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STUDY ON PRODUCTION OF EATHANOL FROM BIOMASS

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ABSTRACT

Enormous amount of biomass is depositing each day in the environment. The agriculture countries can make use of such resources for various useful purposes. Bioethanol is one of the important commodities which can be produced by using biomass. Bioethanol can be considered as future fuel which has the potential to replace fossil fuels. Bioethanol is in fact a cheap source of energy and can help in clean environment management. However in few cases consideration are needed to overcome the anomalies of using some specific biomass resources which can affect our food reserves. A brief survey of the various important aspects involved in bioethanol production is done in this report to grasp the basic concept of bioethanol production from biomass.
Cellulosic materials are abundant and prominent feedstock for cheap ethanol production.

Ethanol from biological feedstock has emerged as a promising alternative for the generation of energy from renewable sources in order to mitigate the damages caused by the gas emissions associated to the consumption of fossil fuels. In many countries, ethanol is already being produced at industrial scale from different biological raw materials. However, there are some technical issues related to this process that need to be addressed and one of the major problems is the high heat requirements which makes this process less competitive against well-established fuels.

KEYWORDS: *biorefinary biomass sources, ethanol production.*

INTRODUCTION

Cellulosic ethanol (sometimes referred to as *cellanol*) is ethanol fuel produced from cellulose, a naturally occurring complex carbohydrate polymer commonly found in plant cell walls. Cellulosic ethanol is chemically identical to ethanol from other sources, such as corn, sugar or starch, and is available in a great diversity of biomass including waste from urban, agricultural, and forestry sources. However, it differs in that it requires an extra processing step called cellulolysis – breaking cellulose down into sugars. Cellulosic ethanol production currently exists at "pilot" and "commercial demonstration" scale. The figure below shows how biomass is processed to transform it into cellulose ethanol.

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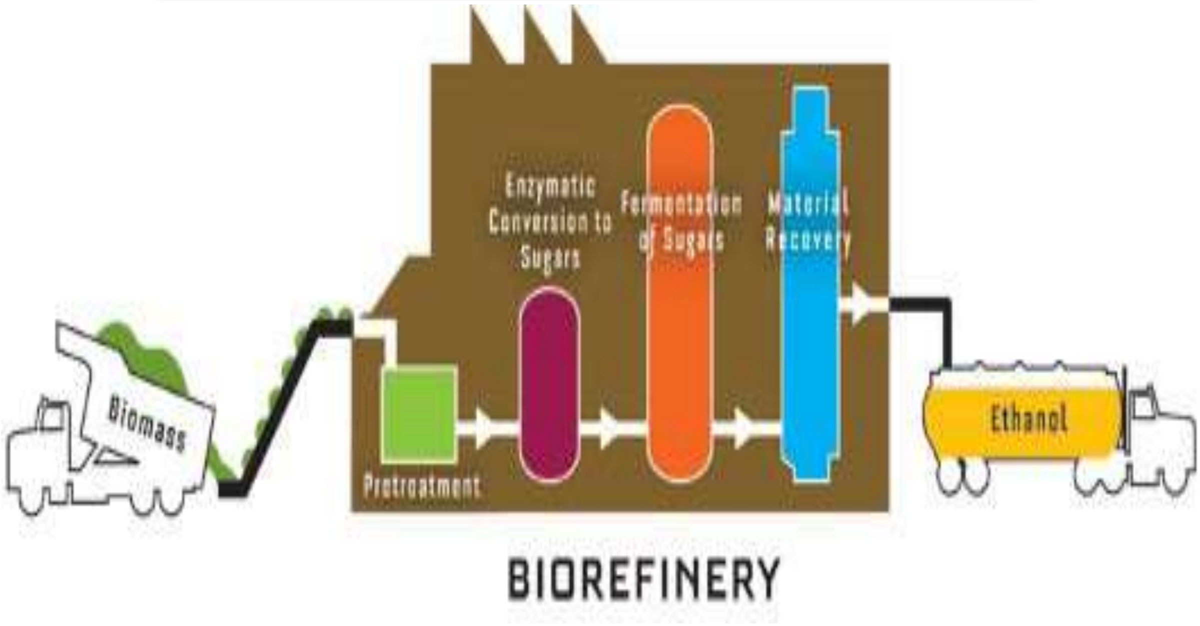

Figure: Bio refinery

Cellulosic ethanol is a renewable liquid biofuel that has emerged as a prospective alternative transportation fuel source with significant environmental implications.

SOURCES:

Sources of cellulosic biomass from which ethanol can be made include, but are not limited to: agricultural wastes such as corn Stover, cereal straws, and sugarcane biogases; grasses; woods; and plant wastes from industrial processes, such as sawdust and paper pulp.

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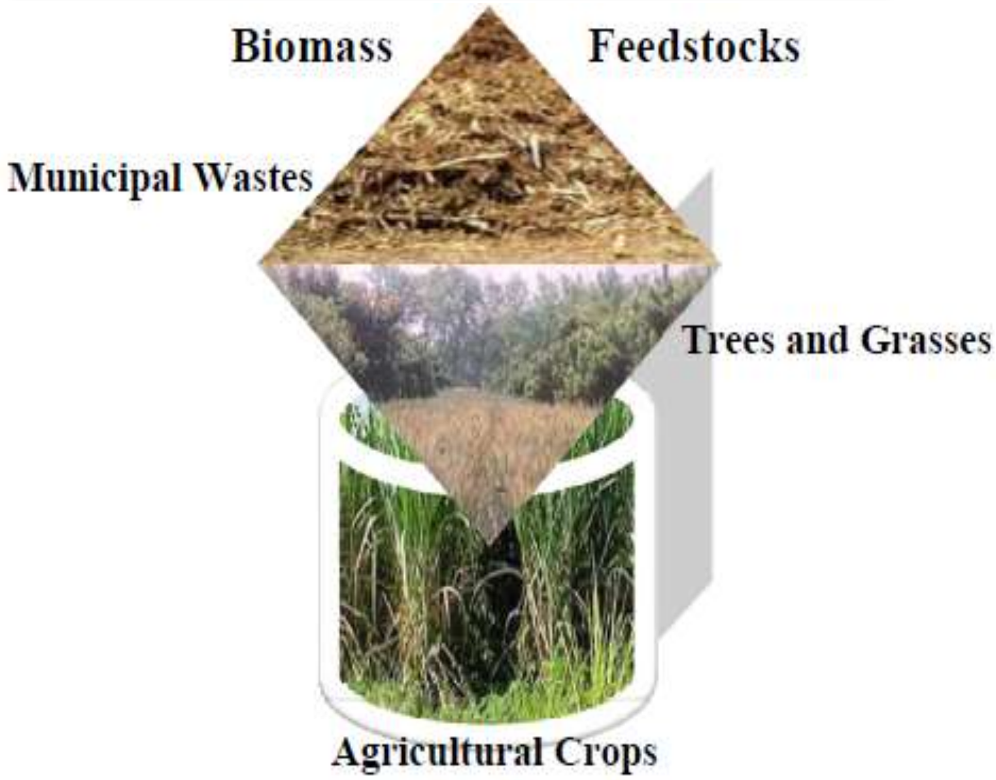

Figure: Biomass Source

Major environmental concerns do exist concerning the question of converting land to grow products containing the biomass that can be used to produce cellulosic ethanol. Converting land use to energy crop production could potentially result in:

- Loss of biodiversity due to monoculture of biomass feedstock
- Displacing natural land cover (that has higher carbon sequestration potential) with crops such as corn.
- Loss of food producing agricultural area

Increased use of fertilizers that are harmful to overall ecosystem health

In addition, there is active scientific debate over the extent to which these land use changes will counteract the benefits of fixing atmospheric carbon into organic carbon. As an example, one recent study (that does not reflect a universally accepted scientific understanding of the topic) suggests that greenhouse gas emissions from the transportation sector could nearly double over the next 30 years as the use of corn-based ethanol increases. The same study states that increasing cultivation of switch grass (for cellulosic ethanol) on corn lands could increase greenhouse gas emissions by 50 percent beyond expected increases.

THEORETICAL PRINCIPLES

His part of the thesis contains the different type of ethanol production and a quick explanation on starch ethanol.

PROPERTIES

Many properties of cellulose depend on its chain length or degree of polymerization, the number of glucose units that make up one polymer molecule. Cellulose from wood pulp has typical chain lengths between 300 and 1700 units: cotton and other plant fibers as well as bacterial cellulose have chain lengths ranging from 800 and 10,000 units. The following are the basic properties of cellulose: 1. it is tasteless and odorless.
2. It is insoluble in water and most organic solvents.
3. It is hydrophilic.
4. It is biodegradable.
5. It can be broken down chemically into its glucose units by treating.

THERMO CHEMICAL PROCESS

There are two ethanol production processes that currently employ thermo chemical reactions in their processes. The first system is actually a hybrid thermo chemical and biological system. Biomass materials are first thermo chemically gasified and the synthesis gas (a mixture of hydrogen and carbon oxide) bubbled through specially designed fermented.

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A micro-organism that is capable of converting the synthesis gas is introduced into the fomenters under specific process condition to cause fermentation to ethanol.

The second thermo chemical ethanol production process does not use any micro-organisms. In this process, biomass materials are first thermo-chemically gasified and the synthesis gas passes through a reactor containing catalysts, which cause the gas to be converted into ethanol. An intensive effort was made to develop these processes for fuel. Have been made since then to develop commercially viable thermo chemical-to-ethanol processes.

Ethanol yields up to 50% have been obtained using synthesis gas-to-ethanol processes. Some processes that first produce methanol and then use catalytic shifts to produce ethanol have obtained ethanol yields in the range of 80%. Unfortunately, like the other processes, finding a cost-effective all-thermo chemical process has been difficult.

RESULT AND DISCUSSION

According to the increasing demand for renewable energy resources, bioethanol is considered as one of the most suitable and economical future fuels. The environmental effects caused by the biomass can be decreased by utilizing them into useful products. Various pretreatment processes and strains of bacteria and yeast are used to convert biomass into bioethanol. For renewable processing of biomass or direct bioethanol production, the cost effective technologies are needed which need further research, development, demonstrations, and diffusion of commercialized new technologies. The conversion of biomass into bioethanol not only can accomplish the demand for energy resources but all have positive effects on the environmental and socioeconomic position of the country. The further research and technologies development are needed in the field of bioethanol production so that can replace the fossil fuel causing environmental and economic burdens.

Table. Ethanol yield from different biomass.

No.	Type of Biomass	Ethanol Yield (G/G Biomass)
1	Sugarcane biogases	0.25 -0.27
2	Sweet sorghum	0.19 -0.20
3	Switch grass	0.12 -0.13
4	Rice straw	0.10 -0.11

The purpose of this study was to determine the ethanol yielding capacity of some selected lignocelluloses based- wastes. The results show that sawdust produced the highest glucose and ethanol yield among the substrates. Bioconversion offers a cheap and safe method of not only disposing the agricultural residues, but also it has the potential to convert lignocelluloses waste into usable forms such as reducing sugars that could be used for ethanol production. Hence the conversion of lignocelluloses "wastes" into biofuels such as ethanol will help reduce environmental pollution, contribute toward the mitigation of greenhouse gases emissions and serve as a sustainable solid waste management strategy.

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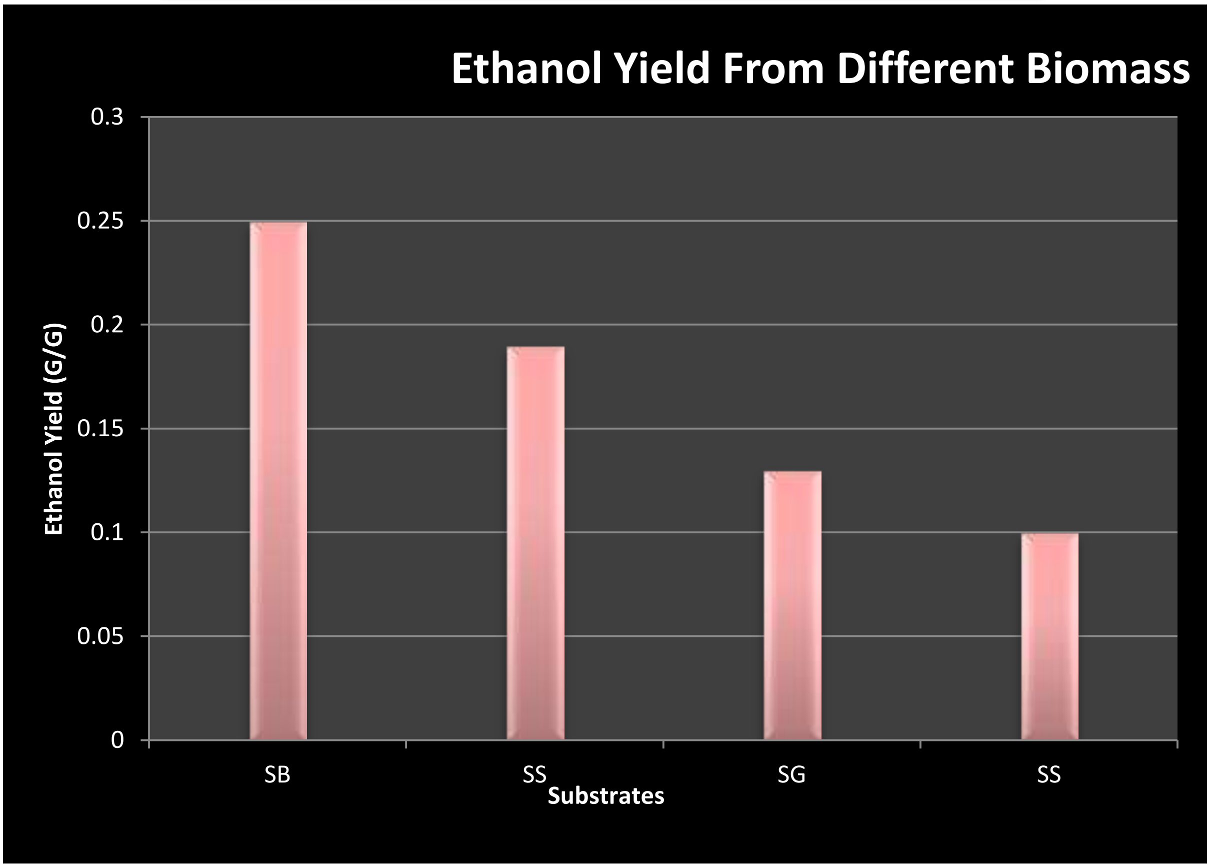

Table : The results of chemical properties test of bioethanol from various types of Biomass.

No.	Raw Material	Bioethanol Content (%vol)	Methanol content (mg/l)	Water content (%vol)	Cu content (mg/kg)	CI content (mg/l)	Gum content (mg/100ml)
1	Sugarcan Bagasse	94	0.0049	0.202	0.072	17.758	5.2
2	Sweet Sorghum	93	0.0088	0.653	0.052	39.547	3.4
3	Switch Grass	94	0.0013	0.684	< 0.01	35.354	6.5
4	Rice Straw	93	0.0052	0.353	0.095	19.651	4.5
5	Bioethanol Standard	99.5 min	300 max	1.0 max	0.1 max	40.0 max	5.0 max

Table. The results of physical properties test of bioethanol from various types of Biomass.

No.	Raw Material	pH value (mg/l)	Heating Value (kcal/kg)	Density (g/cm^3)	Viscosity (cSt)	Flash point (°C)
1	Sugarcane Bagasse	5.5	6786	0.858	2.762	15
2	Sweet Sorghum	7.8	5524	0.824	2.149	12
3	Switch Grass	6.3	5696	0.817	2.843	13
4	Rice Straw	5.8	6445	0.836	1.961	16
5	Bioethanol Standard	6.5-9.0	6380	0.789	1.525	12

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Based on the presented data, it is obvious that bioethanol can be an alternative solution for the current fuel issue. There has been significant progress in renewable biomass pretreatment, cellulose production and co fermentation of sugars (pentose and hexode) as well as bioethanol separation and purification in recent decades, but bioethanol (based on the production costs) is still not competitive (exception can be only bioethanol production from sugar cane in Brazil) to the fossil fuels. The biggest challenge remains how to reduce the production cost of bioethanol. Therefore, the biorefinery concept is needed to utilize renewable feedstock more compre-hensively and to manufacture more value-added co products (*e.g.* bio-based materials from the lignin) that would reduce the cost of bioethanol production. This will make bioethanol more economically competitive than the fossil fuels.

ENVIRONMENTAL BENEFIT / EMISSION REDUCTION POTENTIAL

Cellulosic ethanol has the potential to provide significant lifecycle GHG reductions compared to petroleum- based gasoline. In addition, the use of cellulosic materials to produce ethanol may yield a variety of other environmental benefits relative to corn-based ethanol.

Ghg Emission Reduction Potential

Researchers at the University of California at Berkeley estimated that on a life-cycle basis, cellulosic ethanol could lower GHG emissions by 90 percent relative to petroleum-based gasoline. Other analyses have shown that cellulosic ethanol produced using certain feedstock could be carbon- negative, which means that more carbon dioxide (CO_2) is removed from the atmosphere than is emitted into the atmosphere over the entire life-cycle of the product. However, these studies do not include estimates of emissions due to indirect land use change. Which can affect GHG emission profiles significantly? An analysis undertaken by the California Air Resources Board as it developed the California Low Carbon Fuel Standard found significant life-cycle GHG emission reductions from cellulosic ethanol relative to gasoline.

Other Environmental Considerations

Using biomass for transportation fuels raises questions regarding land use and land use change, fertilizer and pesticide use, water consumption, and energy used for production and cultivation of feedstock. Grasses and trees generally require lower inputs than other row crops such as corn. For example, grasses (e.g., switch grass) are perennial crops that do not need to be re-planted for up to 20 years. Both grasses and trees require fewer passes of field equipment compared to annual crops such as corn, and they generally have lower fertilizer and pesticide needs. In addition, cellulosic feedstock's can be grown on marginal lands not suitable for other crops, although in this case per acre yields can be lower than feedstock's grown on other lands. Feedstock's can also include a variety of residues (e.g., agricultural and forestry residues). Where agricultural and forestry residues are used, care must be taken to ensure long-term soil health.

CONCLUSIONS

According to the increasing demand for renewable energy resources, bioethanol is considered as one of the most suitable and economical future fuels. The environmental effects caused by the biomass can be decreased by utilizing them into useful products. Various pretreatment processes and strains of bacteria and yeast are used to convert biomass into bioethanol. For renewable processing of biomass or direct bioethanol production, the cost effective technologies are needed which need further research, development, demonstrations, and diffusion of commercialized new technologies. The conversion of biomass into bioethanol not only can accomplish the demand for energy resources but all have positive effects on the environmental and socioeconomic position of the country. The further research and technologies development are needed in the field of bioethanol production so that can replace the fossil fuel causing environmental and economic burdens.

Experiment data of production of ethanol from corn during the course of the literature was compared to the values for the production of ethanol from cellulose. It can be deduced from the data that from same mass of corn, more ethanol is produced using SHF (enzymatic though) and SSF. It is also seen that production of ethanol from cellulose is more costly compared to corn ethanol. Thus if ethanol is made from cellulose it will result in an increase in ethanol prices. Therefore, this will make the future of cellulosic ethanol very oblique. Fuel derived from cellulosic biomass is essential in order to overcome our excessive dependence on petroleum for liquid fuels and also address the build-up of greenhouse gases that cause global climate change. The conversion offers the potential for radical technical advancement through application of powerful tools of modern biotechnology to realize truly low costs However, if strict bans are made on the production of food ethanol, cellulosic ethanol will thrive well and costs of enzymes may fall. Also, a breakthrough in genetically engineering an organism that will directly convert cellulose to ethanol will be more desirable in the production of cellulosic ethanol. Bioethanol production from waste feedstock has been spurred by the recent global energy policies and fluctuating oil

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prices. Depending on the feedstock's and conversion technologies chosen, second (third)-generation bioethanol could offer a myriad of benefits, such as reduced GHG emissions, reduced competition with food production, soil conservation, carbon sequestration, water quality improvement, and habitat improvement. Several research groups have for decades studied the various aspects of developing novel and sustainable techniques for bioethanol production from several types of waste biomass, and they are still persistent in their efforts.

Obstacles to Further Development

Technological immaturity and high cost are two key barriers to cellulosic ethanol at present. Making this fuel competitive in the marketplace will require more experience and significantly reduced production costs, including capital costs. If the costs of cellulosic ethanol production come down as the technology matures, this fuel will still face some, although not all, of the obstacles that corn-based ethanol currently faces.

Flex-fuel vehicle deployment

Recent research indicates that current passenger vehicles may be capable of running on fuel blends containing up to 20 percent ethanol by volume (E20). Higher-level blends (up to E85) can be used by flex-fuel vehicles. Flex-fuel modifications are relatively inexpensive when made during vehicle production but retrofitting existing vehicles could be costly. As of 2008, an estimated 7.3 million light-duty E85 vehicles,23 or roughly 3 percent of the roughly 250 million passenger vehicles currently registered in the United States,24 were flex-fuel vehicles. Higher-level blends also require dedicated pumps to dispense the fuel. Currently most of the 1,600 stations with E85 dispensing capability are concentrated in the Midwest, where most ethanol production occurs.

Infrastructure requirements

Ethanol cannot be shipped in existing crude oil or petroleum fuel pipelines, because ethanol can absorb water and other impurities that accumulate in these pipes, affecting fuel quality, and because ethanol's corrosiveness can shorten pipeline lifetime. Instead, ethanol is currently transported via rail (60 percent of domestic ethanol shipped), truck (30 percent), and barge (10 Percent).26 Currently in the United States, cellulosic feedstock's can be most easily grown in the Midwest and Southeast, but much of the demand for transportation fuels is along the coasts. Thus, large volumes of ethanol may need to be shipped long distances to reach areas of high demand in the future. Without substantial infrastructure investment, increased ethanol shipping could result in significant bottlenecks on both rail and highway networks. These problems could be reduced by encouraging the use of high-level ethanol blends (i.e., E85) regionally instead of low-level blends (E10) on a national basis. Distributing and using ethanol close to where it is produced – i.e., in the Midwest and Southeast – would also minimize the GHG emissions associated with transporting ethanol.

Food versus fuel

Unlike corn ethanol (or ethanol produced from sugarcane), cellulosic ethanol does not necessarily compete with food markets for feedstock directly. However, the production of cellulosic crops is constrained by land availability, which is a limited resource. To decrease competition with other agricultural crops, cellulosic feeds tocks could be grown on degraded or marginal farmland unsuitable for production of food crops. However, doing so can decrease yields or increase input energy and fertilizer requirements, which could result in higher feedstock prices and increased GHG emissions.

Land use change

The production of fuels from biomass feedstocks has direct and indirect impacts on land use. For Example, clearing grasslands or forests to plant biofuel crops is direct land use changes that result in releases of carbon stored in soils and vegetation. Indirect land use change refers to the land use changes that result from the impacts on land and biomass prices due to increased demand for biomass for biofuel production and the interactions with ongoing demand for food, feed, and fiber products.

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