REVIEW OF BIOFUEL PRODUCTION FROM FOOD WASTE: A PROMISING APPROACH TO A SUSTAINABLE FUTURE

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ABSTRACT

As the global population increases, so does the need for fuels and chemicals, and so do the rate at which these supplies may be exhausted. Biofuel has the potential to ease the pressure on fossil fuel supplies. When compared to fossil fuels, biofuels may produce less carbon gas than fossil fuels. This is due to the fact that biofuels are carbon-neutral, which means that they balance the carbon dioxide they receive during growth with the carbon dioxide they generate when burnt. Global food waste is enormous and increasingly considered an environmental crisis. Wasted food is an unusable resource that provides no benefit. The bulk of food waste consists of starch, protein, oil, fat, amino acids, and other minerals. Bioethanol, biodiesel, and bio-oil may all be produced from food scraps since they have a high concentration of carbon-containing components. An alluring and realistic approach to the world's present energy crisis and to establishing a sustainable bio economy is to convert food waste into biofuels such as biodiesel, bioethanol, bio hydrogen, bio oil, bio char, and bio methane utilizing well enough and efficient extraction and processing technology. This method of food waste management not only addresses a critical environmental concern, but also reduces reliance on fossil fuels for power generation. In this article, we looked at the feasibility, difficulties, and regulations of making biofuels from waste food by pyrolysis, gasification, fermentation, transesterification and enzymatic process. The review says that reusing through combined pyrolysis-gasification methods can make a number of high-value goods (biofuel, bio char/ash, and water) with little or no effect on the environment. It has been suggested that making biofuels from organic garbage is a good way to improve energy security, cut pollution, and encourage healthy production.

Keywords: *Food waste, biofuel, pyrolysis, transesterification, fermentation*

1. INTRODUCTION

There is a great significance of food waste in the world. Food waste (FW) is the unrecyclable by-product of commercial and domestic food processing operations. There are several reasons for the widespread occurrence of food waste across the whole food supply chain. Food waste refers to all edible and non-edible items removed from the food system for the purposes of recycling or disposal. Over a third of the food produced worldwide for human use is lost or wasted every year, totalling about 1300 million tons, according to studies(Gustafsson et al., 2011). High-income nations are responsible for roughly as much annual food waste as all of Sub-Saharan Africa. Consumers in developed nations contribute significantly to FW by purchasing excessive quantities of food and then discarding the surplus. The main causes include inefficient marketing data collection, poor harvesting practices, and a lack of necessary infrastructure in poorer nations. Removing expired or spoiled human edible food from the supply chain due to ignorance, bad stock management, or commercial conduct, according to the United Nations (UN), is a good idea, considered a waste of food(Leung et al., 2010). It's worth noting that the United Nations is also involved. Food that is not consumed and instead used for human consumption, animal consumption, or bioenergy production is termed waste(Joardder & Masud, 2019).

When compared to producing electricity and animal feed, biomass for fuel generation usually generates more value(Lin et al., 2013). The demand for biofuels is substantially higher than the demand for chemicals(Marchetti et al., 2008). In addition, decreasing dependency on crude oil via turning FW to biofuel may assist to maintain stable food costs. This portion of the text focuses on FW valorisation for the production of biofuels including biodiesel, ethanol, hydrogen, and methane.

Even when considering the more conventional use of biomass, modern bioenergy stands out as a major contributor to global final energy consumption, accounting for five times as much as wind and solar PV combined. Growth in the use of bioenergy as a source of electricity and as a fuel for vehicles has been spurred by supportive legislation in recent years. However, the heating sector still accounts for the vast majority of bioenergy used today(Ananno et al., 2021).

Traditional biomass usage for heating and cooking in developing and emerging countries is not included in modern bioenergy because of the severe health and environmental impacts associated with its ineffective open flames or basic cook stoves(*Bioenergy - Fuels & Technologies - IEA*, n.d.). Hydrothermal liquefaction is similar to pressure cooking in that it involves heating food waste at high temperatures. The resultant oil has excellent fuel efficiency. Liquid food waste is then put via anaerobic digestion by industry experts. Microbes perform the breakdown of food waste into biogas in this procedure. In addition to carbon dioxide and methane, this biogas also includes other gases.

The transformed gas may be used to make power and heat by specialists. However, experts may also use various techniques to extract methane from garbage dumps. However, they choose a hybrid approach that combines anaerobic digestion and hydrothermal liquefaction since it yields better results. While hydrothermal liquefaction may be completed in a matter of minutes, anaerobic digestion might take many days.

Wasted food still contains valuable nutrition, energy, and worth. It can be beneficial through composting or generating renewable energy like biogas. However, incinerating food waste stops its useful potential and turns it into a source of carbon dioxide emissions. In fact, if food waste were a country, it would be the third-largest emitter of carbon dioxide globally, after the U.S. and China(Tonini et al., 2018).

Biodiesel is a sustainable, clean-burning liquid fuel produced from sources like vegetable oils, animal fats, and even recycled food waste. It can be used in diesel engines just like traditional diesel and comes in various blends, not limited to pure biodiesel (B100) and the common B20 blend. Ethanol, another sustainable fuel, can be made from various biomass sources and is often mixed with gasoline to improve performance and reduce emissions. E10 (10% ethanol) is widely used, but some vehicles can use E85. Most ethanol in the US currently comes from maize starch, although research is ongoing to use non-edible plant fibres for production. The main process for ethanol production is fermentation by microorganisms like bacteria and yeast(*Biofuel Basics | Department of Energy*, n.d.).

1.1 FOOD WASTE CHARACTERISTICS:

Home kitchens, industrial kitchens, cafeterias, hotels, as well as other food processing technologies all contribute to the organic waste stream known as "food waste"(Uçkun Kiran et al., 2014). As Food losses, according to the Food and Agriculture Organization (FAO), are defined as: “Food that is intended for human consumption yet is not consumed by humans. "Food is thrown out or squandered in many ways all across the world. The entire food supply chain, from the point of origin to the point of consumption the final users (Figure 1). The massive amount of food waste created. Its manufacturing, handling, and storage all have the potential to cause harm. Processing, dispersion, or use are all terms used to describe how something is processed, dispersed. Further, before being disposed of, a large portion of food waste can be categorized as avoidable food waste (consumable) or unavoidable food waste (no consumable).

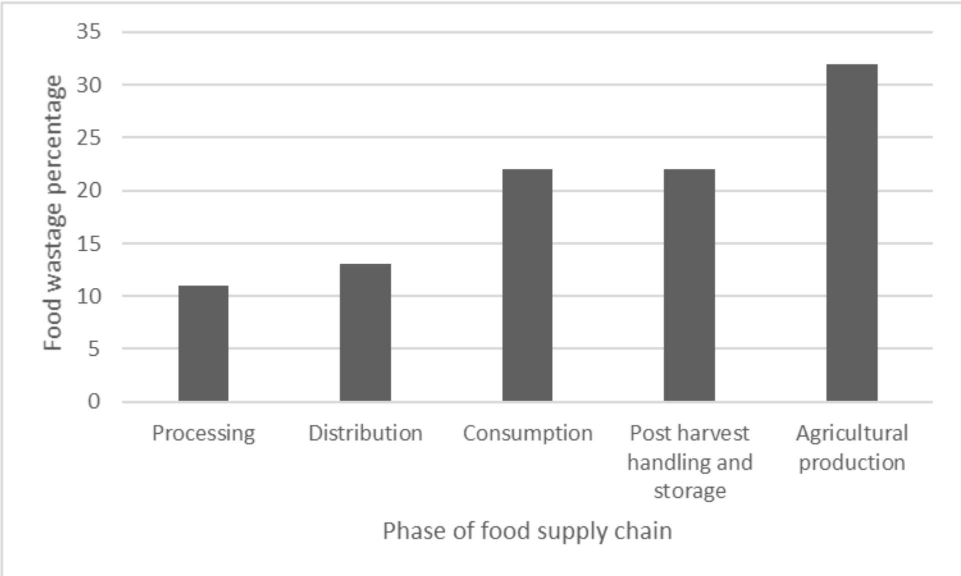


Figure 1: Worldwide food waste over the whole food production(Martin-Rios et al., 2020)

1.2 FOOD WASTE MANAGEMENT:

The worldwide food value chain, beginning with agricultural production and ending with ultimate consumption, is not immune to food loss and waste. There is a correlation between the production of food and the destruction of habitats, the release of greenhouse gases, the usage of water and pesticides, and the generation of waste heat and pollution. Toss outs occur at every level of post-harvest operation, from transportation to storage to processing to distribution. Finally, as much as 40 percent of all food is wasted during final consumption (this includes both commercial and residential usage. There is conclusive evidence that the final consumer stage of the food supply chain accounts for the vast majority of food waste in affluent nations.

Consequently, FW management, which encompasses all efforts made to prevent, minimize, or repurpose waste at every stage in the production and consumption process, has risen to the top of the list of priorities. This leads one to wonder whether there isn't room for improvement in food supply networks to lessen food waste(Martin-Rios et al., 2020)

2. PRODUCTION OF BIOFUEL:

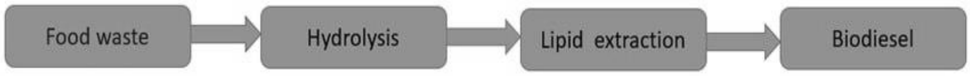
Nations are focusing on sustainability to reduce food waste. Disposing food scraps in landfills is harmful. Greater efficiency in food service and manufacturing is crucial. Food waste can be repurposed through advanced valorisation processes, including environmentally friendly catalytic methods.

These processes offer the potential to create liquid biofuels from various food waste sources. Bi-enzymatic systems are being explored to convert bakery and mixed food waste into valuable compounds, and chemo- and bio-catalytic methods are used to produce bioethanol and biodiesel. Additionally, bio-oil can be derived directly from food waste.

2.1 Production of biodiesel:

Biodiesel, also known as fatty acid methyl ester or mono alkyl ester of fatty acids, is a renewable and clean-burning diesel alternative to petroleum that is booming in popularity. Biodiesel is a fuel that is widely used throughout the world, including Europe and the United States. The chemical building blocks (FAME) of biodiesel are methyl esters of fatty acids. Biodiesel may be constituted of saturated or unsaturated fatty acid methyl esters depending on the feedstock used, such as vegetable oils, animal fats, or recycled cooking oils. Sunflower, palm, soybean, rapeseed, and other edible plant oils are frequently utilized in the production of biodiesel. Since biodiesel is made from more expensive food oils, its current price is higher than that of petroleum fuels. The debate over whether or not to use food as fuel has begun. As a result, low-cost non-edible oils are necessary for biodiesel production. In this vein, research on biodiesel production from non-edible plant oils such as Jatropha, Pongamia, Mohua, and others has already begun(Karmee et al., 2006; Karmee & Chadha, 2005; Khan et al., 2014). Edible oils are a renewable resource with the same energy content as a gallon of biodiesel. However, because these vegetable oils are so much more expensive than fossil fuels, they are impractical to employ.

There are several kinds of environmental and social difficulties linked with the use of edible oils, including the possibility of a food vs fuel conundrum, the deterioration of vital soil resources, deforestation, and the exploitation of the majority of the world's arable land. Furthermore, since the mid-2000s, the cost of vegetable oil plants has increased significantly, threatening biodiesel's long-term viability as a viable fuel alternative. Furthermore, the growing discrepancy between the production and use of these oils makes their long-term use in many countries impractical (Atabani & César, 2014). As a result, the existing supply of these feedstocks limits the biodiesel industry's potential for expansion(Dahiya et al., 2015). The use of edible oils in biodiesel production is challenging, but there are alternatives, and one of the most promising is the use of non-edible oils(Mofijur et al., 2013). In addition to cutting the price of biodiesel raw materials and shielding the sector from food-market competition, employing waste oils and other non-edible resources has a number of other advantages(Aransiola et al., 2014). As a result, nonedible feedstock has been determined to be the most reliable and cost-effective resource for manufacturing biodiesel(Demirbas & Demirbas, 2007). Growing the non-edible oils necessary to manufacture biodiesel necessitates a significant amount of labour as well as a significant number of resources such as land, water, compost, and energy. As a result, food waste, kitchen by-products, municipal hard waste, and garbage cooking oil can all be used as alternative raw materials for biodiesel production. Food waste has no monetary value and has the potential to end the "food vs. fuel" debate because it requires no agricultural land and does not compete with food production(Uçkun Kiran & Liu, 2015). Biodiesel made from such low-value resources has many advantages, including being carbon neutral, nontoxic, biodegradable, and sustainable. Biodiesel is a renewable fuel generated from food waste and leftover cooking oil that has several advantages over standard diesel fuel. Several strategies for producing biodiesel from food scraps have been detailed in published works. The two most common approaches to producing biodiesel are transesterification with acid/base catalytic or even enzymes and microalgal fermentation(S. Li & Yang, 2016). The removal of lipids from food scraps is a crucial step in the process of making biodiesel. Before adding non-polar chemical solvents like n-hexane or diethyl ether, food waste is first combined with water to form slurry. In other words, this is optional but not impossible. Once a combination has been produced, it is placed in a separating funnel. An organic solvent-free lipid is obtained by separating the organic layer and evaporating it at a low pressure. Using noodle scraps, many scientists were able to refine an oil. The leftover instant noodle weight was typically cooked with one litre of water, or 100 grams. After that, 500 ml of n-hexane was used to extract the oil. Five millilitres of oil were extracted from one hundred grams of noodle scraps using this approach(Yang, Lee, Yoo, Choi, et al., 2014; Yang, Lee, Yoo, Shin, et al., 2014). Microbial hydrolysis of food waste using a bienzymatic catalytic system consisting of Saccharomyces awamori and Aspergillus oryzae may separate fat and food hydrolysate rich in glucose, amino acids, and phosphate(Pleissner et al., 2014). The crude lipid is separated from the food hydrolysate by centrifugation once hydrolysis is completed. Water is removed from the crude lipid by heating it to 100 °C(Karmee & Lin, 2014). Soxhlet extraction, in addition to being a more effective alternative to the standard extraction procedures, may be used to extract lipids. In this vein, supercritical fluids are widely used as solvents for lipid extraction from natural herbs and as reaction media for the execution of chemical and enzymatic processes(Karmee et al., 2009, 2010). In particular, scCO2 is employed for the oil extraction process. When it comes to removing fat from food scraps, this technique is worth a go. Unlike traditional extraction methods, scCO2 does not introduce organic solvent contamination into the lipids it extracts. Furthermore, the pressure and temperature of the scCO2 extraction process may be fine-tuned for maximum efficiency(Karmee et al., 2014).



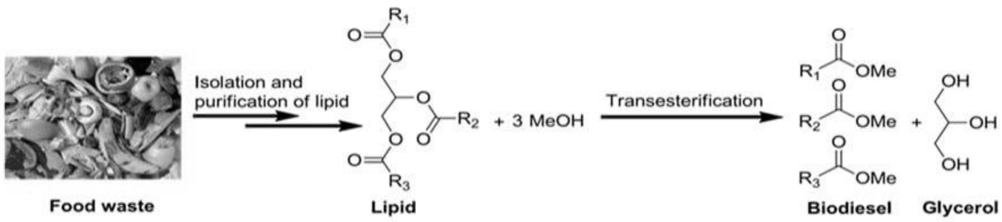


Figure 2: Transesterification of isolated and purified lipids yields biodiesel(Karmee, 2016)

Because of this, the lipid that is extracted is pure and suitable for use in biodiesel manufacturing without any further processing. Several methods for removing lipids from a substance are shown in Fig. 3. An acid value and moisture content test are performed on the lipid recovered from the food scraps. According to the literature, KOH and NaOH may be used as catalysts in a base esterification reaction to produce biodiesel from feedstocks with low quantities of free fatty acids (FFA). Acid catalysed transesterification may also be used to produce biodiesel. A two-stage reaction is utilized to process feedstock with a high concentration of FFA. The acid value of lipid feedstocks must be lowered first, and this may be done by acid catalyst esterification or, in certain cases, base catalyzed pre-treatment(Yang, Lee, Yoo, Choi, et al., 2014). Following this procedure, a high yield of biodiesel may be produced by transesterification with a base catalyst. Relative humidity has a function in both acid- and base catalysed reactions.

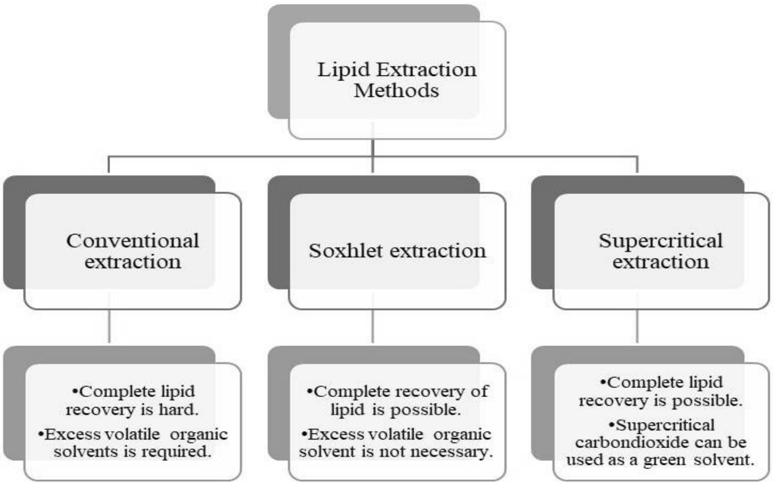


Figure 3: Lipid may be recovered from food scraps by a variety of processes(Karmee, 2016).

Saponification, rather than transesterification, occurs when a base catalysis a process in the presence of water. In addition, the presence of water triggers hydrolysis through acid catalysed transesterification. High reaction temperatures are needed for acid-catalysed and base-catalysed reactions alike. It is well knowledge that both acids and bases may cause damage to and be harmful for ecosystems. All enzymes are proteins. When making biodiesel, enzymes may be employed instead of chemical catalysts. Lipid hydrolysis, esterification, and transesterification are all catalysed by lipases(Karmee, 2008). Since lipase catalysed biodiesel manufacturing may be done under moderate circumstances with minimal by-products, it has received a great deal of attention. In addition, lipases may function in wet environments. Biodiesel may be prepared using either free or immobilized lipases. After transesterification, immobilized lipases are recovered and may be employed again. In order to create biodiesel from food scraps, researchers have reported using acid, base, and enzyme catalysed processes figure 4. Biodiesel synthesis from oil produced from discarded instant noodle was investigated by (Yang, Lee, Yoo, Shin, et al., 2014)

In order to convert the fats and oils into biodiesel, both potassium hydroxide and hydrogen sulfuric acid were utilized as catalysts. Potassium hydroxide (2% w/v) with a 1:8 CH_3OH to oil molar ratio, together with 60 C and 2 hours yields 98.5% biodiesel under optimal reaction conditions. Whereas, 1: 6 methanol to oil molar ratio at 80 °C and 5% v/v H_2SO_4 catalysed process yielded 97.8% biodiesel in 3 hours(Parawira, 2009; Ranganathan et al., 2008; Robles-Medina et al., 2009; Yang, Lee, Yoo, Choi, et al., 2014). Noodle waste oil was trans esterified using Novozyme-435, according to Yang et al. There were four variables that were tweaked for maximum effect. Biodiesel production factors include (i) the ratio of oil to alcohol (ii) the time required for the reaction (iii) the amount of lipase (iv) the amount of water, and (v) the influence of various alcohols. The biodiesel output was 95.4% under ideal reaction conditions(Yang, Lee, Yoo, Shin, et al., 2014).

2.2 Production of Bioethanol:

Ethanol may replace gasoline as a transportation fuel, be used as a feedstock in the chemical industry, and be burned to produce electricity, utilized in fuel cells to produce electricity via thermochemical reaction, or used in cogeneration systems. Ethanol's widespread industrial uses have contributed to a recent uptick in demand throughout the world. Starch-rich crops including maize, potatoes, rice, and sugar cane have long been used in the production of bioethanol. Corn and sugarcane, the two main feedstocks used to make ethanol in the United States and Brazil respectively, are also utilized as food. Increases in the production of gasoline ethanol have contributed to a rise in the price of maize over the last 626 Handbook of Biofuels Production decade. To that end, there has been a rise in the popularity of bioethanol made from inexpensive feedstocks. Each 100 tons of processed potatoes produces 2-3 tons of starch, with an estimated resale value of $180. The report also recommends using FW as a feedstock for biofuels. Unfortunately, only 31 million tons of bioethanol can be produced globally from FW, meaning that 61.3 million tons of starch found in FW will be consumed. Mixed food waste, wheat-rye bread mashes, kitchen wastes, banana peel, and potato peel are among the food scraps that have lately been used in the manufacture of bioethanol(Arapoglou et al., 2010; Cekmecelioglu & Uncu, 2013; J. H. Kim et al., 2011; J. K. Kim et al., 2008; Koike et al., 2009; Kumar et al., 1998; H. Li et al., 2011; S. Li & Yang, 2016; Lin et al., 2013). Enzymatic hydrolysis cannot begin unless food waste has been properly pre-treated (Fig. 4). In order to kill any bacteria that could be lurking in food scraps, an autoclave is often necessary. Degradation of food wastes occurred during thermal pre-treatment; thus, it is prevented. Pre-treatment is followed by hydrolysis (or scarification) of the food waste (Fig. 4)(Pham et al., 2015; Uçkun Kiran & Liu, 2015). Starch hydrolysis to tiny sugar units is often accomplished by a combination of alpha-amylase, beta-amylase, and glucoamylase. Fermentation is next performed on the obtained food hydrolysate (Fig. 5). In order to get pure ethanol, distillation is the last step. The Saccharomyces cerevisiae H058 strain was used to convert the hydrolysate from food scraps into ethanol(Yan et al., 2011).

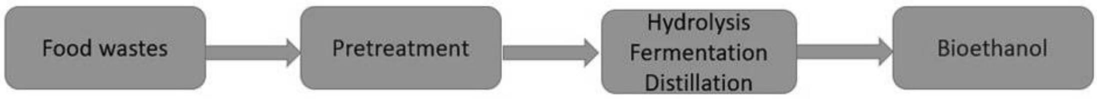


Figure 4: Production procedure of bioethanol

S. cerevisiae K35 was used in a scarification and fermentation process to turn the starch residue from discarded instant noodle packaging into bioethanol. The fermentation process was optimized to the point that 96.8 percent ethanol conversion could be achieved in 36 hours.Similarly, potato peels are an abundant source of carbohydrates and should not be thrown away. Enzymes and acid were used to hydrolyze potato peel. A total of 7.6 g L1 of ethanol was produced by fermentation of the obtained sugar by S. cerevisiae var. bayanus. Carbohydrase and Saccharomyces cerevisiae were used for the enzymatic hydrolysis and fermentation processes. When hydrolysis and fermenting were performed separately, 0.44 g ethanol per gram total solids were produced, but when they were performed simultaneously, only 0.31 ethanol per gram total solids were produced. The pulp of bananas might be used to produce alcohol. Pervaporation using a hollow membrane was investigated for its ability to separate ethanol from banana waste(Bello et al., 2014; Yang, Lee, Yoo, Choi, et al., 2014; Yang, Lee, Yoo, Shin, et al., 2014). Enzymatic saccharification and ethanol fermentation from food were optimized using response surface approach. While the model predicted a maximum concentration of 117.0 g reducing sugar/L and a maximum concentration of 57.6 g ethanol/L, testing findings indicated that 120.1 g reducing sugar/L and 57.5 g ethanol/L are attainable. Producing ethanol from kitchen scraps was done.

2.3 Production of Bio Hydrogen

Rapid urbanization, industrialization, and adaptations in lifestyle have all increased the need for energy, necessitating its constant production and reliable supply. Hydrogen gas is an attractive energy carrier of the future since it is a clean energy source with high energy output and zero emissions of greenhouse gases when burned. In addition, hydrogen's energy production (122 kJ/g) is about 2.75 times that of fossil fuels(Dahiya et al., 2015; Kahyaoğlu et al., 2012). Sustainable green fuel biohydrogen (H_2) has piqued the interest of the scientific community all around the globe. The generation of biohydrogen from waste products has gained widespread attention across the globe. Photochemical activities, bacterial electrolysis, acidogenic fermentation, dark fermentation, photo digestion, and the combination of these and other processes are all viable options for producing hydrogen (H_2). Dark fermentation is seen as a promising technology because of its increased hydrogen production potential and its ability to decompose organic pollutants with no need for light(Han et al., 2016).

Due to its consistent high proportion of biodegradable organic components, FW is a promising feedstock. Benefits include cost-effectiveness, operational robustness, and the ability to produce biohydrogen in nonsterile environments when using blended consortia as the biocatalyst. Additional advantages of producing hydrogen from FW feedstock using heterogeneous consortia of biocatalytic include the production of different products with variable biochemical capabilities, the exploitation of carbon-rich substrates, straightforward process management, and the potential for process scaling. Recent years have seen significant technological advancements in the manufacture of biohydrogen from a wide range of biogenic waste, notably food waste, which might be an encouraging first step toward the building of industrial applications and the use of H_2 as a major transport fuel(Pasupuleti & Venkata Mohan, 2015).

2.4 Production of Biooil

Dark brown in hue, bio-oil is a liquid fuel. Bio oil might eventually replace petroleum-based fuels. There are a number of labs working on methods to mass-produce bio-oils right now. Biomass, such as braided grass, agricultural leftovers, municipal bio wastes, and forestry wastes, may be processed into bio-oils. Bio oil is made using a process called pyrolysis. The process of flash pyrolysis for the production of bio-oil is being studied for potential use on a commercial basis. Bio oils have many drawbacks, including (i) low thermal stability, (ii) weak fuel characteristics, and (iii) a corrosive tendency. So yet, bio-oils are not sold commercially at gas stations like biodiesel and bioethanol. Producing bio-oils from food scraps has received little attention so far. Some researchers, have documented pyrolysis and gasification of food waste. Enzymatic hydrolysis of food waste was reported by Balasubramanian et al. before it was subjected to hydrothermal treatment to create hydro chars and biooil. Carbohydrase, protease, and lipase were used in the pre-treatment of food scraps(Ahmed & Gupta, 2010; Kaushik et al., 2014). The production of hydro chars and bio-oil was enhanced by the enzymatic pre-treatment. Maximum bio-oil production occurred at 350 °C. The findings indicate that food scraps have promise as a raw material for making biooil. Belgium is a market leader in the field of waste-to-biooil conversion using the rapid pyrolysis process.

2.5 Production of Biochar

Biochar production is a promising technology for reducing greenhouse gas emissions, improving soil fertility, and producing renewable energy. Biochar is a carbon-rich material produced by heating biomass in an oxygen-limited environment. This process is called pyrolysis. Pyrolysis can be done at a variety of scales, from small batch systems to large industrial plants.

The basic biochar production processes are Biomass preparation, Pyrolysis, Quenching and conditioning. In biomass preparation the biomass is first prepared by drying and grinding it to a consistent size. This helps to ensure a uniform pyrolysis process and produces higher-quality biochar.

In pyrolysis the biomass is then heated in a closed chamber with limited oxygen. This drives off the volatile compounds, such as water, methane, and carbon monoxide, leaving behind a solid carbon residue. In quenching and conditioning the biochar is then cooled and conditioned to improve its stability and handling properties. This may involve quenching the biochar with water or other liquids and then drying and storing it in a sealed container.

The specific conditions of the pyrolysis process, such as temperature, heating rate, and residence time, will affect the properties of the biochar produced. For example, higher temperatures and longer residence times will produce a more stable biochar with a higher carbon content.

Biochar can be produced from a wide variety of biomass materials, including agricultural waste, wood waste, and municipal solid waste. However, some biomass materials are better suited for biochar production than others. For example, biomass materials with a high carbon content and low ash content produce higher-quality biochar.

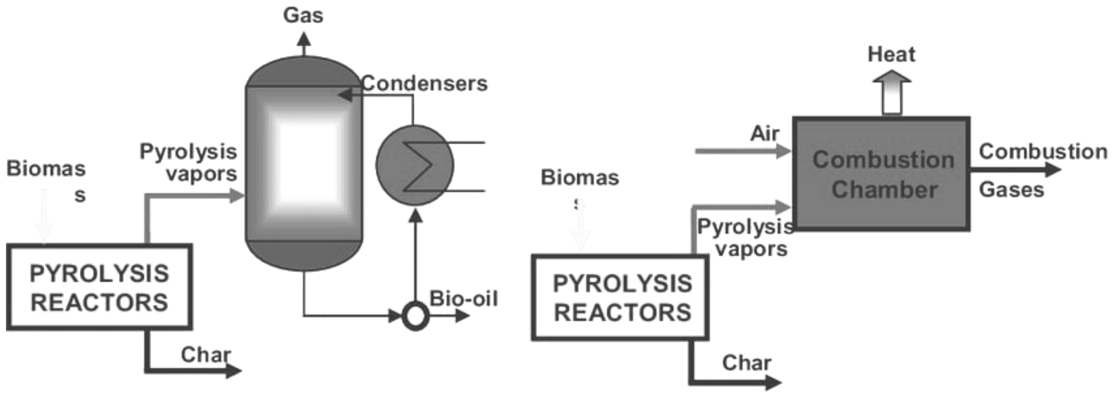


Figure 5: BioChar and Bio-oil production (Zaman et al., 2017)

2.6 Production of Biomethane

Humans have historically relied on biogas, particularly methane (CH4), as a sustainable energy source. Methane is widely recognized as one of the most significant greenhouse gas emissions from landfilled food waste. Greenhouse gas releases from food waste may be reduced with controlled biomass conversion to methane, which also recovers energy that was lost in the production. Digestate, which is rich in nutrients, may also be used as a fertilizer or soil conditioner, and the two-step process of producing methane and hydrogen can be combined. Food scraps, yard clippings, uneaten food, industrial effluents, sewage, and animal manure are just a few examples of the organic wastes that may be handled using anaerobic digestion (AD). Perishable FW include methanogens, making methane generation from FW a more realistic prospect. Similar to the hydrogen generation process, the major parameters impacting AD performance are feedstock compositions, inoculum, and process design(Molino et al., 2013).

3. CONCLUSIONS

Food waste are a resource that can't be used since they're not appetizing. Therefore, it may be utilized to create efficient methods of producing biofuels at low cost. To turn food scraps into biofuels and other useful goods, scientists in both the academic and business sectors are working on new food extraction and purification technologies. Biofuel is a renewable energy source that may be used in place of fossil fuel. Research in the future should investigate whether or not it is possible to convert vast quantities of wasted food into biofuels using efficient chemical and biological processes. Loss of habitat, water, energy, ecology, and greenhouse gas emissions are all associated with food waste. These days, food waste is the root of many social, economic, and ecological issues. However, food waste occurs naturally throughout the whole food production and distribution process. Most of the greenhouse gas emissions and groundwater pollution from current food waste management practices, particularly those involving food waste disposed of in landfills, should be avoided. The biofuel industry allows massive participation from the root level. Utilization of food waste into biofuels, on the other hand, may combine food waste control with energy recovery.

4. FUTURE RECOMMENDATIONS

It is not worthy that enriching the carbon habitats of the land area for production of harvesting food. The emission of greenhouse gas is to be controlled by using biofuel. The main goal is to be produce non valuable asset to valuable asset.

i. To limit spread and guarantee removal at the origin, every community should set up a central garbage dump.
ii. Gathering and transporting food waste to bio-refineries should have their own team and trucks.
iii. Connecting large and small plants to restaurants and food parks reduces transportation costs.

iv. Valorisation discarded food into biofuels requires well-organised, cost-effective methods.
v. Groups, NGOs, and volunteers must raise food waste awareness.

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