# Lignocellulosic biomass as a sustainable solution for bioethanol production

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**Abstract:** In this modern era, technology has revolutionised the whole world. With the rise in the human population and increasing industrial affluence, to meet the global energy demand whole world is dependent on fossil fuels for deriving energy. These fossil fuels are non-renewable source of energy and are on the edge of depletion. Other problems associated with the use of fossil fuel based en energy are that it is harmful for the atmosphere and human health as well. This has attracted researchers towards the use of biomass feedstock for the production of ethanol that can be used as a substitute for petroleum products. Starch in the potato can be used for ethanol production and has shown a large potential market. Sufficient quantities of starch, cellulose, hemicellulose present in the potato peel can be pre-treated by various methods to yield fermentable sugars that ensure the use of potato starch as a potential feedstock for ethanol production. The *Saccaromyces cerevisiae* is used for the ethanol fermentation from the potato peels. FTIR and GC analysis are used to ensure the yield of bioethanol produced.

**Keywords:** Bioethanol, Potato, Fermentation, Yeast

**I. Introduction:** The drawbacks of fossil fuel based energy sources have put pressure on the society to search for renewable source of energy as a substitute to fossil fuels. One of the most important alternative fuels is bioethanol which can be obtained from biomass feedstock by implementing certain conversion technologies. Thus, now days the researchers are focussing on novel process technologies for the utilization of biomass to produce ethanol, optimization of fermentation technology and development of genetic engineered strains of bacteria and yeast, metabolic and enzyme technology (Ho *et al*., 1998; Arapoglou et al.,2010 ).

It is an organic material that undergoes combustion reaction and natural metabolic processes and release heat which can be used as a source of energy for running automobiles and other industrial processes. It has been more emphasised these days because of economical, ecological and environmental point of views (Balat et al.,2008; Chaturvedi, & Verma, 2013). The petroleum refinery, in which crude oil obtained from earth's crust by processing the fossil feedstock for the production of fuels such as petroleum and diesel, plastics, waxes, fertilizers, natural gas, coal and other petrochemical products, is not regarded as sustainable source of energy and is questionable because of various factors such as greenhouse emissions and declining fossil fuel reserves etc. consequently, major research emphasis now days is on the biofuel production in the context of biorefinery. In biorefinery agricultural feedstock, crops, lignocellulosic biomass, starch feedstock, algal biomass plant oil, animal fats, domestic and industrial waste are being utilized by the microorganisms for the production of biofuel, biogas, hydrogen and other biochemical (Cardona and Sanchez, 2007; Balat,2007)..

## 2. Biomass for ethanol production

On the basis of the feedstock used for the production of biofuel, there are four different generations of biofuels. The first generation of biofuel includes the utilization of vegetable oils, seeds, grains, sugars, starch such as wheat, barley, corn, potato. These first generation biofuels have potential to meet the global liquid transport fuel necessity set by the government but there are some factors that limit the use of these fuels as a substituent for the petroleum products (Sims *et al*., 2010) and also the economic growth of these fuels:

- The cost of production and processing of first generation of biofuels is very high and thus need government subsidies in order to compete with petroleum products.
- The substrates used for the generation of biofuel are edible and thus cannot be widely used as there is scarcity of food in some parts of the world.
- There is a competition for land and water that is being used for food and fibre production. (Searchinger *et al*., 2008, Fargione *et al*., 2008).

These limiting constraints of first generation biofuels have stimulated the research emphasis on the production of biofuels from lingo-cellulosic biomass such as forest products and residues, agriculture residues (barley straw, corn Stover, rice straw, wheat straw and bagasse), herbaceous and woody crops such as switch grass, poplar and willow. By applying various pre-treatment methods such as acid/alkali hydrolysis or enzymatic hydrolysis, these feedstock can be converted into bioethanol or butanol. Though these energy crops are still competing with food and fibre crops for the land on which it is grown but the energy yield is very high as compared to that of first generation biofuels. Also these crops do not require much amount of water and land with more amounts of nutrients and thus utilizing even the poorer quality land. But the production cost is still a major constraint in order to compete with petroleum products.

The third generation of biofuels utilize algal biomass and sea weeds as the substrate for the production of biodiesel, bioethanol or bio-butanol. These substrates have higher growth yield as compared with classical lingo-cellulosic biomass (Brennana and Owendea, 2010). These are used for the production of biodiesel as they have very high lipid content (Liang *et al*., 2009) but the major constraints are the geographical location and the large volume of water required to give high yield at the industrial scale.

The fourth generation of biofuels can be obtained from genetically modified carbon negative crops. This includes the metabolic engineering of algae that involves the cellular modification that will enhance the metabolism process and thus will lead to enhance biofuel production as compared to third generation biofuels (Lu *et al*., 2011).

Sarkar *et al*. (2012) have described four types of substrates for the production of bioethanol. These are cellulose, hemicellulose, lignin and protein. Cellulose is an unbranched, crystalline polymer composed of glucose monomers. It acts as an supportive material and provides strength to the cell walls. During hydrolysis it gets broken down and gives reducing sugars that can be utilized by microorganisms to produce ethanol (Hamelinck *et al*., 2005). Cellulose in embedded in hemicellulose which is a branched polysaccharide made up of xylose, arabinose, glucose, galactose and mannose. As compared to cellulose, hemicellulose is easily hydrolysed during pre-treatment methods (steam explosion, ammonia fibre explosion and acid pre-treatment) and yields D-xylose (Hamelinck *et al*., 2005).Whereas lignin is an amorphous hydrophobic polymer that made up of derivatives of phenyl propane. It gives chemical resistance to the cellulose and hemicellulose. During hydrolysis it yields ferulic acid, coumaric acid and vanillin (Lynd, 1996).

Various microorganisms are used for the biological pre-treatment processes to degrade lignin, hemicellulose, starch, lignocellulose etc. Microorganisms meet their energy demand by fermenting these available carbon sources to by-product such as Carbon dioxide, lactic acid and ethanol etc. Fermentation is the process in which there is the generation of energy with no electron transport mechanism (Shuler and Kargi, 2008).

**3. Conclusions:** Microorganisms used different pathways for fermenting sugar to form ethanol such as Yeast uses the Embden-Mayerhof Pathway whereas bacterium *Zymomonas mobilis* follow Entner-Doudroff Pathway . The most common yeast used in the fermentation industry is *Saccharomyces cerevisiae*. But *S. cerevisiae* is not able to degrade lignocellulosic and starch material. To solve this problem hydrolysis is done before fermentation process that converts the unfermentable sugars to glucose by hydrolysing enzymes. For hydrolysis mixed cultures or genetically engineered microorganisms can be used that will enhance the ethanol yield and assimilate pentose. The transformed *Saccharomyces spp*. having recombinant plasmid gene of dehydrogenase for xylose reductase and xylitol from *Pichia stipites* and xylulokinase gene from *S. Cerevisiae*. Co-fermentation of xylose and glucose can be done by this method.

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