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Production Of Bio Ethanol from Banana Peel and Pineapple Peel Through Fermentation

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ABSTRACT
Many countries have their biofuel policy programs in place as part of their overall strategy to achieve sustainable development. Among biofuels, bioethanol as a promising alternative to gasoline is of substantial interest. In the present study Banana peel and pineapple peel are used as raw material for the production of bio ethanol with the help of Yeast Saccharomycescerevisiae. In my study, bio ethanol was produced by using pretreatment techniques namely, alkaline and acidic pretreatment on the production of bio ethanol from banana peel and pineapple peel. We applied the hydrolysis process for both sample by using H_2SO_4. Then with the help of fermentation process is use to produce bio-ethanol. The yeast Saccharomycescerevisiae is use to convert the reducing sugars to bioethanol via three day fermentation process. The bioethanol concentrations detected by Gas Chromatography Flame Ionization Detector (GC-FID) from the water and conducting emission test of bio-ethanol. However, the production of bioethanol from food crops needs to be regulated to ensure food security, and requires border analysis to migrate economic and environmental risks.
Keywords : Bioethanol, Banana Peel, Pineapple Peel, Production

I. INTRODUCTION

The world is in urgent need to resort an alternative energy sources due to the rapid exhaustion of the world's energy supply.The inevitability of the oil depletion, global warming and the greenhouse effects put the earth on an alarming condition..Due to increased pollution and global warming, the research has been moved towards the development of alternative fuel that is eco friendly.

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. As depletion of world's fossil fuel happened, the prices of fuel continue rising up and the pressure for oil independence and environmental concerns creating a strong market for biofuels.The use of bioethanol as an alternative either as an octane enhancer or main fuel tend to reduce the problems associated with fossil fuels. However, deriving bioethanol from food sources is not a viable alternative, because we have to make the choice between food and ethanol. Lignocellulose biomass is a sustainable alternative that produces new-generation bio-based chemicals, such as biofuels, food additives, enzymes, and others,Lignocellulose biomass includes all kinds of agricultural wastes, forestry residues, and feedstock, as well as marine algae, and it can be provided on a large-scale platform from all kinds of materials [4,5]. In general, lignocellulose biomasses consist of lignin, cellulose, and hemicelluloses, some organic extracts and inorganic components, which are turned into ash after combustion.Most of the previous research studies reported that bioethanol used instead of fossil fuel can reduce the emission of greenhouse gases. Rajendran (2013) reported that life cycle, economic, environment and energy assessment provide policy for the use of energy. Mostly, any plants that are producing large amount of sugar used as raw materials to produce an ethanol. For instance, potato, sugarcane and pineapple are one of example of fruits and vegetables that produce high yield of bioethanol as byproduct due to high amount of sugar contain in it. Usually, bioethanol are produce in 3 ways which are firstly sugar directly convert into ethanol through fermentation process; next, starch are hydrolyze by specific enzyme into small molecules which is sugar and undergo fermentation process resulting in an ethanol solution as final product; lastly cellulose and hemicellulose was run into a specific process in order to produce ethanol production.Use of biofuel has become very important due to depletion of fossil fuel and necessary to protect to environment from greenhouse emissions. Furthermore, exhaust gases of ethanol are much cleaner. It has been reported earlier that use of 85% ethanol and 15% gasoline reduced the emissions of greenhouse gases around 38% compared to fossil fuel. This study will give more knowledge on potential bio-ethanol that can be produce for scientific community and public to further studies regarding bio-ethanol production from wastes.Fruits and vegetables produce a significant amount of solid waste. Management of solid waste had become a greater concern because open dumping of solid waste is creating environment problem. From our online observation, research journal according to this topic mostly came from Africa and India. The bioethanol production from fruit and vegetable waste using S. cerevisiae less explored in Malaysia. The scientific community and public have less information about fruit and vegetable waste can produce bioethanol through fermentation technology.

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 lignocelluloses biomass to ethanol.

There are limitations to the production of bio ethanol from lignocelluloses materials, these limitations range from the choice of pre-treatment, hydrolysis, and fermentation technologies, to the economic and commercial scale application of the resource.

Despite the presence of different pre-treatment techniques, not all are suitable for different classes of lignocelluloses biomass. In my study alkaline pre-treatment is used for the further process. Pre-treatment is the processes that are used to remove impurities from fibres or fabric to make it dye able or printable. After pre-treatment the study moves on towards next process called filtration.

Filtration involves the separation, removal, and collection of a discrete phase of matter existing in a dispersed or colloidal state in suspension. After filtration process yeast is added for fermentation to producing bio ethanol as an alternative fuel.

There are four types of yeast are used for fermentation process. They are (1) Active Dry Yeast (2) Fresh Yeast (3) Instant Yeast (4) Rapid Dry Yeast. In my study active dry yeast is used, Active dry yeast is the most common type of yeast in stores, and you'll find that this yeast is ideal for most types of bread. In fact, most bread recipes will call for active dry yeast unless otherwise specified. Resembling small granules, this yeast will activate once placed in water.

Fermentation process is the last stage of production; Fermentation is **a** metabolic process that produces chemical changes in organic substrates through the action of enzymes. In biochemistry, it is narrowly defined as the extraction of energy from carbohydrates in the absence of oxygen.

Response surface methodology (RSM) is a collection of statistical and mathematical techniques used for the purpose of. Setting up a series of experiments (design) for adequate predictions of a response. Fitting a hypothesized (empirical) model to data obtained under the chosen design. In statistics, response surface methodology (RSM) explores the relationships between several explanatory variables and one or more response variables. The method was introduced by George E. P. Box and K. B. Wilson in 1951. The main idea of RSM is to use a sequence of designed experiments to obtain an optimal response. Box and Wilson suggest using a second-degree polynomial model to do this. They acknowledge that this model is only an approximation, but they use it because such a model is easy to estimate and apply, even when little is known about the process.

The aim of our study is to produce bio ethanol from organic waste such as banana peel and pineapple peel by co-culture of Saccharomycescerevisiae.

II. MATERIALS AND METHODOLOGY

A. COLLECTION OF BANANA PEELS AND PINEAPPLE PEELS

Ripped banana peels and pineapple peels are collected from the market and fresh juice shops. After collecting the peels, cut into small pieces by using knife and scissors. Then the peels are placed under the sunrays for drying from 5 to 6 days. After drying, with the help of mixer make them into powder form and mark as banana peel powder and pineapple peel powder.

B. PREPARATION OF PRE-TREATMENT

There are two type of pre-treatment are used for the production of bio ethanol. They are alkaline and acidic pre-treatment, for alkaline pre-treatment in banana peel, 15g of sample is taken from the banana peel powder and add 150ml of distilled water into it and mix well by using conical flask. Then add 5g of potassium hydroxide into the flask. Repeat the same process for pineapple peel powder.

Then heat the both sample in steam water tub at 75^{o}C for 2 to 3 hrs and cooled it for 24 hrs.

For acidic pre-treatment method, 15 g of banana peel powder was taken and add 150ml of distilled water into it and mix well by using conical flask. And then add 30 ml sulphuric acid was added into the mix, placed in the conical flask. Repeat the same procedure for pineapple peel powder.

Then heat the both sample in steam water tub at 75^{o}C for 2 to 3 hrs and cooled it for 24 hrs.

C. FILTERATION PROCESS

A day after pre-treatment the study moves towards the filtration process, for filtration process take 150 ml of pre-treated samples after pre-treatment process. Filter 150 ml sample by using filter paper and pour into the conical flask and mark as sample A (alkaline pre-treated sample of banana peel). Repeat the same method for pineapple peel sample and label as sample A1 (alkaline pre-treated pine apple peel). And heat the sample of about 60°C by using water tub for 45 minutes.

Follow the same procedure for acidic pre-treatment samples, and label as sample B (acidic pre-treatment of banana peel) and mark as sample B1 (acidic pre-treatment of pineapple peel).

D. ADDITION OF YEAST

In this project active yeast is used for fermentation process. Separate 100 ml of alkaline pre-treated samples of banana peel and pineapple peel after filtration and add 5g of yeast into it. And mix well for 1 to 2 minutes. Repeated the same procedure for acidic pre-treated samples of banana peel and pineapple peel.

E. FERMENTATION PROCESS

For fermentation process, close the conical flask which contains samples by using plastic cap. And place the sample in a dark room for 4 to 5 days for fermentation.

F. QUANTITATIVE ANALYSIS OF REDUCING SUGAR PRESENT IN THESAMPLES

The quantitative analysis was carried out using 3,5–dinitrosalicylic acid. The concentration of the reducing sugar present in the samples was determined by adding $1cm^3$ of 3, 5-dinitrosalicylic acid to $1cm^3$ of each of the samples and boiled for 5 minutes and $10cm^3$ distilled water was added. The absorbance of each of sample was determined at 540nm using JENWAY 6400 spectrophotometer. Thus, the concentration values were extrapolated from the glucose standard curve.

G. Qualitative and Quantitative Analysis of EthanolPresent in the Distillate

The filtrates were distilled at 70^0C using rotary evaporator. The qualitative analysis was carried out using ethanolic acid. Two cubic centimeters of ethanolic acid was added to $1cm^3$ of the distillate and heated in the water bath for 5 minutes until characteristics sweet smell of esters was perceived. The quantitative analysis was carried out by determining the densities of the distillates as follows.

$$\text{Density} = \frac{WB + D - WEB}{VD}$$

WB = Weight of the Density Bottle

D = Distillate

WEB = Weight of Empty Density Bottle

VD = Volume of Distillate

Thus, concentrations of the distillates were extrapolated from the density standard curve. Furthermore, the pH, refractive index, and specific gravity values were extrapolated from the standard curves prepared from each parameter since the concentrations of the distillates were known.

III. RESULT AND DISCUSSION

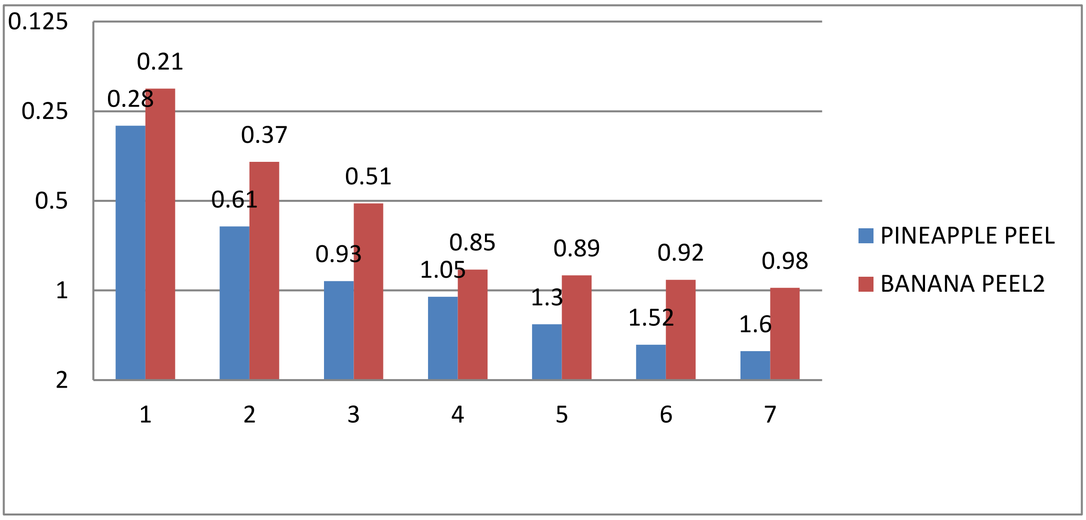
The results show that from the first day to the seventh day of fermentation, the yeast and mould biomass yield obtained from pineapple, banana and plantain peels fermentation media increased from 0.34 to 1.89 (OD), and 0.21 to 0.98 (OD) Respectively. The ability of the amylase and cellulose secreted by A. Niger to breakdown the 3 substrates into reducing sugar was determined in the study. The results are presented in Fig.1 in terms of the amount of reducing sugars (mg/cm3) produced at 24 hours interval for seven days. The results show that in all the substrates the concentration of the reducing decreased gradually as the fermentation period increased. Thus, on day 7 of the fermentation period, the highest reducing concentration (0.94mg/cm^3) was obtained from pineapple peel. This was closely followed by banana peel (0.82mg/cm^3) while Pine apple peel had the least (0.4582mg/cm^3).

WM Yeast and Mould Biomass (Cell Density at 690nm) for seven days

	1	2	3	4	5	6	7
BP	0.28	0.62	0.93	1.05	1.30	1.52	1.60
PP	0.21	0.37	0.51	0.85	0.89	0.92	0.98

WM = Waste Material, BP = Banana Peel, PIP = Pineapple Peel

Reducing Sugar Concentration (mg/cm^3)



Fermentation Period (days)

Figure 1: Reducing sugar concentrations obtained from banana and pineapple peels fermentation medium for seven days.

The results of the ethanol yield obtained from the two substrates are shown in Figure 2. During the fermentation period, the ethanol yield of 2 substrates were found to increase gradually from the first day to the seventh day with the pineapple peel having the highest yield of 8.34% (v/v), followed by banana peel 7.45% (v/v). The ethanol yield from pineapple in this study compared favorably with the ethanol yield obtained by these authors reported that they obtained 9.30% (v/v) after 7 days of fermentation period. Agricultural wastes rich in fermentable sugars have been found to be good substrates for ethanol production, a promising alternative energy source for limited crude oil. Ethanol derived from biomass feed stock which is one of the modern forms of biomass energy has the potential to be a sustainable transportation fuel as well as a fuel oxygenated that can replace gasoline [7]. The gradual increase in cell densities of the 3 substrates from the day one to the day seven of the fermentation periods suggested that substantially more carbon was utilized for ethanol production instead of cell production and this due to the ability of yeast S. cerevisiae to ferment the sugar to ethanol (Table I). The amount of biomass present in the substrates is directly proportional to quantity of ethanol production.

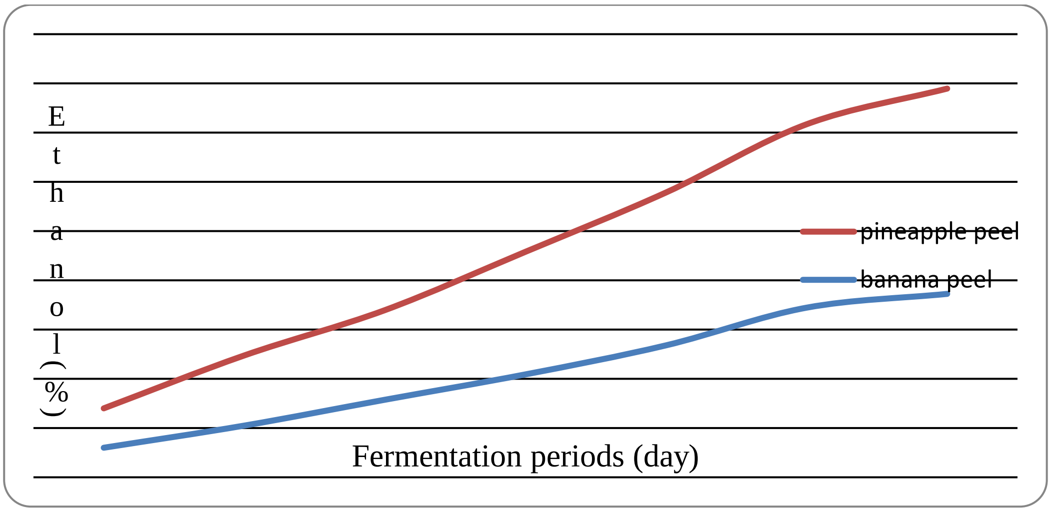


Figure 2. Ethanol yield obtained from banana, plantain and pineapple peels fermentation medium for seven days.

IV. CONCLUSION

Conclusively, the present work has clearly shown that simultaneous saccharification and fermentation of waste materials from banana, and pineapple to ethanol by a mixture of starch digesting fungus A. niger and non starch digesting sugar fermented (S. cerevisiae) is feasible. Simultaneous saccharification and fermentation has been found to effectively remove glucose, which is an inhibitor to cellulase activity, thus increasing the yield and rate of cellulose hydrolysis. It is interesting to note that even though ethanol is produce from renewable resource, economic factors such as land availability, labour, taxation, utilities, crop processing costs and transportation are to be put into consideration otherwise there will be no profit for its production.

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