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A Review on the Bioethanol Production from Prosopis Juliflora

E. K. Sindhu[1]
B. Tech- Biotechnology
Department of Biotechnology
Karunya University
Coimbatore – 641114, Tamilnadu, India

Mr. G. Gnanavel[2]
Assistant Professor
Department of Biotechnology
Karunya University
Coimbatore – 641114, Tamilnadu, India

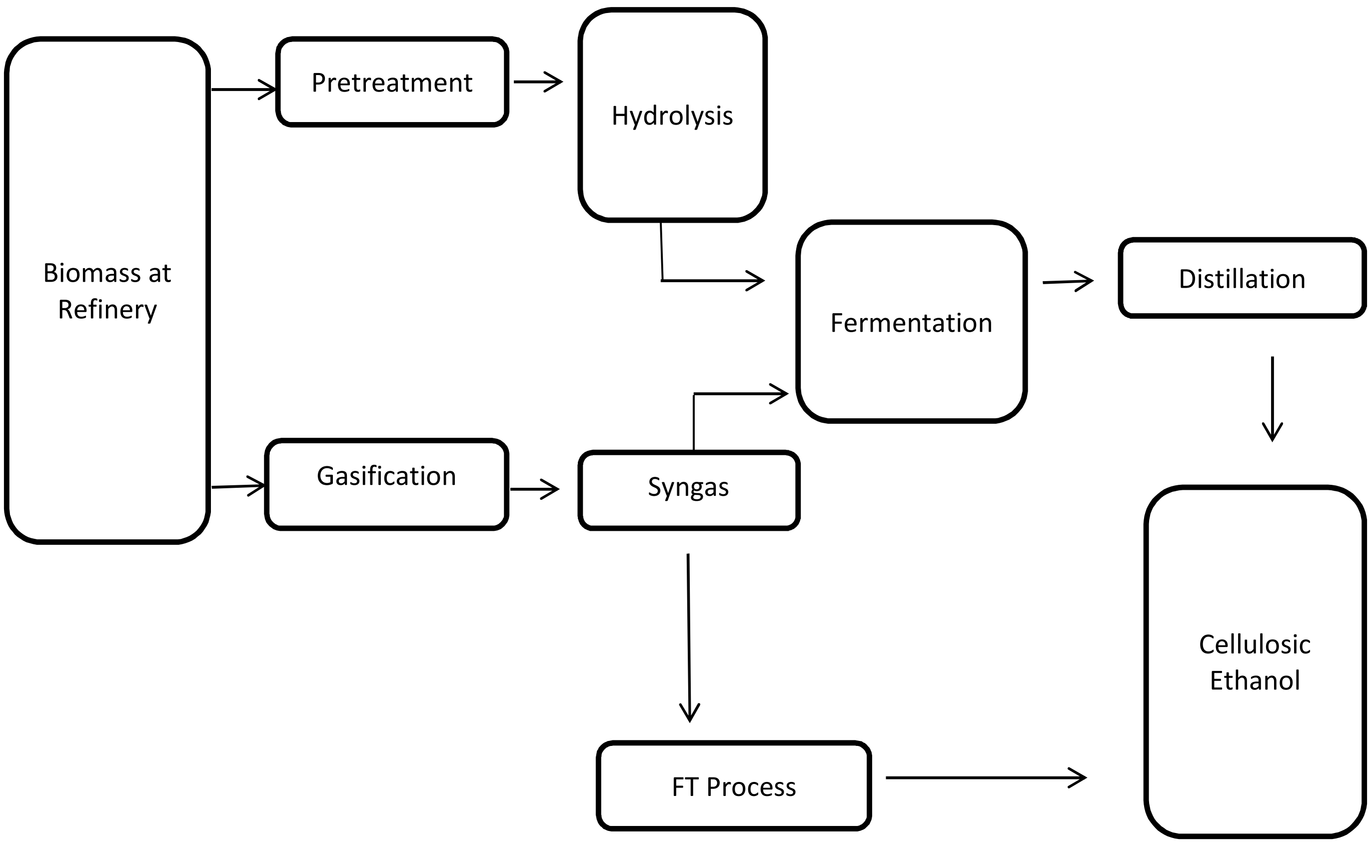
Abstract: **Bio-fuel has been a source of energy that human beings have used since ancient times. Increasing the use of bio-fuels for energy generation purposes is of particular interest nowadays because they allow mitigation of green house gases, provide means of energy independence and may even offer new employment possibilities. The economic aspect is based on the fact that wastes may be used as low-cost raw materials for the production of other value-added compounds, with the expectancy of reducing the production costs. Lignocellulosic materials (eg. *Prosopis juliflora*) can be utilized to produce ethanol, a promising alternative energy source for the limited crude oil. This study involved optimization of acid hydrolysis in ethanol production from *Prosopis juliflora*. The conversion of *Prosopis juliflora* to ethanol can be achieved mainly by three process steps: pretreatment of *Prosopis juliflora* wood to remove lignin and hemicellulose, acid hydrolysis of pretreated *Prosopis juliflora* to convert cellulose into reducing sugar (glucose) and fermentation of the sugars to ethanol using Saccharomyces cerevisiae in anaerobic condition. An optimization was carried out to optimize acid hydrolysis process variables so as to determine the best acid concentration, solid fraction, temperature, and contact time that resulted maximum ethanol yield.**

Keywords*: *Biofuel, lignocellulosic, mitigation, optimization, Prosopis juliflora, hydrolysis.

I. INTRODUCTION

Bio-fuel has been a source of energy that human beings have used since ancient times. They are being investigated as potential substitutes for current high pollutant fuels obtained from conventional sources. Bioethanol production from renewable biomass such as lignocellulosic materials is widely investigated nowadays. Lignocellulosic feed stocks are cheap, renewable, abundant and do not compete with the food production. They are rich in holocellulose and lignin which form a recalcitrant ligno-cellulose complex that resists saccharification processes (Nikolic et al., 2009). Lignocellulose is the most plentiful renewable biomass produced from photosynthesis. Cellulose, hemicelluloses and lignin are major components of the lignocellulosic biomass. Ethanol as well as other bio-fuels produced from plant biomass is alternative to fossil fuels. Ethanol does not add to a net carbon dioxide atmospheric increase thus there is in theory no contribution to global warming. Combustion of ethanol results in relatively low emissions of volatile organic compounds, carbon monoxide and nitrogen oxides. Ethanol was used as transportation fuel at the beginning of 20th century in the U.S., but it was abandoned for fuels processed from petroleum (oil) after World War II because these were cheaper and had higher energy values (Lin and Tanaka, 2006; Ford, 2004). During the last two decades, technology for ethanol production from non-food-plant sources has been developed to the point at which large-scale production could be a reality in the next few years (Mosier, N., et al., 2005). Bioethanol market is expected to reach 100 $x10^9$ liters in 2015. The largest producers in the world are the US, Brazil, and China. In 2009, US produced $39.5x10^9$ liters of ethanol using corn as a feedstock while the second largest producer, Brazil, created about $30x10^9$ liters of ethanol using sugarcane. China is a country that has invested much in the production of ethanol, and is nowadays one of the largest ethanol producers (Ivanova et al. 2011).

Schematic Diagram of Ethanol productions from lignocellulosic feedstocks (Zhu JY et al., 2009).



The world has been confronted with an energy crisis due to depletion of finite resources of fossil fuel, difficulties in their extraction and processing, leading to an increase of its cost. Also fossil fuels contribute an important role in accumulation of greenhouse gases (GHG) which can ultimately pollute the environment. Fossil fuels are being used for the production of fuel, electricity and other goods. Excessive consumption of these fossil fuels has resulted in high levels of pollution during the last few decades. The level of greenhouse gasses in the earth's atmosphere has drastically increased. In this scenario, renewable sources might serve as an alternative. *Prosopis juliflora* is one of the most economically and ecologically important tree species in arid and semi-arid zones of the world. It is an important species because of its high nitrogen fixing potential in very dry areas and in drought seasons and also because of it provides shelter and food to many species of animals on its nectar, pollen, leaves and fruits. Hence it is necessary to look forward for alternative fuel. Ethanol contains 35% oxygen, which results in a complete combustion of fuel and thus lowers the emission of harmful gases. Moreover, ethanol production uses energy from renewable sources only; hence, no net carbon dioxide is added to the environment, thus reducing green-house gas emissions. The increasing demand for various industrial purposes such as alternative source of energy, industrial solvents, cleansing agents and preservatives, has necessitated increased production of ethanol (Brooks 2008). Furthermore, ethanol by fermentation offers a more favorable trade balance, enhanced energy security, and a major new crop for a depressed agricultural economy. Ethanol is considerably less toxic to humans than is gasoline (or methanol). Ethanol also reduces smog formation because of low volatility; its photochemical reactivity and low production of combustion products. Furthermore, low levels of smog-producing compounds are formed by its combustion (Wyman and Hinman 1990). In addition, the low flame temperature of ethanol results in good engine performance. Ethanol has a potential market as big as the oil market. It can potentially replace the entire fuel market for gasoline. Furthermore, plastics such as polyethylene can be produced from ethanol through ethylene. However, the amounts of sugar substances and grains are limited in the world. They are relatively expensive feedstocks for ethanol production, and ethanol competes with human food for these raw materials. This competition may lead the price of grains and sugar to higher levels in the future.

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II. MATERIALS AND METHODS

METHOD 1:

Seeds of *Prosopis juliflora* was collected and washed in the running tap water and kept for drying in the hot air oven at 45 °C for 18 hours. It is then grinded for the appropriate size and weighed. Later 50gms is taken and transferred to 500ml conical flask and 200ml distilled water is added. It is then kept in hot water bath for 60 minutes at 95 °C and filter the mixture. Then centrifuge the mixture at 3000rpm for 15 minutes, supernatant is vaccum filtered. Now the filtered sample is autoclaved for 15 minutes at 121 °C. It is then cooled to the room temperature and aliquots were dispensed aseptically in a sterilized Erlenmeyer flask for fermentation. Then 10ml of 24hr old culture and 0.2g of ammonium sulphate, 0.4g of potassium di hydrogen orthophosphate is added in to the flask and incubated at room temperature for 72hrs. Then 100ml of the filtrate is distilled.13ml of ethanol is distilled at 78 °C and water at 100 °C. Finally ethanol is analysed by keeping the filtrate in the UV spectrophotometer by noting the absorbance at 197nm.

METHOD 2:

The seeds are collected and kept for drying and grinded, sieved. Then pretreatment is made by adding 1.2% dilute sulphuric acid and kept inside the autoclave and heated at 135 °C for 30 minutes. Then dilute acid hydrolysis is made to determine the acid concentration, solid fraction, time and temperature. Then fermentation is done with the composition of 100gm dextrose, 2gm dry yeast extract, 10gm urea, 1gm $MgSO_4.7H_2O$ and 1000ml distilled water for 1 litre. Finally distillation is made for the separation of ethanol by keeping the filtrate in the rotary evaporator at 85 °C.

III. RESULTS AND DISCUSSION

METHOD 1:

The maximum concentration of ethanol from the seeds of *Prosopis juliflora* was 372ml/lit which is of highly loaded sucrose content that was found on the third day of fermentation. In this it shows that the sugar is being fermented by the help of the microorganism saccharomyces cerevisiae.

METHOD 2:

In this study the best hydrolyzing method was found to break the long chains of cellulose to free sugar before fermentation for alcohol production. The interaction between the acid hydrolysis process is carried out using the experimental design expert 7 software. The cubic polynomials have explained the above mentioned variables on the ethanol yield. And the alcohol produced from the acid hydrolysis is more than the alkaline based hydrolysis. So it is considered to be the productive process.

IV.CONCLUSION

Due to the high sugar content in the seeds of *Prosopis juliflora* the yield of ethanol was 372mg/lit. The microorganism saccharomyces cereviseae convert the sugar and ferment in to bioethanol with the optimum pH of 4.5-6.0 and the sugar present in the seed varies from place to place. So lignocelluloisic feedstocks play a major role in the production of bioethanol as an alternative and a promising fuel for the future. This is also based on the economic aspect that it is of low cost and is more reliable and efficient.

In the method 2 experimental design was selected for the acid hydrolysis process. Ethanol yield of 40.91% was obtained when optimum conditions were acid concentration 0.5%, solid fraction 5%, temperature of 105.01°C, time of 10 minute, which indicates that at this condition no inhibitors are produced that inhibit the fermentation process steps. Also this method of optimization is efficient and reliable.

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