World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(RESEARCH ARTICLE)

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Bioethanol production from banana peels

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World Journal of Biology Pharmacy and Health Sciences, 2023, 13(01), 440–444

Publication history: Received on 16 December 2022; revised on 22 January 2023; accepted on 25 January 2023

Article DOI: https://doi.org/10.30574/wjbphs.2023.13.1.0049

Abstract

Banana varieties have a significant effect on the reducing sugar content in the peel. In recent years, potential efforts have been directed towards the utilization of cheap renewable agricultural resources, such as banana peel waste as alternative substrate for ethanol production. Various conversion pathways are compared from technical, economic, and environmental points of view. This study also deals mainly with the yield of ethanol from molasses with respect to the dilution ratio and the amount of yeast used for fermentation keeping the temperature and fermentation duration constant. This fuel energy is also a safer substitute to methyl tertiary-butyl ether (MTBE), a common additive used in gasoline for clean combustion.

Keywords: Banana Peels; Bioethanol; Fermentation. Hydrolysis; Pretreatment. S. cerevisiae

1. Introduction

Recently the demand of ethanol has increased considerably because of the use of gasohol in addition to their applications in industries which needs production of alcohol on large scale [1]. Fossil fuels are the major source of energy worldwide. The use of fossil fuel is associated with global warming, climate change, and a variety of energy and security problems. Moreover, fossil fuel is non-evenly distributed within nations, and equally non-renewable. Bioethanol, an ethanol liquid that is known to be a clean fuel for combustion engines, is a readily available substitute since it can be derived from plant based materials. The total consumption of bioethanol in 2008 was more than 65,000 million liters and the usage is growing rapidly because it has already replaced 5.4 % gasoline usage in 2013. The use of bioethanol as an alternative either as an octane enhancer or main fuel tend to reduce the problems associated with fossil fuels [2] [3].

It has been realized that fossil energy causes greenhouse gas emissions that have adverse effect on the environment. Burning of petroleum-based fulse causes the increase of co_2 level in the environment which is directly responsible for global warming [4]. Another important concern of fossil fuel reliance is the political crisis. For example, inicidence of oil supply disruption by the middle east countries in the 1970s caused unrest essential sector [5] .

Ethanol also called alcohol is a colourless, flammable, volatile liquid with a molecule formula of C_2H_6O. It has a molar mass of 46.07 g/mole, a density of 0.789 g/cm3, a melting point of −114 °C, and a boiling point of 78.37 °C. It is widely used as a solvent, a fuel, and as a raw material for the production of other useful chemicals that have wide applications in the industry. It is also consumed as alcohol beverage, for household heating, and applied as an antiseptic. It is produced from ethylene hydration and fermentation of sugars, starch, lignocellulosic materials, or hydrocarbon-based ethanol production. The use of lignocellulosic biomass for bioethanol production is a recent alternative with great promise and still under research [7,8].

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Conversion of cellulose polymer to ethanol involves two different processes 1. Converting cellulose to glucose units via hydrolysis and the sugars produced from the hydrolysis process can then be converted to ethanol by 2. Fermentation using Saccharomyces cerevisiae. Pre-treatments are normally applied to separate the mixed polymers of lignin, hemicellulose and cellulose to provide the sugars needed for the hydrolysis and the fermentation processes [9]. The basic steps involved in the conversion of lignocellulosic biomass to ethanol are shown in chart 1.

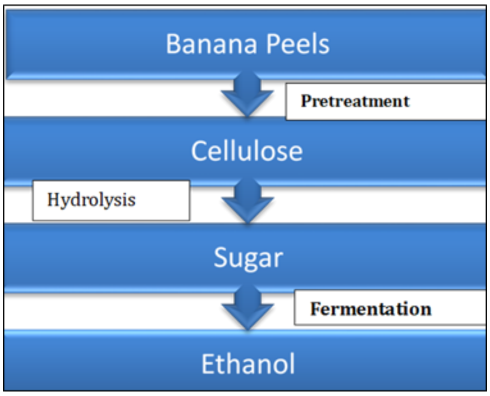

Figure 1 Steps involved in the conversion of lignocellulosic biomass to ethanol

Table 1 Plant profile

Scientific classification	
Kingdom	plantae
order	Zingiberales
family	*Musaceae*
genus	*Musa*

2. Material and methods

Waste banana peels were collected from local market. Peels were washed with the help of distilled water and chopped into small pieces.

2.1. Methodology

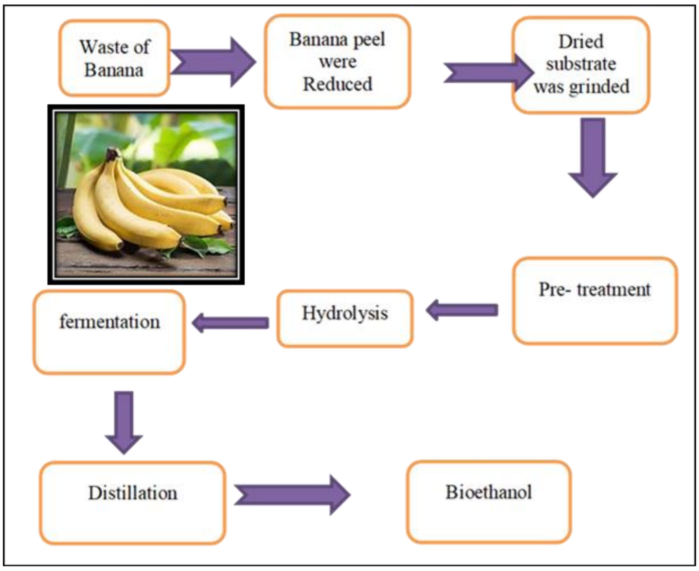

Figure 2 Flow Chart for Methodology

2.2. Pretreatment of Banana Peels

Fresh banana peels were cut into small pieces of sizes between 4cm to 5 cm. The cut pieces were next washed with water to remove undesirable particles followed by drying operation in hot air oven for a period of 24 h at 65o C. The peels were next grounded using mortar-pastle to powdered form. In a test tube, 2g of ground sample was taken and 10 ml distill water was added to it and the solution was then boiled for 10 min. Next, a 5ml sample of this liquid was taken and the glucose content was estimated based on standard techniques using a UV spectrophotometer. Sample contained maximum initial glucose concentration of 0.32 wt/vol % or 3.2g of initial sugar per 100g of peel. This sample of banana peel was then used for the acid hydrolysis experiment.

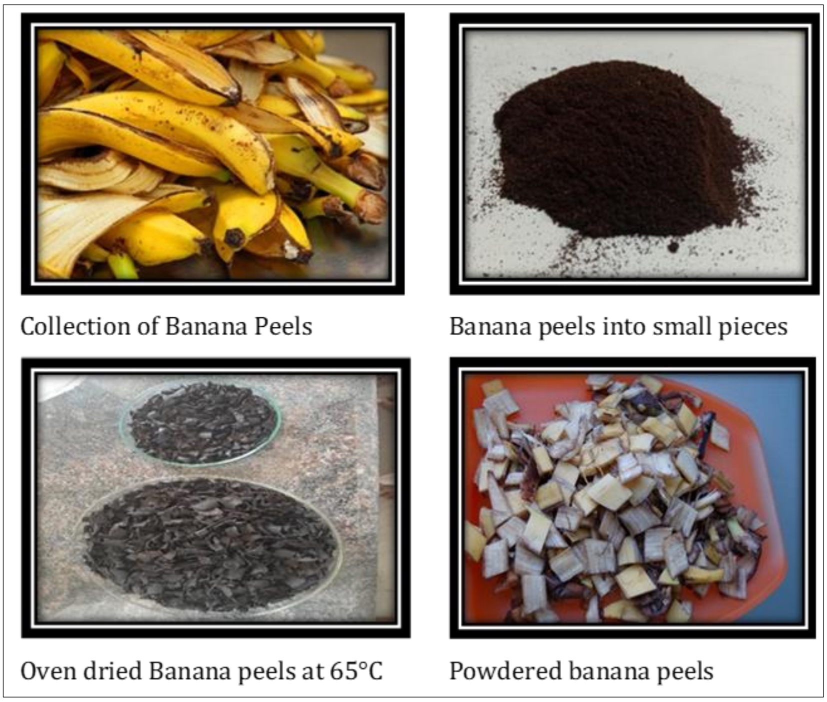

Figure 3 Stepwise Procedure

2.3. Acid Hydrolysis

Since banana peels contain both starch and sugar, in order to increase the yield of ethanol, the starch was hydrolyzed to convert it to sugar and afterwards, the total fermentable sugar was converted to ethanol. 5 g of ground peels was taken in a 150 ml conical flask and 50 ml 4 (N) HCl was added to it. The solution was heated in a water bath for 10min, 20min, 30min, 60min, 75min and 90min. Table 1 shows the amount of glucose liberated in different interval of time, revealing the comparative increase in glucose level after acid hydrolysis. Temperature maintained was 80ºC to 100ºC. The hydrolyzed sample was cooled to room temperature. The cooled sample was filtered using a filter paper.

Table 2 Glucose Concentration After Hydrolysis

Sr.no	Time(min)	Glucose (W/V)
1	10	0.32
2	20	0.70
3	30	0.75
4	60	0.79
5	75	0.80
6	90	0.80

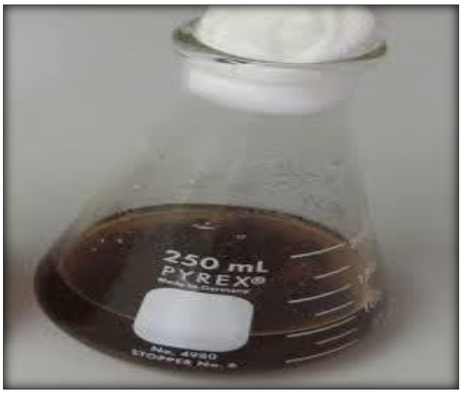

Figure 4 Hydrolysed Banana Peels Solution

2.4. Processes of ethanol production

The raw materials that contain sugars, or materials which can be transformed into sugars, can be used as fermentation substrates. The fermentable raw materials can be grouped as directly fermentable sugar materials, starchy, lignocellulose materials and urban or industrial wastes. Sugar containing materials require the least costly pretreatment, where starchy, lignocellulose materials and urban/industrial wastes needed costly pretreatment, to convert into fermentable substrates (Sun and Cheng, 2002).

Sugar containing materials which can be transformed into glucose, can be used as fermentation substrates under anaerobic conditions, glucose is converted to ethanol and carbon dioxide by glycolysis. The phosphorylation of carbohydrates is carried out through the metabolic pathway and the end products are two moles of ethanol and carbon dioxide. Although fungi, bacteria, and yeast microorganisms can be used for fermentation, specific yeast (S. cerevisiae also known as Bakers' yeast, since it is commonly used in the baking industry) is frequently used to ferment glucose to ethanol.

Theoretically, 100 g of glucose will produce 51.4 g of ethanol and 48.8 g of carbon dioxide. However, in practice, the microorganisms use some of the glucose for growth and the actual yield is less than 100% (Lin & Tanaka, 2005). Ethanol production from grain involves milling of grain, hydrolysis of starch to release fermentable sugar, followed by inoculation with yeast. Chemically starch is a polymer of glucose (Marina et al., 2009).

Yeast cannot use starch directly for ethanol production. Therefore, grain starch has to be wholly broken down to glucose by combination of two enzymes, viz., amylase and amyloglucosidase, before it is fermented by yeast to produce ethanol.

Alcohol produced from fermented broth and remaining spillages is processed to produce Distiller's Dried Grain and Soluble (DDGS), which is an excellent ingredient for animal feed.

3. Results and discussion

The result of the investigation showed that, the fermented banana peels produced a 45% of ethanol obtained at 1.55v/v acid concentration. The solution was kept for 7-8days for the production of ethanol, regularly note down the changes. The required for the fermentation process decreases dramatically with increase in the concentration of yeast. The Bioethanol estimation done by potassium dichromate method (Five different test tubes were taken and to each test tube ethanol is added in the increasing concentration and then 2ml of potassium dichromate solution is added to each test tube and Shaked well. Incubate it for 20min in room temperature and check for O.D. the graph was plotted concentration versus O.D).The graph was plotted ethanol concentration versus O.D and by graph obtained the percentage of bioethanol is 6.5%

4. Conclusion

The work reveals the possibility of producing bioethanol from fermentation of banana peel and which may serve as cheap alternative source of fuel and energy generation. The use of banana peel is means to reduce the pollution and biological conversion of cellulose to fermentable sugar for the process of bioethanol which ecofriendly.

Compliance with ethical standards

Acknowledgments

I take it as a privilege to sincerely express my gratitude to Prof. Ms. Rutuja Santosh Gaikwad, Samarth Institute of Pharmacy, Belhe for valuable guidance, support and encouragement.

I would like to express my warm thanks to my friends especially, Ms. Kandhare Komal, Mr. Kate Vikas ,Mr. Sherkar Shubham and Mr. Kale Sujit for their strong Support and valuable suggestions. They was a critical reviewer as well as a best friend who was always there with me in my thick and thins. Who helped me in every aspect of encouragement.

Disclosure of conflict of interest

No conflict of interest.

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