Research Paper Biotechnology

Bioethanol Production From Agricultural Wastes and Its Economical Impacts: Review

Mohd Nawaz Khan

Akhilesh Kumar Dwivedi S/O- SHRI GAUTAM DWIVEDI, "DWIVEDI-SADAN", BICHALI BAZAR , MAIRWA, POST- MAIRWA, DIST.- SIWAN (BIHAR)

Bharat Gupta

ABSTRACT

Agricultural wastes are produced during the production of agri products at pilot scale. These wastes are daily produced and get accumulated into the environment and these wastes contain different types of toxic compounds which could disturb the ecological balance by elevating the emissions of green house gases. Non renewable sources of energy are depleting at a very faster rate so these agriwastes could be an alternative source for the production of renewable energy (green energy). These wastes could be used as a primary raw material having less cost for the development of other products having a demanding economical value. Various processes like physical treatment and chemical treatment methods are involve in the production of bioethanol from agriwastes. The production of bioethanol has positive merits but still the researchers are focusing on different methods and techniques to offer bioethanol more economical value.

KEYWORDS : Agricultural wastes, bioethanol, methods, economical impacts.

Introduction

The world is facing a lot of crisis for fossil fuel because they are depleting at a very faster rate , resources such as petrol , diesel , natural gas have a very high consumption rate in different industrial sectors. The resources are being utilized in the production of industrial goods in different sectors **[1]** and as the utilization rate of non renewable resources are very high it is also affecting the environment by emission of green house gases **[2]**. The increase in human population drastically is another which affects the consumption of the fuel rate as the resources are being rapidly utilized globally in different industries **[3]**. Currently at present the only way to overcome this problem and to save worldwide future is to depend on the use of natural resources such as solar energy, water, and biomass which will not only solve the current problems but also will help in preserving the environment**[4]**. Currently the researchers are focused in developing biofuel from biomass for the production of green energy and they have found an alternative and highly efficient source which is bioethanol. Bioethanol has been defined by the scientists as an effective source for the production of energy in different industrial fields. Bioethanol is obtained by the fermentation of sugar with the help of microbes via enzymatic activity. Bioethanol is being currently implemented as a biofuel for the vehicles **[5] [6]**. Different renewable resources are being utilized for the production of bioethanol and currently agricultural wastes such as crop residues such as rice straw, corn straw, bagasse and sugarcane are being used because of their abundance and low cost value **[7]**.In this review different processes of bioethanol production and its impacts have been discussed.

Process &different methods involved in production of bioethanol

Pre-treatment

This method involves the breakdown or to decreased the solid property of cellulose thereby helping it become more amorphous making it more susceptible towards the enzymatic action **[8]**.

Physical treatment

Mechanical size reduction

It is the very first step and it involves the mechanical reduction of the agri wates by simply grinding and helpful in enhancing the efficiency of downstream process **[9]** and it involves consequent processes like wet milling , dry milling and compression milling etc. The power required for the reduction of the agri wastes depend on the nature of the wastes and it moisture content.

Pyrolysis

Pyrolysis or thermal cracking is the process which involves the treatment of the waste at an elevated temperature of 300^{0}C as result of which the cellulosic material get degraded very rapidly and leads to production of hydrogen and carbonmonoxide gas. The degradation process is slow and volatile products are formed **[10]** and the remaining solid carbonaceous matter is further treated by another process called leaching by the help of weak acid and the leached water have sufficient carbon for the optimum growth of microbes for the production of bioethanol.

Physiological pre-treatment

Autohydrolysis

It is one of the prominent method making biomass more and more susceptible towards the enzymatic action and this method does not implements any type of catalyst for the decomposition of the biomass into acid and alcohol (levulinic acid, xylitol). This method implements the use of high thermal energy at an elevated pressure for a lesser time interval and the reaction process is ceased by a sudden decrease in pressure and finally attains the atmospheric pressure **[11]**. The xylose recovery is very high so it's quite economical and also eco-friendly.

Liquid hot water

This process use hot eater liquid having pressure above the saturation point for the hydrolysis of the hemicelluloses materials. This process occurs at an elevated temperature ranging between 175^0 C -235^{0}C and pressure ranging between 4.8 MPa-5MPa for 20-30 minutes. This process leads to the formation of inhibitors compounds which inhibit the growth of micro-organisms. The xylose recovery is very high so it's quite economical and also eco-friendly **[12]**.

Chemical pretreatment

This method involves basically the utilization of acid or an alkali or other organic solvent, sulphur dioxide, carbon dioxide etc.

Acid treatment

Acid pretreatment is considered as one of the promising method which helps in production of more sugar from lignocellulosics. This method involves the use of concentrated or diluted acids (usually between 0.2% and 2.5% w/w) at high temperature ranging between 130 C and 210 C. Sulfuric acid is commonly utilized acid for the pretreatment method

among different types of acid such as hydrochloric acid, nitric acid and phosphoric acid . Acid pretreatment enhances the cellulosic hydrolytic activity.The acid activity is focused more on the polysaccharides, for example , hemicelluloses which easily undergoes hydrolysis than cellulose [13]. This method results in development of inhibitors which inhibit the growth of the micro-organisms. Higher hydrolysis activity from lignocelluloses was reported when preliminary treatment was carried out with dilute sulphuric acid when compared to other acids [14].

Alkaline pre treatment

Alkaline pretreatment involves the breakdowns of lignocelluloses and makes cellulose and hemicellulose susceptible for enzymatic breakdown **[15]**. This methods involves the lysis of the cell wall by solublizing hemicelluloses, lignin, and silica, by the hydrolysis action on uronic and acetic esters, and by enlarging cellulose volume and because of the enlargement of cellulose the crystal like property of cellulose get decreased Crystal like feature of cellulose is decreased due. By this process, the substrates could be broken down into alkali-soluble lignin, hemicelluloses and residue, which make it easier and simple to use them for production of economical products. This processes implements the use of low temperature and pressure with respect as compared to other methods.

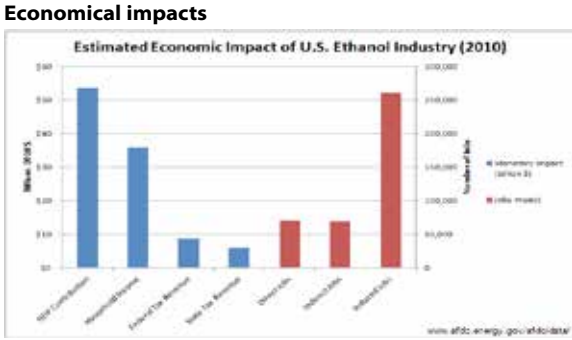
Biological pretreatment

It involves the breakdown of lignocellulosic material to produce cellulose with the help microbes for example brown rot, soft fungi and white rot. This process involves the breakdown of the hemicelluloses and cellulose and involves the white rot fungi which is very efficient microbe. This process is quiet safe and compensation of energy is less and this methods does not requires any types of chemicals but the rate of hydrolyzation in this process is quite slow which is negative impact of this method and limits it from being used [16].

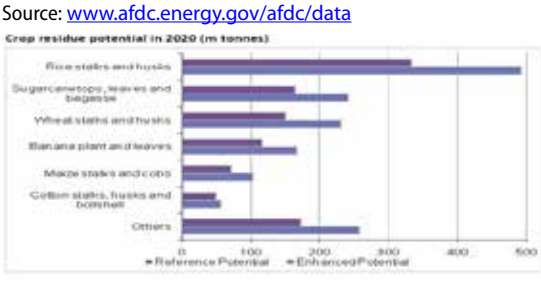
Enzymatic hydrolysis

This method involves a very crucial step called saccharification where carbohydrates (complex) by simple breakdown get converted into a monomeric form and thereby helping to produce bioethanol. This method utilizes gentle environment conditions and the requirement of energy is low **[17]**. Therefore this method is more preferred over other methods because no toxic compounds are formed, cheaper and no inhibitors are formed to affect the process.

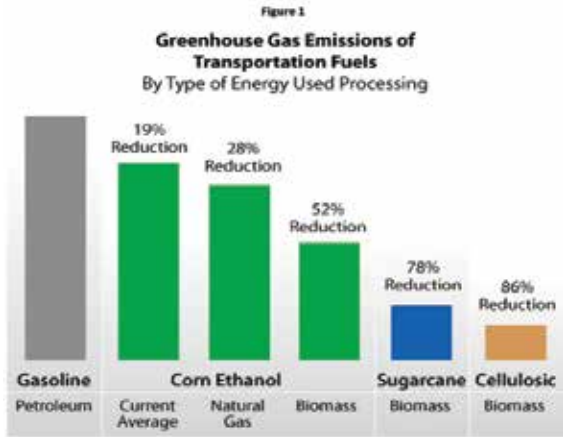
Economical impacts



Source: www.afdc.energy.gov/afdc/data



Source: Bloomberg New Energy Finance , UN Food and Agriculture organization



Source: www. snrecmitigation.wordpress.com

Conclusion

Bioethanol from agricultural wastes has the potential to replace fossil based petroleum, The commercial scale production of bioethanol requires careful consideration of several issues .The usage of bioethanol as a fuel resource provides dual benefit, i.e. biomass for the production of biofuels and also save our environment from air and water pollution and reduces the waste disposal problems by utilizing agri waste and flue gases for the growth. Different research is still being carried out for discovering more efficient method for bioethanol production.

References

1. Uihlein, Andreas, and Liselotte Schebek. "Environmental impacts of a lignocellulose feedstock biorefinery system: an assessment." *Biomass and Bioenergy* 33.5 (2009): 793-802.
2. **Ballesteros, Ignacio, et al. "Ethanol production from steam-explosion pretreated wheat straw."** *Twenty-Seventh Symposium on Biotechnology for Fuels and Chemicals*. **Humana Press, 2006.**
3. **Campbell, Colin J., and Jean H. Laherrère. "The end of cheap oil."** *Scientific American* **278.3 (1998): 60-5.**
4. **Lynd, Lee R., and Michael Q. Wang. "A product-nonspecific framework for evaluating the potential of biomass-based products to displace fossil fuels."-** *Journal of Industrial Ecology* **7.3-4 (2003): 17-32.**
5. **DEMİRBAŞ, AYHAN. "Bioethanol from cellulosic materials: a renewable motor fuel from biomass."** *Energy sources* **27.4 (2005): 327-337.**
6. **O'Rourke, T., T. Godfrey, and S. West. "Industrial enzymology." (1996): 103.**
7. **Kim, Seungdo, and Bruce E. Dale. "Global potential bioethanol production from wasted crops and crop residues."** *Biomass and Bioenergy* **26.4 (2004): 361-375.**
8. **Sanchez, Oscar J., and Carlos A. Cardona. "Trends in biotechnological production of fuel ethanol from different feedstocks."** *Bioresource technology***99.13 (2008): 5270-5295.**
9. **Sun, Ye, and Jiayang Cheng. "Hydrolysis of lignocellulosic materials for ethanol production: a review."** *Bioresource technology* **83.1 (2002): 1-11.**
10. **Mtui, Godliving YS. "Recent advances in pretreatment of lignocellulosic wastes and production of value added products."** *African Journal of Biotechnology* **8.8 (2009).**
11. **Balat, Mustafa, Havva Balat, and Cahide Öz. "Progress in bioethanol processing."** *Progress in energy and combustion science* **34.5 (2008): 551-573.**
12. **Taherzadeh, Mohammad J., and Keikhosro Karimi. "Pretreatment of lignocellulosic wastes to improve ethanol and biogas production: a review."***International journal of molecular sciences* **9.9 (2008): 1621-1651.**
13. **Cardona, C. A., J. A. Quintero, and I. C. Paz. "Production of bioethanol from sugarcane bagasse: status and perspectives."** *Bioresource technology***101.13 (2010): 4754-4766.**
14. **Mosier, Nathan, et al. "Optimization of pH controlled liquid hot water pretreatment of corn stover."** *Bioresource technology* **96.18 (2005): 1986-1993.**
15. **Pandey, Ashok, et al. "Biotechnological potential of agro-industrial residues. I: sugarcane bagasse."** *Bioresource technology* **74.1 (2000): 69-80.**
16. **Hamelinck, Carlo N., Geertje Van Hooijdonk, and Andre PC Faaij. "Ethanol from lignocellulosic biomass: techno-economic performance in short-, middle-and long-term."** *Biomass and bioenergy* **28.4 (2005): 384-410.**