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Bioethanol production from renewable raw materials wheat straw and waste vegetables

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Abstract- Bioethanol significantly contributes to the reduction of crude oil consumption and environmental pollution and has been identified as the mostly used biofuel worldwide. It can be produced from various types of feed stocks such as sucrose, starch, lignocellulosic and algal biomass through fermentation process by microorganisms. *Saccharomyces cerevisiae* is the common microbes employed in ethanol production due to its high ethanol productivity, high ethanol tolerance and ability of fermenting wide range of sugars, compared to other types of microorganisms and yeasts. Yeasts can directly ferment simple sugars into ethanol while other type of feedstocks must be converted to fermentable sugars before it can be fermented to ethanol. The common processes involves in ethanol production are pretreatment, hydrolysis and fermentation. The efficiency and productivity of ethanol can be enhanced by immobilizing the yeast cells. This review highlights the different types of yeast strains, fermentation process, factors affecting bioethanol production and immobilization of yeasts for better bioethanol production.

Keywords:- ***Saccharomyces cerevisiae,*** **bioethanol, waste vegetables, wheat straw,**

INTRODUCTION

In today's modern society global economic growth contributes to a rapid increase in the consumption of traditional energy sources. According to numerous energy consumption analyses, the progressing depletion of fossil fuels calls for new initiatives on the market of renewable energy. Biomass today is regarded as one of alternative energy sources.[1,2] At present, only about 5 billion out of 150 billion tons of biomass harvested each year are processed into food. Biomass is not used for energy generation to the extent permitted by the existing technology.[3,4,5] Renewable energy sources today are becoming increasingly important in the energy balance of the country, and they are a characteristic feature of innovative and forward-looking economies (Kogut *et al.* 2012)[6]. There are various steps that can be enhanced for energy generation from biomass by combustion, gasication, ethanol and methanol fermentation or by using oilseed crops as a source of fuel. According to Nguyen *et al.* (2013)[7], energy generated from straw by gasification seems to be more environmentally-friendly than that produced by straw combustion. The combustion of fossil fuels produces harmful emissions to ambient air, mainly CO_2, which contribute to the greenhouse effect leading to global warming[8]. Thus the use of straw acts as an alternative source of energy that could reduce global

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warming and the depletion of fossil fuels[9,10]. The energy value of two tons of wood or straw is equivalent that that of one ton of high-quality hard bituminous coal.

One of the methods of generating energy from biomass is alcoholic fermentation. Simple sugars are converted into ethanol by yeasts[11-12] and these steps have been taken since generations. Ethanol is dehydrated and used to enhance or substitute Petroleum[13-14]. A variety of feedstocks from the first, second and third generation has been used in bioethanol production. Second-generation bioethanol comes from lignocellulosic biomass such as wood, straw and grasses. The first-generation bioethanol involves feedstocks rich in sucrose (sugar cane, sugar beet, sweet sorghum and fruits) and starch (corn, wheat, rice, potato, cassava, sweet potato and barley). The use of bioethanol can reduce our dependence on fossil fuels, while at the same time decreasing net emissions of carbon dioxide, the main greenhouse gas[1,2]. However, large-scale production of bioethanol is being increasingly criticized for its use of food sources as raw material.

Microorganisms such as yeasts play an essential role in bioethanol production by fermenting a wide range of sugars to ethanol. They are used in industrial plants due to valuable properties in ethanol yield (> 90.0% theoretical yield), ethanol tolerance (> 40.0 g/L), ethanol productivity (> 1.0 g/L/h), growth in simple, inexpensive media and undiluted fermentation broth with resistance to inhibitors and retard contaminants from growth condition. To obtain efficient ethanol fermentation with *S. cerevisiae*, numerous nutrients, including trace metals and vitamins, are required during the process[15-16]. Chemicals contribute significantly to the cost of large-scale production although it was not in the scope of this study to investigate this, their use should thus be minimized. Wheat hydrolysate, which is relatively cheap compared with chemicals, has been proven to be a potential supplement for lignocellulosic hydrolysate, because it is not only a sugar-containing material, but is also a complex nutrient source [17-18]. The production cost of ethanol is not only dependent on the yield but also on the concentration of ethanol in the fermentation broth, because of the high energy demand in the distillation step to obtain efficient ethanol from fermentation with *S.cerevisiae* numerous nutrients such as metals and vitamins are required during the process. Chemicals really lead to significant increase in the large scale production of ethanol. To obtain efficient ethanol fermentation with *S. cerevisiae*, numerous nutrients, including trace metals and vitamins, are required during the process. Chemicals contribute significantly to the cost of large scale production[20]; although it was not in the scope of this study to investigate this, their use should thus be minimize

MATERIALS & METHODS

Ethanol (also called ethyl alcohol, grain alcohol, drinking alcohol, or simply alcohol) is a chemical compound, a simple alcohol with the chemical formula C_2H_6O. Its formula can be also written as CH3"CH_2"OH or C_2H_5OH (an ethyl group linked to a hydroxyl group), and is often abbreviated as EtOH. Ethanol is naturally produced by the fermentation of sugars by yeasts or via petro chemical processes, and is commonly consumed as a popular recreational drug. The present project was conducted to evaluate sacchrification and fermentation (SSF), SPWS and presacchrified wheat meal of several cellulose material .

Raw Material used

Corn grain: Corn grain such as wheat straw and waste vegetables was obtained from the local markets and main sabzi mandi of Madhepura city and then stored at room temperature before pretreatment.

Saccharification and Enzymatic hydrolysis

The wheat straw was impregnated with a weak sulfuric acid solution and then squeezed using a hydraulic press. The pressed material was pretreated in a steam pretreatment unit and the whole slurry was then mixed with the PWM. The two materials were mixed in different proportions to investigate the effects on the ethanol yield and the ethanol concentration α-Amylase α-Amylase amylolytic were the major enzymes that were used for starch liquefaction and saccharification, respectively. The wheat straw was immersed in an aqueous solution of 0.2% H_2SO_4 at a liquid: dry straw weight ratio of 20. It was stored in sealed buckets for 1 h, and was then squeezed in a manual 3 L press to an average dry matter content of 43%. Steam pretreatment was performed in a unit described previously comprising a 10 L pressurized vessel, with a flash cyclone in which the pretreated material was released and collected. Previously optimized conditions for wheat straw were used; that is, the temperature was maintained at 190°C for 10 min using saturated steam. Each batch that was fed into the reactor was 600 g wet weight. The steam-pretreated wheat straw (SPWS) was then subjected to SSF. The fermentor was loaded with the SPWS and the nutrients, which were sterilized separately at 121°C for 20 minutes, but the PWM was not sterilized because the starch and the enzymes already added would have been damaged at these conditions. SSF was performed at 36.5°C, and the pH was maintained at 5 ± 0.2 by addition of 10% NaOH solution. The experiments were run for 72 h in the case of pure PWM, and for 96 h in the case of SPWS or mixtures of the substrates. Saccharification of the raw material was conducted according to Guo *et al.* (2008)[20] with some modifications.

RESULT & DISCUSSION

The ethanol yields were calculated as a percentage of the maximal theoretical yield for glucose (0.51 g/g) that could have been produced if all the glucose present in the slurry and the PWM, including both monomers and oligomers in the liquid and glucan fibres in the WIS, had been converted to ethanol. The highest yield was obtained when equal amounts of PWM and SPWS were used. Thus, a mixed substrate is favorable in terms of final ethanol yield, probably due to the stress on *S. cerevisiae* caused by weak acids present in SPWS. At the same time, it is also easier to reach a high ethanol concentration using such as mixture than when using wheat straw only as a raw material.

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