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Biofuels as a clever elucidation to conserve non-renewable resources

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Abstract
Biofuels can be derived directly from plants or indirectly from agricultural, commercial, domestic and industrial wastes. The use of waste biomass to generate energy can decrease waste management problems, pollution, greenhouse gases emission and the use of fossil fuels. There is a huge potential for bioenergy obtained from waste to decrease the speed of global warming. Brief summaries of various types of biofuels, generations of biofuels and the basic concepts involved in the thermochemical and biological conversions of biomass fuels are presented in this paper. Various processes such as combustion, pyrolysis, gasification, liquefaction, anaerobic digestion, aerobic composting and fermentation have been discussed.

Keywords: Biofuels, biomass, thermo chemical, biological

Introduction
Biofuel, also called as agro fuel and is derived from biomass and may be in solid, liquid or gaseous form. Biofuels have changed, meeting new demands, conforming to public opinions, overcoming challenging issues and striving for a truly sustainable method for energy production. The re-emergence of first generation biofuel technology was hailed as a salvation from the twin evils of high oil prices and climate changes [1]. However, it was soon discovered that this method of biofuel production increased global food prices. Second generation biofuel technology was design to produce energy from materials that would not impact the food chain such as wood and crop waste.
Biofuels are a type of renewable energy that are produced from organic matter, such as plants or agricultural waste. They are considered an alternative to fossil fuels, as they can be used to power vehicles and other machinery, but are less harmful to the environment.
There are several types of biofuels, including:

- **Ethanol:** a type of alcohol that is produced by fermenting crops such as corn, sugarcane, and switchgrass. Ethanol is commonly blended with gasoline to produce a biofuel blend that can be used in vehicles.
- **Biodiesel**: a type of fuel made from vegetable oils or animal fats. Biodiesel can be used in place of traditional diesel fuel, either on its own or blended with petroleum-based diesel.
- **Biogas:** a mixture of gases produced by the breakdown of organic matter, such as manure, food waste, and sewage. Biogas can be used to generate electricity or heat, or processed into compressed natural gas for use as a transportation fuel.

Biofuels are seen as a way to reduce greenhouse gas emissions and dependence on fossil fuels, but their production and use can have both positive and negative environmental impacts. The sustainability of biofuels depends on factors such as the type of feedstock used, the production methods, and the impact on land use and food production.
Biofuels can be produced from virtually any organic biomass but some materials produce higher efficiencies than others. The biofuel can be burned directly or they can be mixed with conventional fuel. Due to diversity of biomass a wide range of technologies must be used to ensure that the energy is derived in the most efficient manner. The most common biofuel is bioethanol, a bio alcohol produced from sugar or corn for example. Biodiesel is another first generation biofuel produced by extracting oil from crops such as rapeseed, sunflower and palm oil [2]. Biogas [3, 4] and bio hydrogen [4, 5] can be produced using a number of processes such as pyrolysis, gasification or biological fermentation.

The waste buried in landfill site undergoes anaerobic digestion and generates gases. The gases so produced are called landfill gases (LFG). These gases can be burned and looked up as a source of renewable energy. The LFG comprises of almost 50% methane, which is the same gas as found in natural gas. The LFG can be used to generate electricity for public consumption or can be burned for heat.

Biofuels are often considered as a clever solution to conserve non-renewable resources, as they can be used as a substitute for fossil fuels in transportation and other applications. Biofuels are renewable, unlike fossil fuels, which are finite and will eventually run out. By using biofuels, we can reduce our dependence on non-renewable resources and minimize the negative environmental impacts associated with their extraction and use. For example, the production and use of biofuels can lead to lower greenhouse gas emissions compared to fossil fuels, which can help mitigate climate change.

However, it is important to note that biofuels are not a silver bullet solution to all environmental problems. The production of biofuels can also have negative impacts on the environment, such as land use change and water consumption. Additionally, the sustainability of biofuels depends on factors such as the feedstock used, the production methods, and the impact on land use and food production. Therefore, while biofuels can be a useful tool in the transition towards more sustainable energy systems, they should be considered as one of many options in a broader portfolio of solutions.

Generations of Biofuels

First Generation Biofuels

These are made from crops that can be used for both food and fuel, such as corn, sugarcane, and soybeans. The production of first-generation biofuels can have negative environmental impacts, such as deforestation and food price increases. First generation biofuels are produced directly from food crops by abstracting the oils for use in biodiesel or producing bioethanol through fermentation. Crops has proved a very effective crop for use in biodiesel. However, first generation biofuels have a number of associated problems. The most contentious issue with first generation biofuels is fuel vs food. This has been blamed for the global increase in food prices the last couple of years.

Second Generation Biofuels

These are made from non-food feedstocks such as agricultural waste, forest residues, and energy crops like switchgrass. Second-generation biofuels are considered more sustainable than first-generation biofuels, as they use non-food sources and can reduce waste. Second generation biofuels have been developed to overcome the limitations of first generation biofuels. They are produced from non-food crops such as wood, organic waste, food crop waste and specific biomass crops, therefore eliminating the main problem with first generation biofuels. Second generation biofuels are also aimed at being more cost competitive in relation to existing fossil fuels.

Third Generation Biofuels

These are made from algae or other microorganisms that can convert sunlight and carbon dioxide into fuel. Third-generation biofuels have the potential to be highly efficient and sustainable, as they do not require land use and can be produced using non-potable water. However, the technology is still in the early stages of development. The third generation of biofuels is based on improvements in the production of biomass. It takes advantage of specially engineered energy crops such as algae as its energy source. The algae are cultured to act as a low-cost high-energy and entirely renewable feedstock. It is predicted that algae will have the potential to produce more energy per acre than conventional crops.

Fourth Generation Biofuels

The fourth generation biofuels which could be produced using synthetic biology techniques to create new organisms that can efficiently convert carbon dioxide into fuel and aimed at not only producing sustainable energy but also a way of capturing and storing CO2. Biomass materials, which have absorbed CO2 while growing, are converted into fuel using the same processes as second generation biofuels.

Technologies

From the outset, the following waste and wood biomass products are considered for potential energy recovery as Timber, Organic agricultural waste, used vegetable oil, Solid faecal waste (human and livestock). There are two processes for the conversion of biomass to energy. They are 1. Thermo-chemical and 2. Biological.

It would appear that each of the biomass products under consideration above would fit into one of these two types of processes. Liquid biofuels are possible by-products of the conversion process and are viewed as transport fuels. Used vegetable oil will be considered in a similar way to any these biofuel by-products and will therefore not affect the decision on which process to employ to accept and convert the initial waste or wood products. This therefore leaves three other sources of biomass which can be dealt with using the following type of process

Table 1: Technologies waste and wood biomass products

Waste/ Wood Products	Type of Conversion	Possible Processes
Timber	Thermo-chemical	Combustion, Gasification, Pyrolysis, Liquefaction
Organic agricultural waste	Thermo-chemical	Combustion, Gasification, Pyrolysis, Liquefaction
Solid faecal waste	Biological	Anaerobic Digestion

Thermo-Chemical Processes

High temperature chemical reformation process is involved in the conversion through thermochemical technology, where there is a requirement of bond disintegration and resolving of organic matter into biochar (solid), synthesis gas and highly oxygenated bio-oil (liquid). Three major procedural alternatives are available within thermochemical conversion, which are gasification, pyrolysis, and liquefaction. Fig showed the details flowchart of gasification technology. A chemical reaction in oxygen deficiency involving heating of biomass at high temperatures (500-1400 °C), from atmospheric pressures up to 33 bar and with low/absent oxygen content to produce combustible mixtures of gas comprises the gasification technique, where syngas was produced from carbonaceous materials in presence of suitable reagent and the catalyst. Reports also showed that this process is most suitable process for the generation of H2 gas from organic waste [35]. It has also been found that on addition of metal based catalyst, the reverse reaction is accelerated which ultimately gives the outcome of enhanced production of hydrogen and methane.

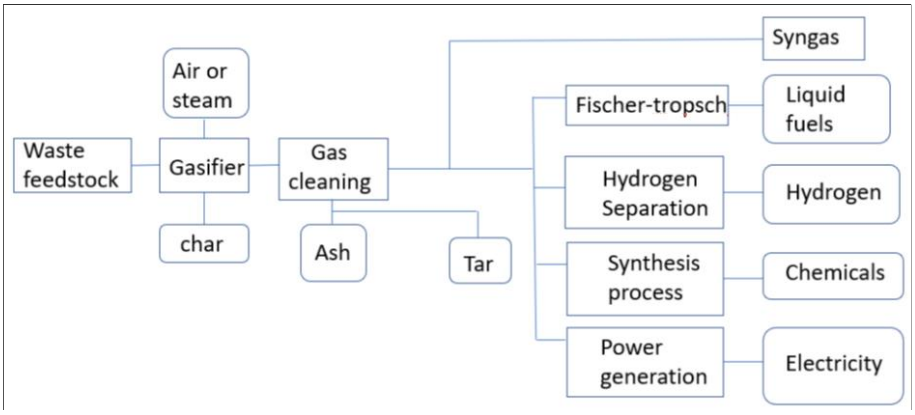

Fig 1: gasification technology

Thermo-Chemical Processes can be describes as

Combustion: Biomass with a low moisture content is often used a feedstock for combustion. This'' refers to the rapid oxidation of the feedstock as it is exposed to high heat'' in a boiler where steam, under high pressure, is passed through a turbine which powers a generator. The main types of combustion processes are: ''fixed-bed combustion, fluidised-bed combustion and dust combustion''.

Pyrolysis: Here, heat is used to chemically convert biomass into fuel. It occurs when biomass is heated in the absence of oxygen. A by-product of pyrolysis is pyrolysis oil that can be burned like petroleum along with biochar. The pyrolysis of wood is a thermal decomposition carried out in a closed furnace with very limited air input (less than 10% stoichiometric). To start the process, a heat source is required, but when the temperature in the furnace reaches more than 2500C, the reactions that take place are exothermic and the processes is self- maintained up to 6000C. There are some by-products of the pyrolysis of wood.

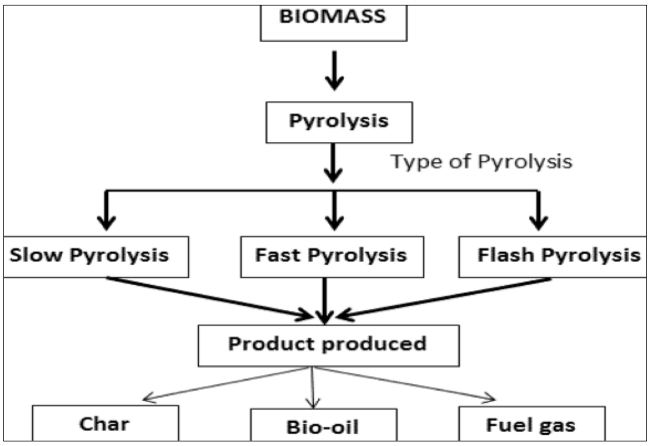

Fig 2: Different types of pyrolysis process

Gasification: The process of heating wood in a chamber until all volatile gases such as CO, H2 and O2 are released from the wood and combusted. The emitted wood gases are then superheated and mixed with air or pure oxygen for complete combustion. Gasification has the great advantage of having extremely high combustion efficiency and thereby generating minimal emissions. Gasification is a quicker process than pyrolysis and differs by the presence of a limited quantity of air (20-80% stoichiometric). The main product of gasification is syngas, composed of CO and H2, which can be of high quality if oxygen is used instead of air.

Liquefaction: Liquefaction is a conversion process resulting in liquid products such as methanol from biomass by direct or indirect process. Indirect, through gas phase and direct without gas phase, for example by rapid pyrolysis. This is a fast process where pressurized water is used to convert a liquid slurry of organic material into hydrocarbon oils and products. Direct liquefaction, or thermal depolymerization, has been successful in producing a liquid oil while the newer indirect liquefaction has had success in producing syngas, ethanol and methanol.

Significance of Thermo-Chemical generation of biofuels

Thermo-chemical generation of biofuels involves the conversion of biomass into fuels through chemical reactions at high temperatures. This process has several significant advantages:

- **High energy yield:** Thermo-chemical conversion of biomass can produce a higher energy yield than other methods of biofuel production. This means that more energy can be obtained from the same amount of feedstock.
- **Versatility:** Thermo-chemical conversion can be used to produce a wide range of biofuels, including bio-oil, syngas, and biochar. This versatility allows for the production of multiple biofuels from the same feedstock, which can increase efficiency and reduce waste.
- **Reduced greenhouse gas emissions:** Thermo-chemical conversion can produce biofuels with lower greenhouse gas emissions compared to fossil fuels. This can help mitigate climate change and reduce environmental impacts.
- **Feedstock flexibility:** Thermo-chemical conversion can use a variety of feedstocks, including agricultural waste, forestry residues, and energy crops. This flexibility allows for the use of non-food sources for biofuel production, which can help minimize competition with food production.
- **Reduced dependence on fossil fuels:** Thermo-chemical conversion can help reduce dependence on fossil fuels, which are finite and contribute to climate change. By producing biofuels from renewable sources, we can move towards a more sustainable energy system.

Thermo-chemical generation of biofuels has significant potential as a sustainable solution to our energy needs. However, it is important to consider the environmental and social impacts of biofuel production and ensure that sustainability is prioritized in the entire biofuel value chain.

Biological Processes

1. **Anaerobic Digestion:** Anaerobic digestion is a biological decomposition process where bacteria are used in controlled anaerobic conditions to break down biodegradable organic waste. The key by-product of anaerobic digestion is methane gas which is produced by the bacteria decomposing the organic waste and can be captured and used as a biogas. Carbon dioxide is also produced.
2. **Aerobic Composting:** Aerobic composting is similar to anaerobic digestion with the key difference being the presence of oxygen. The presence of oxygen means that different bacteria are employed in composting than in anaerobic digestion. Aerobic composting is generally considered to be a commercial process. It should also be noted that temperature, moisture content and good aeration are the main parameters for a good composting process. Aerobic composting also produces gases which can be captured and utilized for energy. In addition, raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes and suitable industrial wastes, enhance their suitability for application to the soil as a fertilizing resource, after having undergone composting(6).
3. **Fermentation:** Fermentation is a biological process in which enzymes produced by microorganisms catalyze chemical reactions. These microorganisms digest sugars to produce the energy and chemicals they need for survival while giving off by- products such as carbon dioxide, organic acids, hydrogen, ethanol and other products (7), which are than collected and utilized for energy production.

Significance of biological generation of biofuels

Biological generation of biofuels involves the use of microorganisms to convert biomass into fuels, such as ethanol or biodiesel. This process has several significant advantages:

1. **Renewable energy source:** Biological generation of biofuels uses renewable sources of biomass, such as agricultural waste or algae, which can be grown and harvested repeatedly, unlike fossil fuels.
2. **Reduced greenhouse gas emissions:** Biological generation of biofuels produces biofuels with lower greenhouse gas emissions compared to fossil fuels, which can help mitigate climate change and reduce environmental impacts.
3. **Feedstock flexibility:** Biological generation of biofuels can use a variety of feedstocks, including agricultural waste, forestry residues, and energy crops. This flexibility allows for the use of non-food sources for biofuel production, which can help minimize competition with food production.
4. **Energy security:** Biological generation of biofuels can help increase energy security by reducing dependence on fossil fuels and foreign oil.
5. **Job creation:** The production of biofuels can create jobs in agriculture, forestry, and other related industries.
6. **Reduced waste:** Biological generation of biofuels can use waste materials, such as food waste or industrial byproducts, to produce biofuels, which can help reduce waste and increase efficiency.

Biological generation of biofuels has significant potential as a sustainable solution to our energy needs. However, it is important to consider the environmental and social impacts of biofuel production and ensure that sustainability is prioritized in the entire biofuel value chain.

Difficulties and Future aspects of biofules

Biofuels have significant potential as a sustainable solution to our energy needs, but they also face several challenges and difficulties. Some of the difficulties associated with biofuels include:

1. **Land use change:** The production of biofuels can result in land use change, which can lead to deforestation, habitat loss, and biodiversity impacts.
2. **Food vs. fuel:** The use of crops for biofuel production can compete with food production, which can lead to food price increases and food insecurity.
3. **Water use:** Biofuel production can be water-intensive, which can lead to increased competition for water resources and environmental impacts.
4. **Energy balance:** The energy input required to produce biofuels can be high, which can reduce the net energy yield and efficiency of the process.
5. **Technological limitations:** Current biofuel production technologies have limitations in terms of feedstock flexibility, yield, and scalability, which can limit their potential impact.

Despite these challenges, there are also several future aspects of biofuels that hold promise

1. **Advanced biofuel technologies:** Research and development into advanced biofuel technologies, such as algae-based biofuels or lignocellulosic biofuels, could overcome some of the limitations of current biofuel production methods.
2. **Waste-based feed stocks:** The use of waste-based feed stocks, such as food waste or industrial by products, can reduce waste and increase the sustainability of biofuel production.
3. **Sustainable land use practices:** The adoption of sustainable land use practices, such as agroforestry or no-till farming, can reduce the negative impacts of biofuel production on land use and biodiversity.
4. **Circular economy:** The integration of biofuel production into a circular economy, where waste streams are used as feed stocks and by products are recycled, can increase efficiency and reduce waste.

Biofuels have the potential to play a significant role in our transition to a more sustainable energy system, but it is important to consider the challenges and opportunities associated with their production and use.

Conclusions

The use of non-renewable resources for energy production is not sustainable and can have negative environmental and economic impacts. The development and use of renewable resources, such as biofuels, can help address the energy crisis and promote social and economic growth in a more sustainable manner. Genomics has the potential to play a key role in the development of biofuels from renewable resources. By understanding the genetic makeup and metabolic pathways of microorganisms such as bacteria and algae, researchers can optimize their ability to produce biofuels and increase their efficiency. One of the main challenges in the development of biofuels from renewable resources is the ability to produce them at scale in an economically feasible manner. Genetic engineering and genomics can help address this challenge by identifying and optimizing the genetic factors that affect biofuel production, leading to the development of more efficient and cost-effective methods for biofuel production.

However, it is important to note that the development and use of biofuels must also take into account sustainability and environmental concerns. For example, the use of land for biofuel production can have negative impacts on biodiversity and food production. Therefore, it is important to consider the full lifecycle of biofuels and ensure that their production and use is sustainable and socially responsible. The use of genomics and genetic engineering in the development of biofuels from renewable resources holds significant promise for addressing the energy crisis and promoting sustainable development.

1. The use of waste biomass to generate energy can decrease waste management problems.
2. The use of biofuels can decrease the pollution and can also decrease the green house gases emission.
3. The increased use of biofuels decreases the demand of fossil fuels thereby decreasing their prices.
4. There is a huge potential for bioenergy obtained from waste to decrease the speed of global warming.
5. Increased use of biofuels include energy security reasons, environmental concern, foreign exchange savings and socioeconomic issues related to rural sector.

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