Biofuel from waste : A review

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Abstract: Better management of resources to meet feedstock needs of the biofuel industry can lead to growth of the global economy. Non-edible feedstock, waste bio-material and biomass that require minimal land use should be fully exploited to sustain the biofuel industry. Our society is currently experiencing constraints imposed by our resource system, which drives industry to increase its overall efficiency by improving existing processes or finding new uses for waste. Food supply chain waste emerged as a resource with a significant potential to be employed as a raw material for the production of fuels and chemicals given the abundant volumes globally generated, its contained diversity of functionalised chemical components and the opportunity to be utilised for higher value applications. There is a huge potential for bioenergy obtained from waste to decrease the speed of global warming. Bioethanol derived from the waste products of agriculture and the food chain is more attractive as this avoids competition with food crops, reduces food waste and lowers the carbon footprint. Inspite of it, various researches are going on to obtain biofuel from paper & plastic also. As per a recent report, by the year 2020, 19 million tons of oil equivalents could be derived from biomass. Out of this, 46% is obtained from bio-wastes like farm waste, agricultural waste, municipal solid waste and other biodegradable waste streams.

INTRODUCTION :

Ethanol is an alternative fuel derived from biologically renewable resources. It is a good substitute for gasoline in spark-ignition engines. [1]. Bio-ethanol production from lignocellulosic waste materials, such as crop residues, municipal solid wastes, forest products wastes, leaf and yard wastes, municipal sludges, and dairy and cattle manures, have been explored. Production of fuel alcohol from biomass is of growing interest worldwide. Biomass is the biological material derived from living, or recently living organisms. It mostly-often refers to plants or plant-based materials, which are specifically called lignocellulosic biomass. Biomass as an energy source can be used either directly via combustion to produce heat, or indirectly after converting it to various forms of biofuels such as methanol, ethanol, methane gas, hydrogen gas or electricity [2]. At the present time, this readily available biomass is considered as a waste and is disposed of through agricultural burning after harvest.

Recently studies on extracting bio-ethanol from fruit waste are getting attraction especially in the developing countries of low income [3-8]. However, bio-ethanol production from waste materials removed from fruits is very rare. The use of fruit waste as biomass would give great advantages considering the shortage of energy resources and increasing disposal costs. Production of fuel alcohol from cellulosic feedstock is of growing interest worldwide

A latest technology has come into being that helps in converting this plastic waste disposal & waste paper into a good source of green fuel.(9)

1. Biofuel production from fruit waste:

(a) From banana, plantain & pineapple peels:

In the present study, wastes from fruits such as banana, plantain and pineapple peels which are in abundance and do not interfere with food security were subjected to simultaneous saccharification and fermentation for 7days by co–culture of Aspergillus niger and Saccharomyces cerevisiae. Biomass yield, cell dry weight, reducing sugar concentration and the ethanol yield were determined at 24 hours interval. The results of the study showed that after 7 days of fermentation, pineapple peels had the highest biomass yield of 1.89 (OD), followed by banana peels 1.60 (OD), while plantain peels had the least 0.98 (OD). The reducing sugar concentrations ranged between 0.27 – 0.94 mg/cm3 for pineapple, 0.20 – 0.82 mg/cm3 for banana and 0.16 – 0.45 mg/cm3 The optimal ethanol yields were 8.34% v/v, 7.45 % v/v and 3.98 % v/v for pineapple, banana and plantain peels respectively. These indicate that pineapple and banana peels ethanol yields were significantly higher ($P<0.05$) than plantain peel ethanol yield. The findings of this study suggest that wastes from fruits that contain fermentable sugars can no longer be discarded into our environment, but should be converted to useful products like bio-ethanol that can serve as alternative fuel.(10)

(b) From Mango:

Mango fruit processing industries generate two types of waste, including solid waste (peel and stones) and liquid waste (juice and wash water). Utilization of this waste is both a necessity and challenge. This work was aimed to investigate the suitability of dried mango peel for ethanol production. The mango peel contained good amount of reducing sugars up to 40% (w/v). Direct fermentation of mango peel extract gave only 5.13% (w/v) of ethanol. The rate of the fermentation was very slow. Nutrients such as yeast extract, peptone and wheat bran extract were tested for the supplementation of

mango peel medium and it was observed that the nutrient supplementation increased the ethanol production significantly up to 7.14% (w/v).

The yeast Saccharomycescerevisiae and facultative bacterium Zymomonas mobilisare better candidates for industrial alcohol production. Z.mobilis possesses advantages over S. cerevisiae with respect to enthanol productivity and tolerance.(11)

©From Orange peel :

Orange peel is an excellent example of a wasted resource. In Brazil, the world's largest producer of orange juice, half the orange fruit is left as waste once the juice has been recovered. This corresponds to eight million tons a year of orange peel that can be used to produce chemicals, materials and fuels.

A box of oranges weighs 90 pounds and results in about 50 percent juice and 50 percent peel material. The citrus peel material includes a mixture of peel, segment membranes, and seeds rich in pectin, cellulose, and soluble sugars. This material is available in large volumes.(1)

In general, the fermentation process that produces ethanol is carried out between 25 and 35°C to maximize ethanol production and prevent heat-inactivation of the yeast.

(d) From orange, apple & tangerine:

The use of fruit waste as biomass would give great advantages considering the shortage of energy resources and increasing disposal costs.

In another research paper, study on bio-ethanol extraction using selected fruit waste as orange, apple and tangerine had been done and the extraction was made on the basis of simultaneous saccharification and fermentation procedure. Utilization of fruit waste can solve environment and energy problem at the same time.

Ethanol production from orange, apple and tangerine with common enzymes Saccharomyces Cerevisiae was performed. The simultaneous saccharification and fermentation process led to the formation of biofuel.(12)

2. From Plastic:

Each day, we have lot of plastic waste disposal from our household. A latest technology has come into being that helps in converting this plastic waste disposal into a good source of green fuel. Not only does this technology helps save our environment from waste accumulation but also helps us save lot of money.

The process of converting plastic waste into bio-fuel is quite simple. It is similar to how alcohol is made. If you heat plastic waste in non oxygen environment, it will melt, but will not burn. After it has melted, it will start boiling and eventually evaporate. You just need to put those vapours through a cooling pipe and when cooled the vapours will condense to a liquid and some of the vapours with shorter hydrocarbon lengths will remain as a gas. The exit of the cooling pipe is then going through a bubbler containing water to capture the last liquid forms of fuel and leave only gas that is then burned. If the cooling of the cooling tube is sufficient, then there will be no fuel in the bubbler, but if not, the water will capture all the remaining fuel that will float above the water and can be poured off the water. On the bottom of the cooling tube is a steel reservoir that collects all the liquid and it has a release valve on the bottom so that the liquid fuel can be poured out.

This method is doubly environmentally friendly as it will reduce the volume of plastic waste being disposed of in the landfill while producing green fuel without generating any green house gases.(13)

3. From Paper:

Modern approach to utilization of non-edible biomass is its conversion to glucose, and the following fermentation of the sugar into final bioproducts. Among various biomass types, the waste of office paper is distinguished by increased content of cellulose and negligible content of lignin; therefore it can be a suitable feedstock for bioconversion into valuable bioproducts.

An advanced technology has been proposed for complete utilization of the paper waste by bioconversion. The technology is comprised of the following main steps: (1). Redispersion of the waste paper and then screening of the pulp in order to separate fibers from mineral fillers; (2). Acidification and washing of the fibers to remove the residual calcium carbonate; (3). High-solids enzymatic hydrolysis of the demineralized paper to obtain fermentable sugar - glucose; and (4). Fermentation of the glucose into biofuel. As a result, from 1 ton of the waste office paper about 280L of bioethanol can be produced that have capacity of the heat energy of 1680kWh. Besides, there remain by-products of the processing including about 260kg of residual fibers and about 270kg of mineral fillers that can be used repeatedly in the papermaking. Thus, the waste paper can be utilized completely for production of the valuable bio product and recycled paper materials.

There is great potential to divert this into a new sustainable source of fuel or higher value chemicals.

CONCLUSION:

To increase the sustainability of biofuels, there is currently a drive to turn away from deriving them from food crops, such as corn and sugarcane. Bioethanol derived from the waste products of agriculture and the food chain is more attractive as this avoids competition with food crops, reduces food waste and lowers the carbon foot print. So, the production of ethanol from

fruit waste, paper & plastic will serve a solution to their disposal and at the same time produce fuel.

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