Shekdar, 1998; CPCB, 2000; Pappu et al., 2007; Shekdar, 2009). This must be based on 0.45 kg/capita/day waste generation. During the last decade, solid waste generation has increased 2.44 times (CPCB, 2013).

1.4 Types of Waste

Municipal solid waste is generally categorized into residential, industrial, commercial and institution, construction and demolition, municipal services, and agriculture and mining. Physical characteristics of MSW include paper, textile, leather, plastic, metal, glass, ash, and dust. Chemical characteristics of MSW shows carbon $(0.64 \pm 0.8)\%$, phosphorus $(0.67 \pm 0.15)\%$, potassium $(0.68 \pm 0.15)\%$, and C/N ratio $(26 \pm 5)\%$. The composition of MSW include compostable waste (fruit and vegetable peels, food waste), recyclable (paper, plastic, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines), inerts, moisture, soiled waste (blood stained cotton, sanitary napkins, disposable syringes) respectively. According to NEERI MSW, India has approximately 40–60% compostable, 30–50% inert waste, and 10% to 30% recyclable.

1.5 Rag Pickers

The role of rag pickers provides an important scenario in MSWM. The rag pickers pick up the recyclable material such as paper, plastic, and tin and sell it to scrap merchants to generate income, so that they can save 14% of the municipal budget annually and reduce up to 20% load on transportation and on landfill (Pappu et al., 2007).

1.6 Solid Waste Management Practices in India

According to CPCB Report 2013, there is an action plan execution and enactment for municipal solid waste management. Due to lack of segregation, only 12.45% waste is scientifically processed and rest is disposed in open dumps. Main features such as land requirement, environment friendliness, cost-effectiveness, and acceptability to the local community block efficient solid waste management system. The following practices are carried out to manage generation of solid waste.

Segregation

Segregation is the process of separating waste into different elements. It can accomplish by sorting manually at household; curbside collection schemes; automatic separation; mechanical biological treatment separating systems, etc. Since segregation of waste is not organized properly, three-fourth of the generated waste does not get disposed suitably (Kaushal et al., 2012).

Collection

Waste collection is a part of the process of waste management. It is the transfer of solid waste from the point of use and disposal to the point of treatment or landfill. The waste produced in household is transferred into communal bin. Waste from other complex sectors, complexes, and industries that come under municipality also transfer their waste to disposal site (Kumar et al., 2009).

Three Rs : Reduce; Recycle; Reuse

It helps to cut down on the amount of throw-away waste. It conserves the natural resources by landfill space and energy. Retrieving useful materials from waste, utilizing them for making new products, sorting out and taking recyclable material such as plastics and glass lead to income generation. In India, in union territories

such as Pondicherry, rag pickers collect all the recyclable material and send these materials for recycling process (Pattnaik & Reddy, 2010).

Transportation

Small to heavy vehicles are utilized for transportation. In villages, bullock carts, hand rickshaws, compactors, trucks, tractor, trailers, and dumpers were used. In small towns, trucks, stationary compactors, mobile compactors/closed tempos, and tarpaulin-covered vehicles are used in the transportation of MSW. Without the transport system, disposal of waste decreased drastically (Joseph, 2002).

Disposal

In India, 59 cities followed the disposal techniques for solid waste generation. The following techniques were followed to carry out the disposal waste material.

1.7 Nutrient Recovery from Solid Waste

Stabilizing organic solid waste retrieves nutrient-rich manure. The organic matter degradation is attained by microbes and earthworm thereby maintaining aeration and fertility of the soil (Garg et al., 2012). Enormous amounts of nutrients have been recovered from organic solid waste such as distillery industry sludge (Suthar & Singh, 2008), agricultural wastes (Suthar, 2009), bagasse (Pramanik, 2010), and water hyacinth (Varma et al., 2016). Soobhany et al. (2015a). Degradation of organic solid waste retrieves all beneficial plant macro-nutrients and micro-nutrients. Techniques involved in degradation of organic solid waste help to minimize the pathogenic compounds (Soobhany, 2018) and reduce the heavy metals (Soobhany et al., 2015b) to produce better quality products with enriched nutrient content.

1.8 Techniques in Treating Organic Waste

There are several techniques followed for treating waste materials. The organic waste material can be directly digested anaerobically to produce biogas or it may undergo aerobically followed by reverse osmosis to produce enormous amount of micronutrient. It can be further subjected into composting or vermicomposting to produce organic fertilizer. It may undergo gasification or pyrolysis to produce bio-char and syn gas.

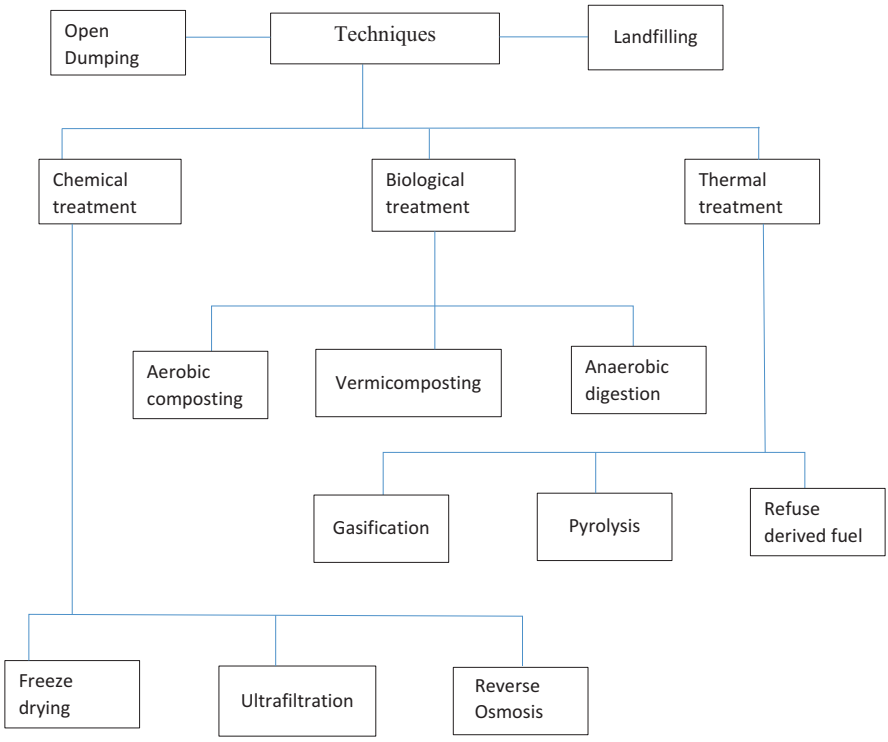
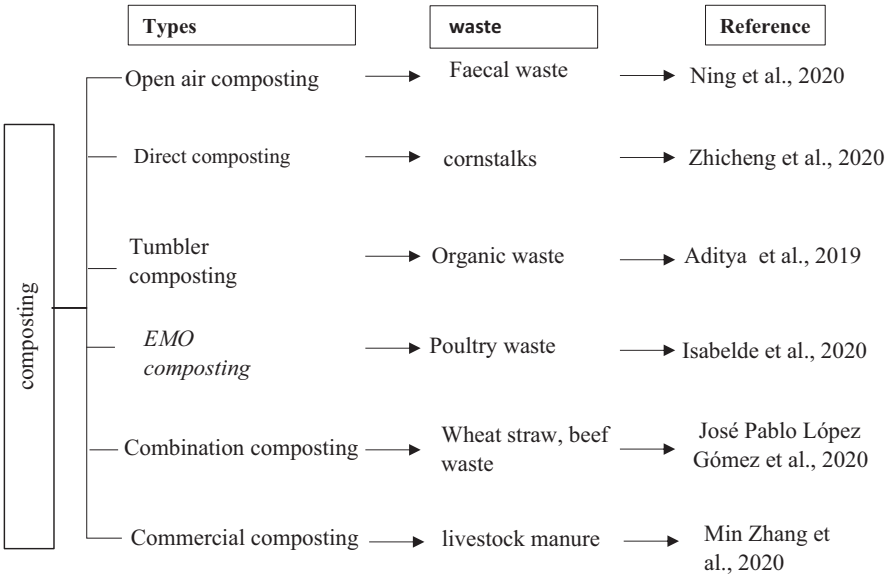


Fig. 1 Methods followed for treating municipal solid waste

1.9 Techniques for Treating Solid Waste

Composting

Organic waste decomposed in aerobic method to produce fertilizer a humus like material. It contains all major and minor nutrients which help in increasing plant growth and soil fertility. This natural fertilizer is dependent upon numerous micro-organisms such as bacteria, actinobacteria, protozoa, fungi, and rotifers. All kinds of degradable waste such as municipal solid waste, green waste, human and animal waste, and sewage waste can be degraded by composting. Compost is performed as soil improver and fertilizer. Production of good compost depends on the temperature, humidity, turning, and moisture, so that efficient organic matter with numerous nutrient content could be obtained (Ahmed et al., 2019).



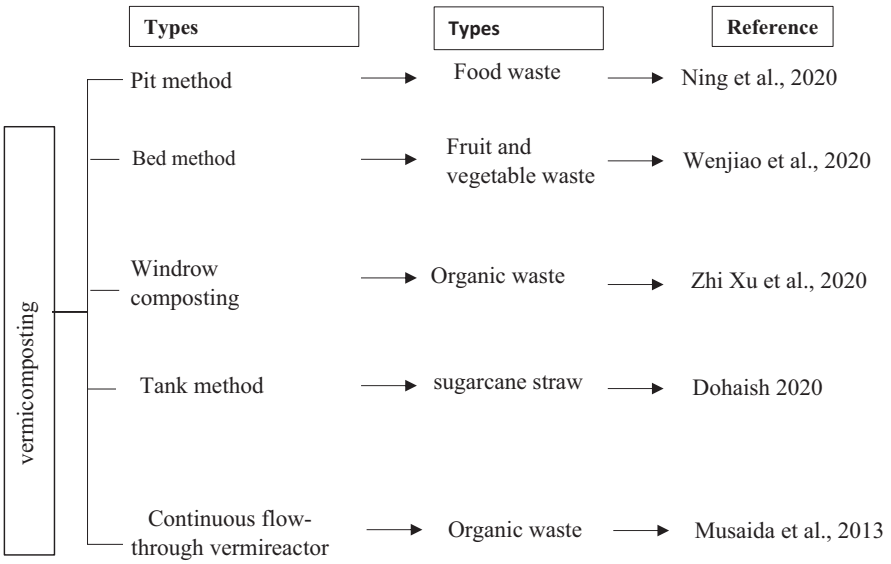
Nutrient Recovery from Composting

According to Paliza et al., compost rich in nutrient content such as phosphorus and nitrogen helps to recycle or maintain the nutrient content where there is loss in leachate and also helps to maximize potential social, economic, and environmental benefits. The compost contains carbon, nitrogen, phosphorus, potassium, magnesium, sodium, and organic matter and thereby improves the soil fertility. The nutrient content can be enhanced by the application of wood ash, lime water, phosphate-solubilizing culture, and broken animal bones. It enhances the physical, chemical, and biological properties of soil. It is an eco-friendly method offering several potential benefits to society. It reduces the utilization of pesticides, fungicides, and herbicides. It develops the entrepreneur in producing new organic products (Joseph et al., 2020) (http://agritech.tnau.ac.in/org_farm/orgfarm_composting.html).

Vermicomposting

Vermicomposting is the process of stabilizing organic waste into value-added product by utilizing microorganism and earthworm under mesophilic condition. It is more effective than composting because of utilization of earthworm. Many earthworm species such as *Eisenia fetida, Eisenia hortensis, Lumbricus rubellus,* and *Eudrillus eugenia* have been used to bring about nutrient-rich manure. It acts as a conditioner in improving the fertility of the soil. The digestive system of the earthworm has numerous of microorganisms which helps to grind and mix the waste

material uniformly to produce compost. It consists of water-soluble nutrients which play relatively easy way for the plants in absorption (Syed et al., 2019)



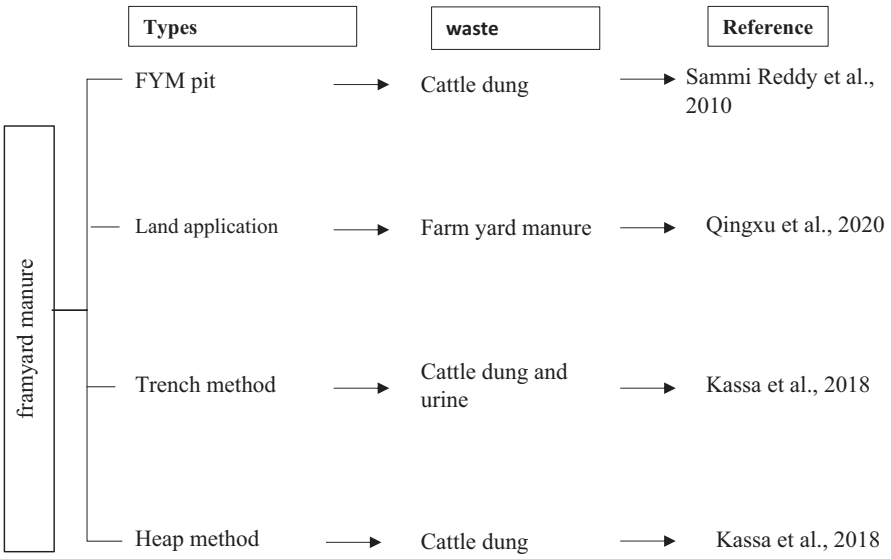
Nutrient Recovery from Vermicomposting

Vermicompost contains numerous nutrients such as pH, organic carbon, organic matter, c/n ratio, TKN, sodium, phosphorus, potassium, calcium obtained from different sources of organic waste such as kitchen waste, green waste, lignocellulosic waste, and municipal solid waste. The nutrient recovery from vermicompost can be enhanced by addition of microorganism along with earthworm, combining different kinds of waste, maintaining pH, and temperature. It acts as a better tool to recover nutrient from organic waste. The nutrient gained through vermicomposting will differ depending on the type of waste that has been degraded. For example, organic waste degradation will be able to gain more nutrient value while comparing the cellulosic waste. Hence by combining the types of waste, there would be better improvement results (Joseph et al., 2020).

Farmyard Manure

Farmyard manure is defined as a decomposed mixture of farm animals such as dung and urine along with leaf litter. It contains complex organic nutrients compared to normal fertilizer. Waste such as cattle waste, human waste, and slaughterhouse waste come under farmyard manure. In addition, the crop wastes, water hyacinth, weeds, and green waste also get mixed. Sheep and goat manure, oilcakes, blood

meal, and fish manure contain enormous nutrients which can be directly applied in the field in the form of organic nitrogen. This nitrogen is converted into ammoniacal nitrogen and nitrate by the soil microorganisms before it is consumed by the plants (Walid et al., 2016).



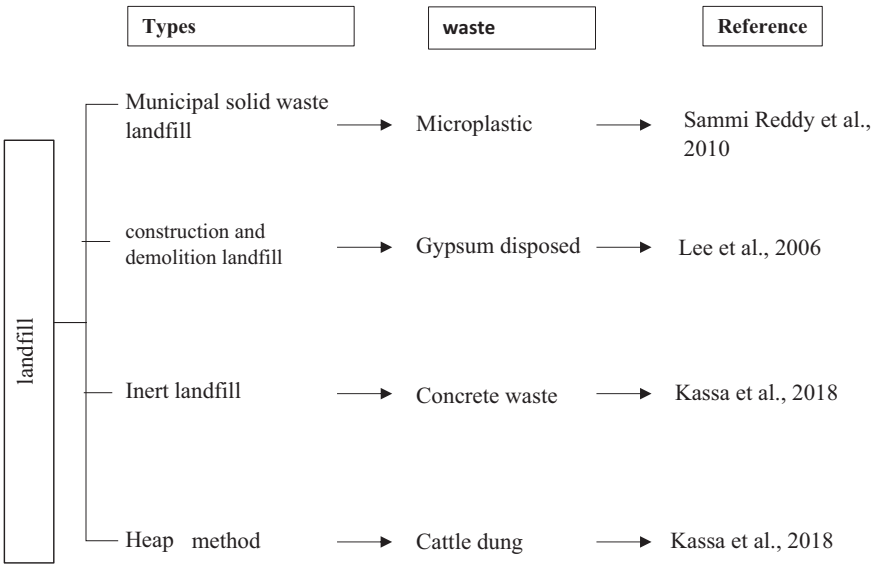
Nutrient Recovery from Farmyard Manure

Enormous nutrients are present in farmyard manure. About 30% nitrogen, 60–70% phosphorus, and 70% potassium were present initially in freshly prepared farmyard manure. Farmyard manure prepared by sheep and goat dung contain 3% nitrogen, 1% phosphorus pentaoxide, and 2% potassium dioxide. Poultry manure contains 3.03% N; 2.63% phosphorus pentaoxide, and 1.4% potassium dioxide. Plant crops such as potato, tomato, sweet-potato, carrot, radish, onion, sugarcane, rice, orange, banana, mango grow well in farmyard manure (Singhal et al., 2017).

Landfill

Landfill is termed as disposal of waste material that is buried in underground. It is one of the oldest methods of disposing the waste material. Landfill should be constructed by not affecting the groundwater. Municipal waste, industrial waste, and hazardous waste can be subjected to landfill. The components of landfill are bottom liner, cells (old and new), leachate collection system, storm water drainage, methane collection system, and ground water monitoring station. Though disposing

waste by means of landfill may cause environmental issues, proper protocols should be followed before constructing the landfill (Pinjing et al., 2019).

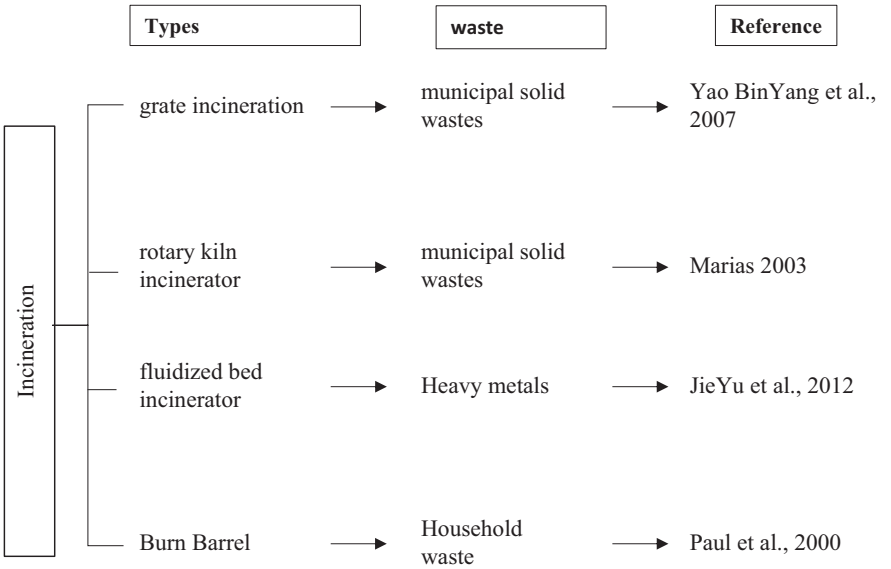


Nutrient Recovered from Landfill

According to the Environmental Protection Agency (EPA), the gas that is generated from landfill should be eco-friendly, which can be utilized as energy resource. Gas to energy facilities by landfill is as follows: (i) to generate electricity for small power plant; (ii) landfill gas in combination with fossil fuel, oil may used for heating purpose; and (iii) natural gas derived from landfill may processed though transmission pipeline for utilization (Naveen et al., 2017).

Incineration

Combustion of organic substance in waste material with the help of thermal treatment is termed as incineration. Through this process, the waste is converted into ash, flue, and gas. The heat generated by this process is used to generate electricity. During incineration, it converts the organic content to potential energy and remaining part is converted into ash. Particular type of waste such as clinical waste, hazardous waste, pathogenic waste, and toxic waste can be destroyed (Luke et al., 2018).

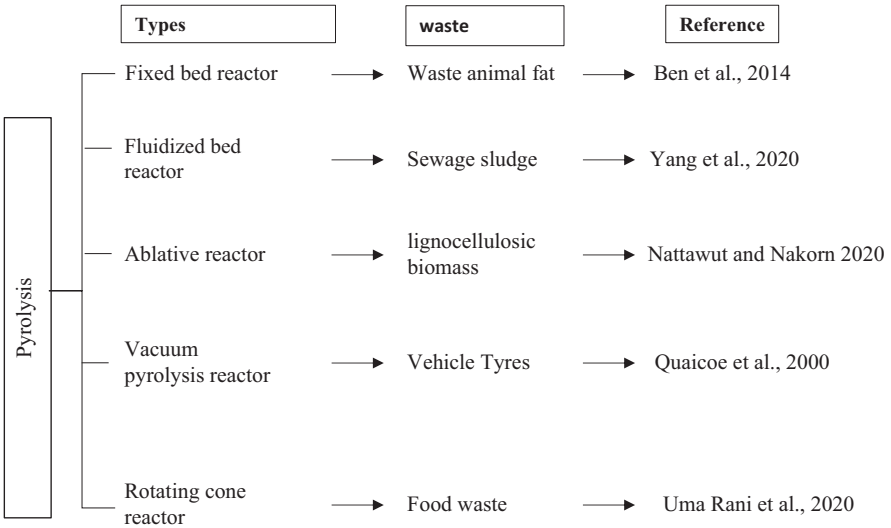


Nutrient Recovery from Incineration

Enormous amount of resources has been recovered from incineration such as silicate, aluminum, and iron oxide. By this process, phosphate recovery from ash is a very useful method. From the incinerated sludge, biofuels are leached from solid waste. After the completion of incineration process, the remaining ash material is either mixed with cement or concrete, and brick can be used as building material. The ash can also be melted and solidified as a ceramic material (Hongwei et al., 2019).

Pyrolysis

Pyrolysis is the process in which waste materials get decomposed at elevated temperature so that the volatile products are produced and leave carbon and char which can be used as soil-enriched material. This process is mainly used in chemical industries to produce ethylene, petroleum, coal, wood, etc. The main advantage of pyrolysis is to help convert the waste plastic to useable oil. Also, syngas and biochar are the by-products produced by the pyrolysis method (Muhammad et al., 2020).

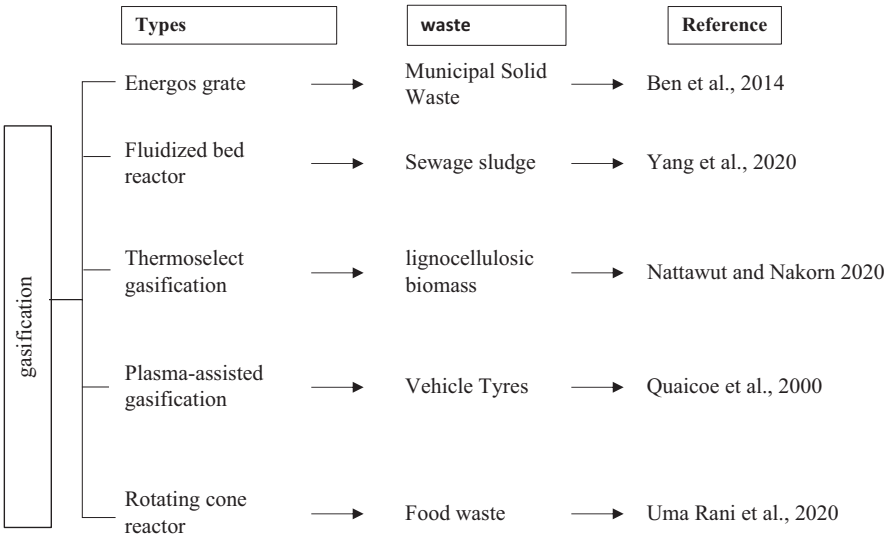


Nutrient Recovery from Pyrolysis

Nutrients recovered from pyrolysis are syngas, biochar, bio oil, etc. Other nutrients such as carbon, hydrogen, nitrogen, and sulphur were determined after combustion. Main elements such as Na, Mg, Al, P, K, Ca, ash, and trace elements (V, Cr, Mn, Co, Ni, Cu, As, Cd, Sn, Sb, Tl, P) are recovered from pyrolysis. The biochar obtained from pyrolysis, alkali-pyrophosphates and sylvine, which were soluble to a sufficient proportion in water and/or in neutral ammonium citrate also act as good organic fertilizer. Also, syngas obtained from pyrolysis have enormous applications from households to industries (Tamer et al., 2020)

Gasification

The process of conversation of organic waste into carbon monoxide, hydrogen, and carbon dioxide is termed as gasification. This technique is accomplished by heating the material at high temperature with controlled amount of oxygen or steam. It acts as a feedstock for chemical conversion of valuable commercial products such as transportation fuels, chemicals, fertilizers, and even substitute natural gas. Many materials like metals and glass can be removed from MSW before it is subjected to the gasifier. The plastic that is removed from the solid waste can be utilized as feedstock for gasification (Shahabuddin et al., 2020)

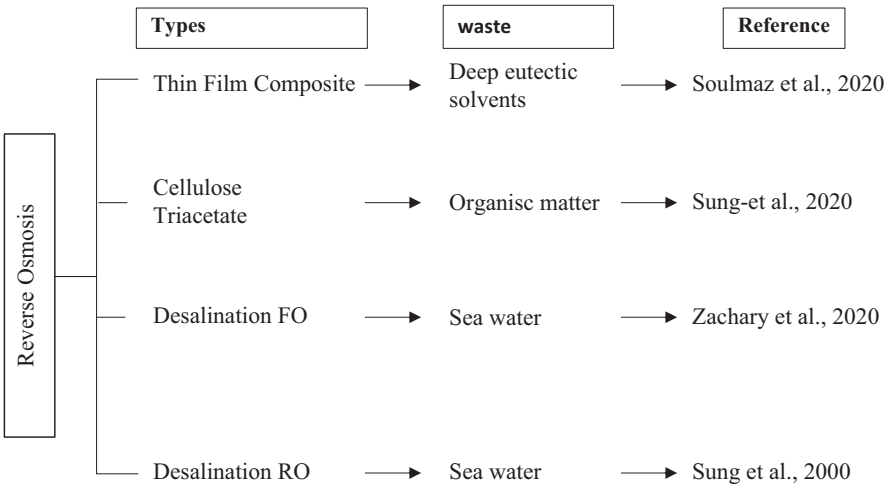


Nutrient Recovery from Gasification

During gasification processing, MSW utilize feedstock to produce syngas and recover energy from a steam circuit, seeking to recover more energy. Other products such as non-combustible material (ash) with carbon fused into glassy or vitreous residue. Volatile gases and steam are largely produced by gasification system. Steam cycle, engine, and gas turbine are generated by this system (Shayan et al., 2018)

Reverse Osmosis

It is the process of purification of drinking water by removing ions, large particles, and unwanted materials using permeable membrane. It works on the principle of thermodynamic parameter. Reverse osmosis is involved in the production of potable water by dissolving chemical and biological substances. The permeable membrane allows pure solvent across the membrane by retaining the ions and larger compounds (Gilles et al., 2018).



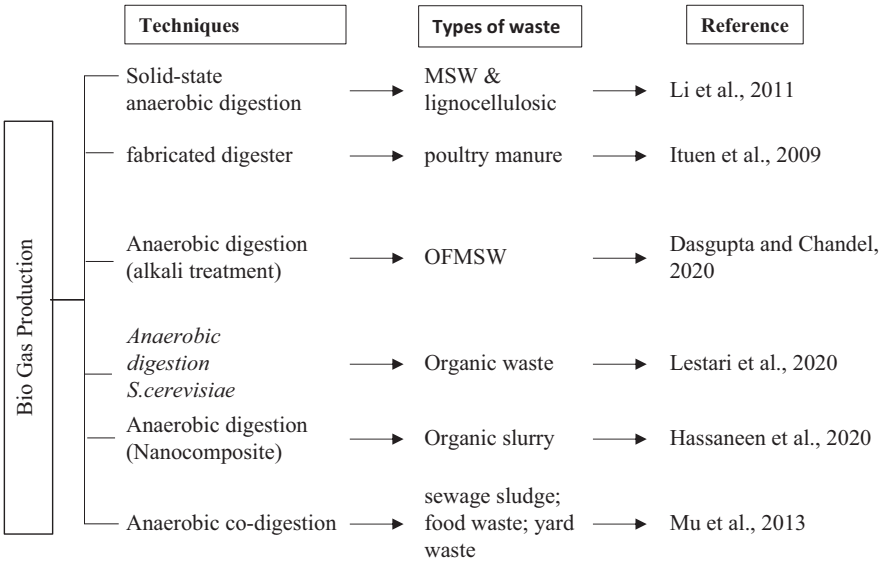
Nutrient Recovery from Reverse Osmosis

During this process, nutrients get recovered from the digested waste water due to the osmotic pressure gradient between the semipermeable membranes. By this way, various nutrients such as ammonium, phosphorus, sodium, magnesium, and sulphate can be obtained from the water digestate. It can be used to remove all the impurities present in wastewater and can be left as a safe disposal. It removes the contaminants present in water. This process used is in industries to clean water, or to convert brackish water, or to recover salts from water needed for industrial applications.

1.10 Nutrients Gain in Treating Solid Waste

Biogas Production

Organic waste such as agricultural waste, manure, municipal waste, plant material, sewage, green waste, or food waste get decomposed in the absence of oxygen and produce mixture of gases consisting of methane and carbon dioxide. Some examples are as follows.



Advantage of Biogas Plant

In a biogas plant, nutrient digestate is collected along with biogas. This digestate is rich in organic matter containing macro- and micro-nutrient, which act as a good plant fertilizer. The substrate, pH, and temperature greatly influence the nutrient recovery of digestate. The main substrates utilized in biogas plant are livestock manures and slurries, crop residues, and organic residues from agri-food processing industries (Peter, 2010).

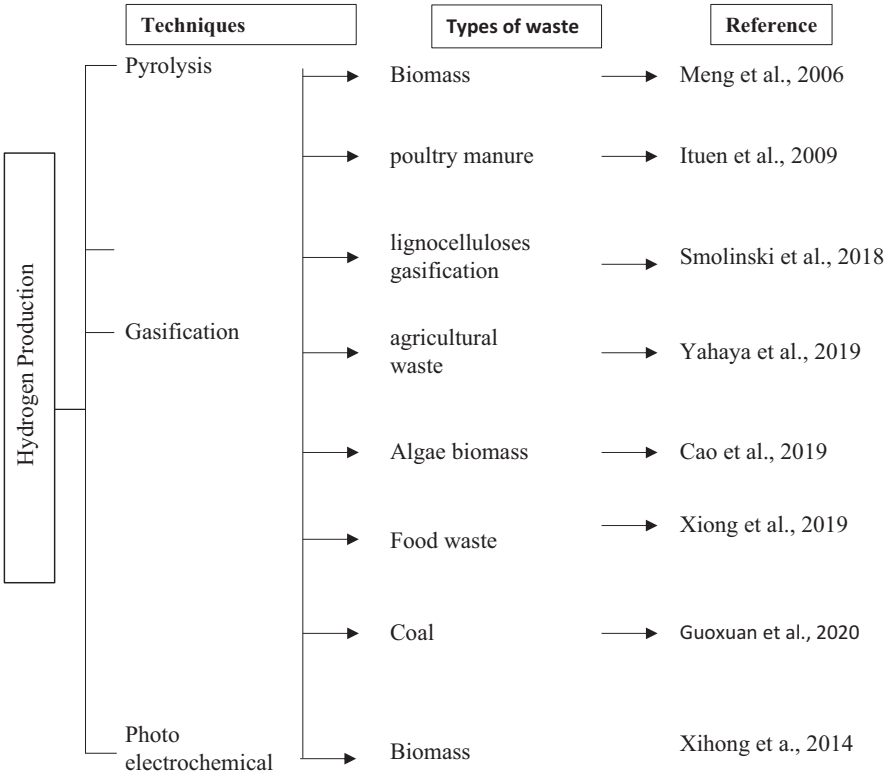
The digestate processing consists of three main steps: (i) Solid phase from the liquid phase, the obtained solid material can be composted, or it straight act as a biofertilizer. (ii) Liquid phase obtained from digestate can follow nanofiltration, ultrafiltration, and reverse osmosis. This membrane technology can be used to produce purified water. (iii) Ammonia stripping, ion exchange, or struvite precipitation techniques can be applied to obtain complete digestate which requires high investment cost due to consumption of chemical reagents. The nutrient-rich digestate can be directly used in the field of biogas processes; hence, the end product is complete biofertilizer and marketable (Pooja et al., 2020).

Hydrogen Production

Overall 95% of hydrogen production is obtained from fossil fuels, stream, natural gas, coal gasification, electrolysis of water, etc. Hydrogen is produced from renewable energy sources by two ways: (i) power to gas; (ii) landfill to gas. Hydrogen gas is utilized in the production of ammonia, hydrodesulphurization, aromatization

process, transport fuel, and compressed form is used in pipeline, cylinder, and trucks. The research undergone by the hydrogen production is as follows (Demei et al., 2020).

The first is blue hydrogen, which can be generated from natural gas with a carbon capturing unit; the second is green hydrogen, which can be produced from renewable sources; and the last one is gray hydrogen, which may be obtained from fossil fuels.

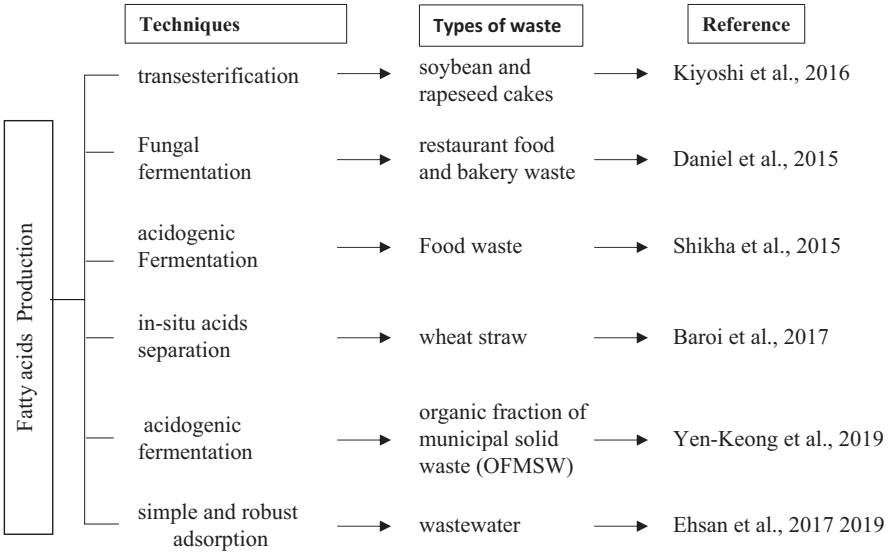


Advantage of Hydrogen Production

Hydrogen production could be obtained from different kinds of wastes such as cellulosic, starch, agriculture, food industry, olive mill, algal, and agricultural. Thus, preparing biohydrogen utilizing varieties of microorganisms helps to gain energy nutrient from the waste. Many kinds of technologies such as photolysis of water; dark fermentation, and photofermentation are involved in production of hydrogen. The nutrients present in all types of waste could be predominantly converted into energy (Yanan & Jianlong, 2016).

Fatty Acid Production

Fatty acids are high-caloric food stuff used for human consumption. It is primarily produced from raw materials such as plant seeds, soybean, rapeseed, and corn. During the manufacture of fatty acids, fats and oil, alkali foots, and spent clay were discharged at the end. It is further processed and utilized as synthetic resin paints, PVC plasticizers, textile oils, oils for rolling of iron and steel, printing inks, and food sugar esters. Fatty acids can also be prepared from baobab seeds, and aquatic algae act as feedstock for biodiesel production (Lijie et al., 2020).

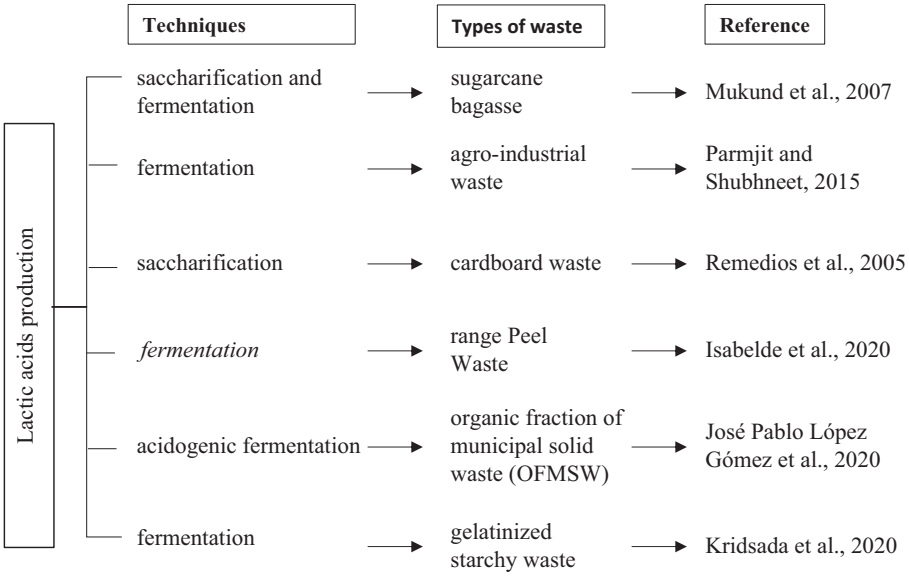


Advantage of Fatty Acid Production

Enormous amounts of nutrients were recovered from fatty acid, used vegetable oil, olive oil, and palm oil promisingly converted into biofuel (Dorado et al., 2002). Various techniques such as adsorption, solvent extraction, electrodialysis, reverse osmosis, nanofiltration, and membrane contractor were used to recover fatty acids. Wen-Yong Lou states that cooking oils containing 27.8 wt% high free fatty acids (FFAs) can be converted into biodiesel. Carbon and nitrogen source can also be generated from volatile fatty acids (Yan et al., 2018). The study by Bengtsson et al. (2017) reveals that a mixture of fermented VFA substrate having acetic, propionic, butyric, valeric, and caproic acids is utilized to produce PHA. Hence, many resourceful nutrient recovery has been gained from waste steam (Merve et al., 2018).

Lactic Acid Production

Lactic acid is produced from lactic acid bacteria by fermenting waste products such as molasses, fruit waste, and agro waste. It play an important role in dairy, baking technology, fish and meat processing industries, energy generation, agriculture, and bioremediation. About 1.3 billion of food get wasted from agriculture to human consumption. The food waste rich in carbohydrate acts as good source for lactic acid bacteria to grow (Sebastian et al., 2019).



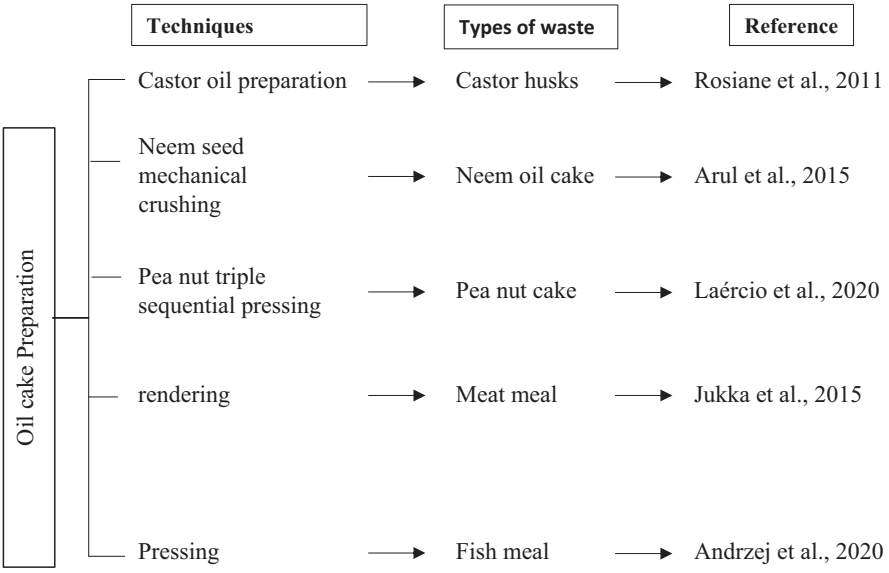
Advantage of Lactic Acid Production

It acts as a descaling agent and antimicrobial agent. It is used as acidulant for deliming, in tanning industries. It has very useful medical applications as electrolyte and surgical sutures. Lactic acid has a wide variety of applications in food industries such as bakery products, soft drinks, dairy products, jams, jellies, and egg processed foods (Joachim et al., 2018).

Oil Cake

Oil cake is produced by separating the remaining solid portion in extracting oil from oilseeds and used as manure. Oil cakes are of two types: edible oil produced from groundnut cake, coconut cake, cotton seed cake, linseed cake, niger cake, rape seed cake, safflower cake, and sesamum cake; non-edible oil produced from castor cake, neem cake, kanranj cake, and Mahua cake. Oil cake could be used as feed for cattle

or fertilizer for crops in horticulture. All the non-edible oil contains about 2–4% of nitrogen, 1% of phosphorus pentaoxide and potassium di oxide; edible oil contains 3–7% of nitrogen, 1–2% phosphorus pentaoxide and potassium di oxide (Rachana & Naik, 2018; Zineb et al., 2019)

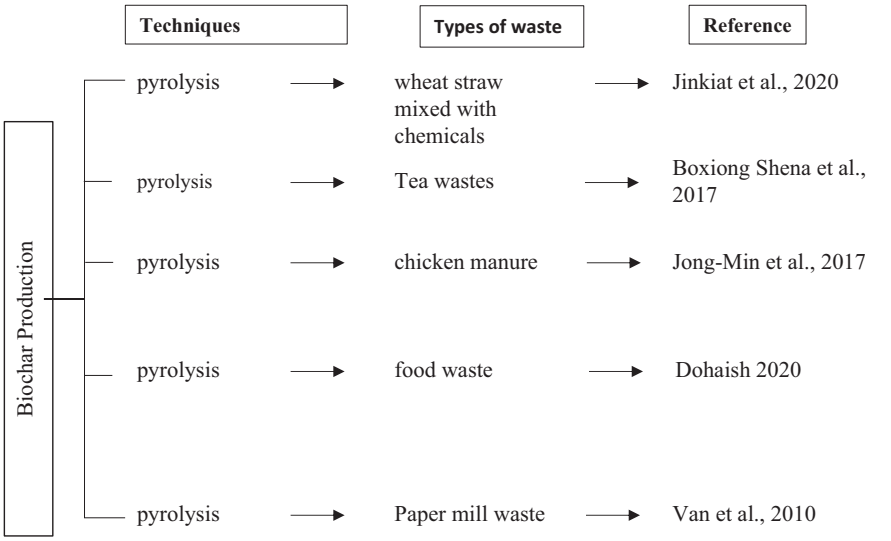


Advantage of Oil Cake

Oil cakes are rich in carbohydrates, fats, proteins, and minerals. It can be a valuable feed for poultry and other animals for proper functioning of metabolic processes. Therefore, the yield of milk, meat, and egg get increased. Feed oil cakes from certain seeds such as castor beans and tung nuts are toxic and are used as fertilizers. The husk that remains after the process of oil cake is enormously rich in fiber content. The fat in oil cakes is also usually a good source of linoleic acid, which is essential for animal metabolic processes (http://collections.infocollections.org/ukedu/en/d/Jnr18se/7.3.html).

Biochar

It is stable solid-rich carbon undergone in soil for more than thousands of years and obtained from thermochemical conversion of biomass with oxygen-limited environment. It is used as best amendments for soil to improve its fertility, agricultural productivity, and restrict the soil-borne diseases. It maintains the pH, nutrient, organic matter, and structure of the soil. It also enhances the growth of microorganism in the soil (Nai-Yun et al., 2020).

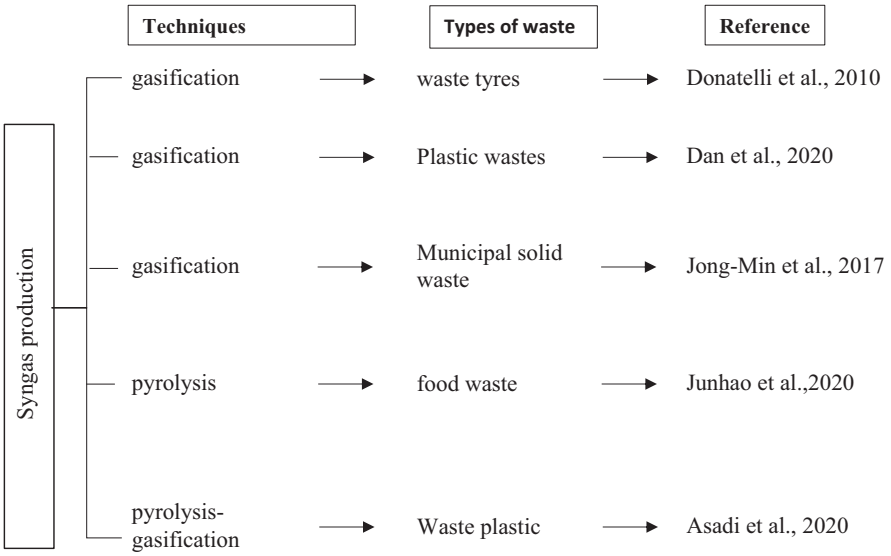


Advantage of Biochar

During pyrolysis the solid residue get reduced. It results in the production of potential fuel with high energetic value. Biochar produced through pyrolysis acts as good fertilizer. It minimizes the use of chemical fertilizer. It improves the soil fertility by enhancing the nutrient level and also reduces acidity of the soil. Many organic pollutants are being sequestered by using biochar. Soil improved using biochar will able to retain the soil nutrients such as magnesium, calcium, phosphorus, nitrogen, and carbon (Ahmed et al., 2019).

Syngas

Syngas is the mixture of hydrogen and carbon monoxide also with small quantity of hydrocarbon, carbon dioxide, and methane. It is produced by anaerobic digestion or biogasification by degrading organic substrate by bacteria. Among total generation of municipal solid waste, three-fourths of them went for landfill or incinerated. As these methods lead to many environmental problems, gasification process was chosen by many countries. Municipal solid waste can be converted into usable syngas through gasification process. Therefore, many commercial products such as transportation fuels, chemicals, and fertilizers can be produced. The ash generated through gasification process is used for making cement, roofing shingles, and as an asphalt filler. Non-degradable plastic waste can act as excellent feedstock for gasification (Gabriele & Siglinda, 2020).



Advantage of Syngas

Syngas is used for the production of ammonia and fertilizer. During this process, ethanol produced from syngas is a marketable and needed product. The generation of hydrogen during the process may be used as fuel for combustion engines. Potential biofuel produced during syngas production may be used for generating electricity and household usage. It is considered to be independent power supply. It is economically efficient by combining heat and electricity (Steven et al., 2018).

2 Conclusion

Even though various techniques are followed for managing solid waste generation, still we cannot reduce the problem. More attention has to be paid to initiate the nutrient recovery by means of different techniques. Apart from nutrient recovering technique 3Rs should be followed by the people to minimize the generation of waste. Not only single techniques were effectively involved in recovering nutrient numerous techniques such as landfill, pyrolysis, gasification, vermicomposting, and composting. By this nutrient, there is increase in soil amendment, fertility of soil, and plant growth promotion can be achieved. Considering the economic feasibility, the technique should be selected to recover maximum nutrient recovery with minimal input. As we are in a developing country, practicing eco-friendly techniques such as composting, anaerobic decomposition, and the usage of biodegradable materials is advisable for a sustainable future. This chapter presents the methods and technical approach of nutrient recovery form solid waste.

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