The Role of Science and Technology in the Conversion of Biowastes to Biofuel in Nigeria

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Abstract

Biowastes are biological wastes which are which are derived from humans, animals and plants. These wastes include agricultural wastes, human wastes and animal wastes. When the environment is littered with biowastes it can serve as a potential source of microorganism which may infect the environment and result in the spread of diseases that are detrimental to both human and animal. Biowastes also affect the environment soil health, crop productivity and contributes to global warming and climate change. Agricultural wastes are basically potential source of biofuel as well as animal wastes like excrement. The burning or use of fossil fuels lead to air pollution, water pollution, climate change and health challenges like, respiratory problems and eye irritation. The conversion of biowastes to biofuel in Nigeria would help to mitigate the challenges associated with biowastes accumulation in the environment and the usage of fossil fuels. This paper highlights and discusses various technologies utilize in the conversion of biowastes to biofuel. These technologies include biochemical and thermochemical technologies. The thermochemical technologies are combustion, gasification, pyrolysis and hydrothermal liquefaction. Biochemical technologies include enzymatic hydrolysis, anaerobic digestion and transesterification. The benefits of biofuel were also mentioned. Biogas, biodiesel, bioethanol and biohydrogen are good examples biofuels obtained from biowastes. They are renewable, have less pollutants and not expensive. The wastes are sewage, crop residue, wood, waste vegetable oil and plant materials

Keywords; Biowastes, Biofuel, Fossil fuel, Pyrolysis, hydrolysis and anaerobic

Introduction

Biowastes are biological wastes which are which are derived from humans, animals and plants. These wastes include agricultural wastes, human wastes and animal wastes (Chattopadhyay,20220&Demirbas,2011). Agricultural wastes are basically potential source of biofuel as well as animal wastes like excrement. When environment is littered with biowastes it can serve as a potential source of microorganism which may infect the environment and result in the spread of diseases that are detrimental to both human and animal. Biowastes also affect the environment soil health, crop productivity and contributes to global warming and climate change. It has been reported that one-third of the food produced is lost every year from food chain as waste resulting in increasing hunger, economic loss and inflation among people (Bhatia,2018). Biofuel is an energy source from wastes which is obtained from the anaerobic break down of biowastes by micro-organism. It is classified into biogas, bio-diesel, bi-ethanol and bio-hydrogen. Bio-fuel is a renewable energy source and cheaper compare to fossil fuel and nuclear energy. It has less pollutant and a good alternative source of energy.

Bio-fuel is use to generate electricity with steam turbines, power our transportation vehicles and for domestic cooking. are the products of anaerobic fermentation of biowastes which include biogas, biodiesel, bioethanol and biohydrogen. These products are good sources of renewable energy and are inexhaustible, environmentally friendly and cheaper to produce. The main contributors of waste energy are municipal solid waste (Adeyemo, 2001).

The Technologies of Conversion of Biowastes to Biofuel

Agricultural wastes are generally converted to biofuel by biochemical and thermochemical technologies. The thermochemical technologies are combustion, gasification, pyrolysis and hydrothermal liquefaction. Biochemical technologies include enzymatic hydrolysis, anaerobic digestion and transesterification The above technologies are explained below

1 **Combustion:** This the process of in which biowastes are burnt in the presence of excess oxygen in other to convert them to thermal energy (Liu,2017). Study has shown in Pakistan in 2016 that 70% rice husk residues generated 1328GWH OF electricity annually.

2 **Gasification:** this is a thermochemical conversion in which biogas is obtained in the presence of oxygen or steam (Yusup,2014 &Liu,2017) Study has shown in Malaysia in 2014 that waste oil palm was used to get the hydrogen which was used as fuel by gasification process (Khan,2014). The hydrogen produced can be used to generates electricity

3 **Pyrolysis:** this is a thermochemical decomposition occurring in the absence of oxygen at a temperature of usually $400^{0c.}$ An intermediate product, a liquid bio-oil is produced and further processed into petrol, gasoline, diesel and other fuels using pyrolysis (Bian,2016 & Alper,2012).

4 **Enzymatic hydrolysis:** This is the conversion of the glucose in biowastes into ethanol by fermentation in the presence of yeast. The process is eco-friendly and reduces air pollution.(Bon &Ferrara,2007).

5 **Anaerobic Digestion:** this is the breakdown of biowastes with the help of microorganism in the absence of oxygen (Hill & Robert,198; Bon &Ferrara,2007)

5 Transesterification: this is the chemical process of conversion of triglycerides in vegetable oil and animal fat in the presence of a catalyst with alcohol like methanol or ethanol to produce biodiesel(Fukuda *et al.*,2001).

Biofuels Generated from Biowastes.

The following products are some of the biofuels generated from biowastes

Biogas

Biogas is a mixture of gases produced by the breakdown of biowastes in the absence of oxygen (Badiyya,2018). Biogas can be produced from regionally available raw materials such as recycled waste: water hyacinths, crop residue, refuse etc. Biogas is produced by anaerobic digestion with anaerobic bacteria or fermentation of biodegradable materials such as cattle dung (Garba, Zuru & Sambo, 1996). Ekwenchi &Yaro (2010) produced biogas from banana leaves. Biogas is primarily methane and carbon dioxide and may have small amounts of hydrogen sulphide,. Biogas is also a key option for short and medium term to mitigate Green House gas emissions and replace fossil fuels since it can be used as source of heat, electricity and produce transport fuel (Elaiyaraju & Partha, 2016). In the United Kingdom, for example. biogas is estimated to have the potential to replace around 17% of vehicles fuel. It qualifies for renewable energy subsidies in some part of the world. Biogas can be cleaned and upgraded to natural gas standard when it becomes bio-methane.

Biogas production in Germany has developed rapidly over the last 20years. In India, over two million household benefit from biogas production due to thriving population of livestock. Compressed biogas is becoming widely used in Sweden in Switzerland and Germany. A biogas powered train has been in service in Sweden since 2005. In 2007, an estimated 12,000 vehicles were being fueled with upgraded biogas worldwide, mostly in Europe. China had installed 6000000 digesters in an effort to make agriculture more efficient. This seems to be the earliest development in generating biogas from agricultural waste. In developing nation, domestic biogas plant converts livestock manure into biogas and slurry.

Bioethanol

Bioethanol is an alternative liquid fuel produced from biowastes that contained large amount of sugar like sugar cane and grain (Magdalena &Lucyna,2010) through fermentation process. Throughout history, alcohol has been used as fuel. The first four aliphatic alcohols (methanol, ethanol, propanol, butanol and ethanol) are of interest as fuels because they can be synthesized chemically or biologically and they have characteristic which allow them to be used in internal combustion engines. Bioethanol is currently being considered as a potential replacement for the conventional gasoline (Ifeanyichukwu,2020)

Biodiesel

Biodiesel (Fukuda *et al.*,2001) is a liquid biofuel obtained by chemical processes from vegetable oils or animal fats and an alcohol that can be used in diesel engines, alone or blended with diesel oil. Biodiesel is a clean burning alternative fuel that comes from 100% renewable resources. Many people believe that biodiesel is the fuel for the future. Biodiesel can be manufactured from waste vegetable oil, animal fat and recycled restaurant greases. Globally, more than 350 oil-bearing crops are known as potential biodiesel feedstocks (Atabi *et al.*,2012). It is safe, biodegradable and produce less air pollutant. Biodiesel is a clean burning alternative fuel that comes from 100% renewable resources. It is made through a process of called trans-esterification. This process involves removing the glycerin from waste vegetable oil or animal fat. Ibeto *et a*l(2012) carried out a study on some oils as a potential feedstock for production of biodiesel . Biodiesel an innovative fuel that is rapidly becoming more available to the general public compared to other alternative fuels. Biodiesel has a number of unique features and qualities. Plastic shopping bags (polythene bag) can be converted into biodiesel (Derek,2014), natural gas and other useful petroleum products.

The conversion produces significantly more energy than it requires. According to Brajendra Kumar Sharma,a senior research scientist at the Illinois sustainable technology centre, a research institute at the University of Illinois, diesel is obtained from plastic bags in an oxygen-free chamber, a process called pyrolysis. Sharma said since plastic is made from petroleum, we can recover almost 50% fuel from it through distillation. Americans throw away about 100 billion plastic shopping bags each year, according to the world watch institute. The U.S Environmental protection agency reports that only 13 percent are recycled. The rest of the bags end up in landfills or escape to the wild, blowing across the landscape and entering waterways. Plastic bags make up a sizeable portion of the plastic debris in giant ocean garbage patches that are killing wild life and littering beaches. Brajendra Kumar Sharma center, with research chemist Dheeptha Murali, converted plastic shopping bag into diesel fuel.

Biohydrogen

Bio-hydrogen is defined as hydrogen produced biologically. Hydrogen is another good alternative to fossil fuel (Bikram, Nayak & Soumya,2013). Bio-hydrogen is a potential bio-fuel obtained from both cultivation and from waste organic materials. The most commonly used techniques of biohydrogen production are bio-photolysis, photo-fermentation and dark-fermentation (Ackmez,Tania&Antoni ,2010). Bio-hydrogen can be used to fuel cell powered passenger cars, buses, forklifts. It is also used as fuel in rockets. Currently there is a huge demand of the chemical hydrogen. There is no log of the production volume and use of hydrogen worldwide, however consumption of hydrogen was estimated to have reached 900 billion cubic meters in 2011. Refineries are large volume producers and consumers of hydrogen.

Today 96% of all hydrogen is derived from fossil fuels, with 48% from natural gas, 30% from hydrogen, 18% from coals and about 4% from electrolysis. An important future application of hydrogen could be an alternative for fossil fuels. Researchers at the Virginia polytechnic and state university have come up with a new and cost-effective way of producing hydrogen

from biomass. Hydrogen is generally regarded as a clean and efficient fuel with great potential for transport. Hydrogen can be produced in various ways. It can be made from fossil fuel like natural gas, but that is an energy Intensive process producing net carbon emissions. It can also be produced from water through electrolysis. This process also uses energy although, but if renewable power is used, it could be a viable and clean option.

Benefits of Biofuel

Biofuel has several benefits. These benefits are classified into environmental, economic and other benefits. The following are the benefits of biofuel.

Environmental Benefits

Biofuel for most part creates no harmful carbon-dioxide emissions. Many energy sources used today struggle to control their carbon-oxide emissions, as these can cause harm to the ozone layer and increase the effect of greenhouse gases, potentially warming the planet. It is completely neutral, has no such carbon dioxide side effect in its use. Biofuel is relatively clean compare to energy from fossil fuels, it has less pollutants and is environmentally friendly. Another benefit is that it can take waste that is harmful to the environment and turn it into something useful. It also prevents methane emission into the environment which can contribute to greenhouse gas emission.

Economic Benefits

The use of biofuel as alternative source of energy reduces dependency on fossil fuels. Unlike energy from fossil fuel, bio- fuel is abundant and renewable. Since they come from living sources and life cyclical, these products potentially never run out, so long as there is something on earth and there is someone there to turn that living things components and waste products into energy. Electricity and heat can be generated from waste which provide an alternative and more environmentally friendly source of energy. The by-products of some waste to energy processes such as anaerobic digestion can be used as fertilizer and improves the nutrient content of soil. As waste to energy plants are generally set up locally, it creates jobs.

Other Benefits

Production of energy from waste is a means of waste management. Waste that would have normally gone to landfills is diverted to an energy processing unit there by saving valuable land. The cost associated with the transport of wastes to land fill is reduced and also land fill taxes imposed by governing bodies are avoided

Advantages of Biofuel over Fossil Fuel

Biofuel is an energy source that is renewable, since they come from living sources and life is in cycle, these products potentially never run out, so long as there is something on earth and there is someone there to turn that living things components and waste products into energy.

It is relatively clean compare to energy from fossil fuels. It does not release carbon dioxide but capture carbon dioxides for its own growth. Methane emission into the environment which can cause or contribute to greenhouse gas emission is preventable. Fossil fuel is non-renewable and releases into the atmosphere carbon dioxide which can contribute to greenhouse gas emission. Bio fuel is cheaper compare to fossil fuel in terms of cost and production. It is easy and cheaper to run bio fuel plant than fossil fuel industry.

Conclusion

The technology of conversion of biowastes to biofuel will go a long way in mitigating the accumulation of wastes in the environment and invariably reducing the spread of diseases associated with biowastes The Biofuel obtained from biowastes is a good example of an energy source because it is a renewable source with less pollutants and cheaper compare to fossil fuel and nuclear energy. The by-products of conversion of biowastes to biofuel processes such as anaerobic digestion can be used as fertilizer and improves the nutrient content of soil. The application of the science and technology in the conversion of biowastes to biofuel will reduce the accumulation of biowastes in the environment and invariably curtail the spread of diseases. It also reduces overdependence on fossil fuel and thereby reducing pollution of the environment associated with the usage of fossil fuel and also create employment for the teeming population of unemployed youth.

Recommendation

1 Government should encourage and sponsor scientists who wish to explore on the above highlighted technologies for sustainable development.
2 Government should include this research topic in the school curriculum so as to encourage creativity and innovation among students.
3 Government should reduce overdependence on fossil fuels and promote diversification of energy sources

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