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Lignocellulosic Biomass as Feedstock: An Insight into Research and Studies

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Abstract

Chemical engineering has become diversified field. It deals with energy and heat recovery, fluid dynamics, optimization, simulation, process integration, process intensification, biochemical engineering and enzyme and catalysis. The reduction in cost of the process by technology is many time off set by environmental impacts. The research and studies in the chemical engineering and related areas are focused on clean technology and energy savings. Use of raw feed stocks for production of various compounds is one of the widely studied areas of research. There is huge potential for cost reduction in the manufacture of chemicals and compounds like amino acids, glucose, lactic acid, citric acid etc. Lignocellulosic biomass is potentially very beneficial feed stock for synthesis of many compounds. Current review summarizes research and studies on use of various lignocellulosic feed stocks.

Key Words: **Biomass, Feedstock. Fermentation, Pretreatment, Yield**

INTRODUCTION

Waste minimization and energy saving are two important aspects of research carried out in chemical engineering and technology. The process intensification aims at reducing space, energy and cost the processes [1-4]. Various techniques such as hydrotropy, reactive distillation, reactive chromatography, and reactive adsorption are being investigated and even used for some specific processes [5-7]. The energy saving studies includes pinch analysis, heat integration and use of nonconventional energy sources. These non-conventional energy sources include solar, tidal and wind energy [8, 9]. Modeling, optimization and simulation can reduce the time and energy [10].

The waste minimization can be carried out by using various anaerobic methods, vermicomposting and incineration [11-13]. The use of raw feed stocks for synthesis of various chemical serves two purposes. Firstly, it minimizes solid waste. Secondly it provides alternative cost and energy effective method for manufacturing of some compounds. Compounds like citric acid, lactic acid, amino acids, can be synthesized from different feed stocks [14-17]. Other compounds like ethanol, starch, glucose, vinegar can also be synthesized from raw feed stoks[18-23]. Immobilization make the bio synthesis from enzyme catalyzed reaction more efficient [24, 25].The current review is focused on use of Lignocellulosic biomass as feed stock for synthesis of various compounds.

STUDIES AND RESEARCH ON LIGNOCELLULOSIC BIOMASS AS FEED STOCK

Limayem et.al. carried out review on use of lignocellulosic biomass for bioethanol production [26]. According to them cellulosic-derived biofuel is promising technology. They presented steps involved in cellulosic-based bioethanol processes and overview of various methods. They also discussed various feed stocks such as Forest woody feed stocks, Agricultural residues, herbaceous and municipal solid wastes (MSW), and Marine algae along with Lignocellulosic biomass. The bioethanol production from food stocks like corns can cause food related issues. Houghton et.al. carried out an investigation on bioethanol production from sugar feed stocks [27].

According to them biotechnology is replacing thermochemical technology in most of the starch processes. According to them, due to inhibitory products and low conversion rates, starch solution with lower quality was produced and low yield was obtained when further fermented to ethanol. Recently, development of thermostable high-productivity enzymes has enabled better results. Sedlak et.al carried out an investigation on developing genetically engineered Saccharomyces yeasts capable of cofermentation [28]. They carried out an investigation on cellulosic biomass hydrolysates and genetically engineered Saccharomyces Yeast for co-fermenting glucose and xylose. Groves carried out studies on optimization of ethanol fermentation process for bioethanol production from starch [29]. They carried out a series of fermentations and growth studies. They also tested Hardwood (aspen), softwood (balsam), and herbaceous (switchgrass) hydrolysates for the effect of the source of the feedstock. They found that *S.* cerevisiae (ER) was not able to utilize all the sugars found in hemicellulose. So it was used in pretreatment step. They also tested furfural and acetic acid for inhibitory effects. They tested three substrate media namely Yeast Peptone (YP), Yeast Nitrogen Base (YNB), and Corn Steep Liquor. The corn steep liquor was slightly better with higher ethanol yields than other fermentation media. Khan and Dwivedi carried out review on fermentation of biomass [30]. Their studies were focused on ethanol production. They studied the processes used for ethanol production from various materials such as sugar beets, sugar cane corn, wheat, barley. Starch or cellulose like materials which can be easily converted into sugar can be used for ethanol synthesis. S. cerevisiae, in many investigations was found to be better microorganism.

Madson and Tereck carried out an investigation on ethanol production from lignocellusosic biomass [31].According to them, primary and secondary lignocellulosic wastes and biomass can be effectively used for ethanol production. They observed that the production of ethanol from a variety of feedstocks including biomass is becoming promising with recent advances in gas phase fermentation via selected bacteria and new gasification technology. A review was carried out on pretreatment of lignocellulosic biomass by Brodeur et.al.[32]. In the use of lignocelluloses biomass, it is important to overcome resistance of plant cell walls to deconstruction. A matrix of polymers-lignin and hemicelluloses and the highly crystalline structure of cellulose cause recalcitrance. For the biomasses such as wood, grasses, and corn, pretreatment is important step for overcoming the recalcitrance.

Brescia et.al. carried out an investigation on enzyme glucose production from glucose feedstock[33].According to their opinion, the enzymatic determination of glucose was a specific, sensitive and rapid mean for glucose quantification. Naik et.al. carried out a review on the biofuel production[34]. Safe, sustainable resources of energy are most important for sustainable economic and industrial growth. The first generation biofuel caused stress on food commodities. Second generation biofuel includes bioprocessing including pyrolysis, Fisher Tropsch, and other catalytic processes. Their review was focused on cost effective technologies and the processes to convert biomass into useful liquid biofuels.

Kumar et.al. carried out studies on pretreatment of the biomass for hydrolysis and ethanol or biofuel synthesis[35]. According to them the hydrolysis of lignocellulosic biomass is often hindered by physicochemical structural and compositional factors. Pretreatment steps like alkali treatment, ammonia explosion can be used to make cellulose easily available for hydrolysis. There are different pretreatment technologies, which are effective for different biomasses. It means the pretreatment technology which is effective for one biomass not necessarily is effective for other biomasses. They observed that the acid or water impregnation followed by steam explosion for barley wheat straw yielded better results.

Zhao et.al. carried out investigation on use of lignocellulosic biomass for ethanol production[36]. In their paper, they reviewed cutting edge progress in bioethanol. They discussed major steps in bioethanol production like pretreatment technologies, enzymatic hydrolysis. To make the bioethanol from biomass, more feasible process, it is envisaged to have research and relentless efforts focused on various aspect of the process. Mast et.al. carried out studies on characterization of different biomasses[37]. The focus of their studies was on sugar profile and characterization of different biomasses. They analyzed 28 biomasses for microbial lipid production. They evaluated the production costs and energy demand of the feedstock production. They observed that out of 28 biomasses, 9 biomasses were suitable.

Mutalik et.al. carried out an investigation on hydrolysis of lignocellulosic feed stock[38].They used Ruminococcus albus for bioethanol production. It was isolated from rumen of herbivorous animals. They observed that optimum temperature; pH and substrate concentrations were 39^{0}C, 8.8 and 3.5 percent respectively. Demers et.al. carried out enzymatic hydrolysis of cellulosic biomass[39].They used the Apple pomace left over from the apple pressing process as substrate. They first carried out conversion of cellulosic biomass into fermentable sugars. Then cellulosic ethanol was synthesized. They observed that a feed stock pretreatment step yield better results than synthesis without pretreatment.

CONCLUSIONS

The use of raw feed stock partially solves the problem of solid waste management. Various compounds can be synthesized by using these feed stocks. The proper pretreatment of the feed stock can increase the yield and make the process more effective. The synthesis of oxalic acid, glucose and other sugar based compounds is widely investigated and practiced method. It can be concluded that improvement in pretreatment technology and effective and suitable process pathways provides huge scope for research on this technology.

CONFLICT OF INTEREST: None

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