ARTICLES BALI INTERNATIONAL SEMINAR ON SCIENCE AND TECHNOLOGY 2011
" Strengthening Basic Sciences and Technology for Industrial Sustainability"
July 22-23 , 2011, BALI-INDONESIA
ISBN 978 – 979-98623-1-0

Making Ethanol from Tapioca Starch Liquid Waste by Hydrolysis and Fermentation

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Abstract

Alcohol or often called ethanol (ethyl alcohol) in the industrialized world which is often used as a solvent, can be produced by fermentation using the yeast Saccharomyces Cereviceae. The basic ingredients that can be fermented include materials that contain saccharin, starch, and selullosa. Production of ethanol in this study carried out by using the basic ingredients of starch derived from tapioca starch liquid waste that has a starch content of 8.14%. Before the fermentation process, first performed by the process of hydrolysis using bacteria producing enzyme α- amylase is Bacillus to obtain a solution containing sugar (glucose). Result of hydrolysis solution containing glucose at 4.82%, 5.3% and 5.7% then fermented for a certain time interval by using yeast Saccharomyces Cereviceae. From the experimental results obtained a conclusion that maximum results are obtained occurs in 10% bacillus fermentation lasts for 15 days with levels of ethanol produced by 20.14%.

Keywords: *Tapioca, alcohol*

INTRODUCTION

Alcohol is widely used in everyday life, such as cosmetic ingredients, the beverage industry, beverage material, organic solvent and as fuel. This need will increase with the possibility Alcohol replacing petroleum as fuel. where the fuel of alcohol is a fuel derived from renewable materials and certainly contrary to the petroleum fuel or gas now used to the longer will be more exhausted. Alcohol can be obtained through a process of fermentation and synthetic. The process of making alcohol for industrial scale usually use the help of microorganisms to transform the basic ingredients that contain sugars into alcohol. In general, the raw material for making ethanol from drops or molasses, where the drops are also a necessary ingredient for other industries such as brewing and the manufacture of cooking spices. Because of the needs of industries that use the drops (liquid byproduct of the sugar factory) as a raw material, then indirectly stock drops (liquid byproduct of the sugar factory) will be increasingly depleted. Therefore, it is necessary to reform raw materials or other alternative is to utilize waste tapioca flour (starch) as a raw material for making ethanol. Because of the needs of industries that use the drops (liquid byproduct of the sugar factory) as a raw material, then indirectly stock drops (liquid liquid byproduct of the sugar factory) will be increasingly depleted. Therefore, it is necessary to reform raw materials or other alternative is to utilize waste tapioca flour (starch) as a raw material for making ethanol. The liquid waste produced from tapioca starch production process, from raw material washing up on the process of separating starch from the water or the deposition process. Tapioca starch Liquid waste has a carbohydrate content of 8:14% and 1.72% glucose. With the carbohydrate content are allowed to be used as a feedstock for ethanol production. The purpose of this research is to find the best conditions in the fermentation process to obtain the results of pure ethanol.

Liquid Waste Tapioca Starch

Tapioca starch Liquid waste is liquid waste derived from water of the result precipitation tapioca starch manufacturing process. Where the current utilization of tapioca starch liquid waste merely as livestock feed, or just dumped (Munandar, 1990). Starch deposition process causes the dissolution of nutrients which involved regardless of cassava into the liquid waste (Grist, 1986). Nutrients involved in the wastewater of tapioca starch include carbohydrates, thiamin, and other organic compounds in which the content is still potential for the manufacture of ethanol (Munandar, 1990).

enzyme hydrolysis

Starch is a component that is more complex than the disaccharide. Before the fermented starch must be broken by using the enzyme amylase into components of the disaccharide is maltose. By using other enzymes are maltase, maltose would be hydrolyzed to glucose. (Gumbira Sa'id, 1987)

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The process of hydrolysis is influenced by several factors, among others, as follows:

a. The number of carbohydrate content in raw materials

$$1/2n\ C_{12}H_{22}O_{11} + 1/2n\ H_2O \xrightarrow{\text{Enzim Maltase}} 1/2n\ C_6H_{12}O_6$$

$$(C_6H_{10}O_5)_n + 1/2n\ H_2O \xrightarrow{\text{Enzim Amilase}} 1/2n\ C_{12}H_{22}O_{11}$$

Carbohydrate content of less then it will produce less glucose and reverse. On the content of the suspension is too high, it could lead to the mix will increase
b. temperature Hydrolysis
In general the higher the temperature, the reaction rate rises either not catalyzed or catalyzed by enzymes. However, if the temperature is too high can accelerate the breakdown or destruction of the enzyme. But keep in mind that enzymes are proteins, so the higher temperatures also increased the enzyme inactivation process. Both enzimztik affect the overall reaction rate. Almost all enzymes have an optimal activation at a temperature of 30 º C - 40 º C.
c. pH
pH affects the amount of hydrolysis products, enzyme shows maximum activity at a pH range of so-called optimum pH. Where is the optimum pH generally ranges between 4.5 -8. The optimum pH is different depending on the origin of an enzyme of the enzyme.
d. Water levels
Water content of the material greatly influences the rate of enzymatic reactions. At low free water content occurs obstacles and barriers so that both the diffusion of enzyme or substrate is retarded, a result terejadi hydrolysis only at the substrate is directly related to the enzyme. (Winarno, 1994)
e. stirring speed
Stirring speed used for the hydrolysis process is 200 rpm. (Olivia, 2004)

Fermentation

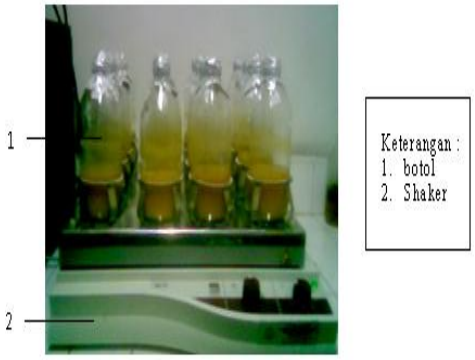
Ethanol is a form of natural dihasikan of fermentation products which are found in beer, wine, spirits and much more. Alcoholic beverages can be classified into two parts, namely:
1. Fermented products are consumed directly.
2. Distilled fermented products first before consumption.

Factors - factors that affect the fermentation process are as follows:

a. pH
A good pH for fermentation, which is between pH 4-5. pH is a pH favor the yeast and the pH can thwart the development of many types of bacteria. To acidify usually used sulfuric acid. Even better is lactic acid, because lactic acid is good for yeast growth, but the ugliness can grow bacteria that could harm the butyric acid fermentation of yeast.
b. time
The time required for fermentation depends on temperature, concentration of sugar. But in general it takes between 36-50 hours. (D. Syamsul bahri)
c. temperature
In general, a good temperature for fermentation between 25-30 º C. The lower the temperature the higher the alcohol fermentation is generated. This is because at low temperatures will be more complete fermentation and loss of alcohol due to be carried away by the gas carbon dioxide would be less.

EXPERIMENTAL

Basic materials used in this research is tapioca starch liquid waste. Yeast species Saccharomyces Cereviseae. Yeast Extract, Malt Extract, nutrient, and amylase-producing bacteria (Bacillus) used for the hydrolysis process.
Tools and Tool Series
The tools used to process tools include fermentation, distillation equipment, and tools hydrolysis.



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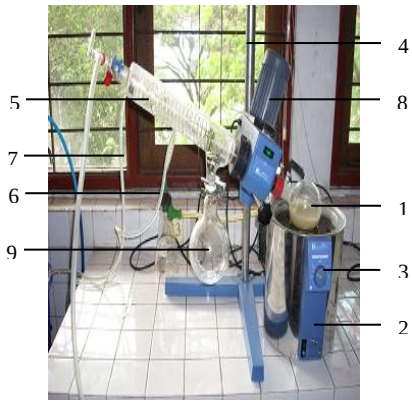
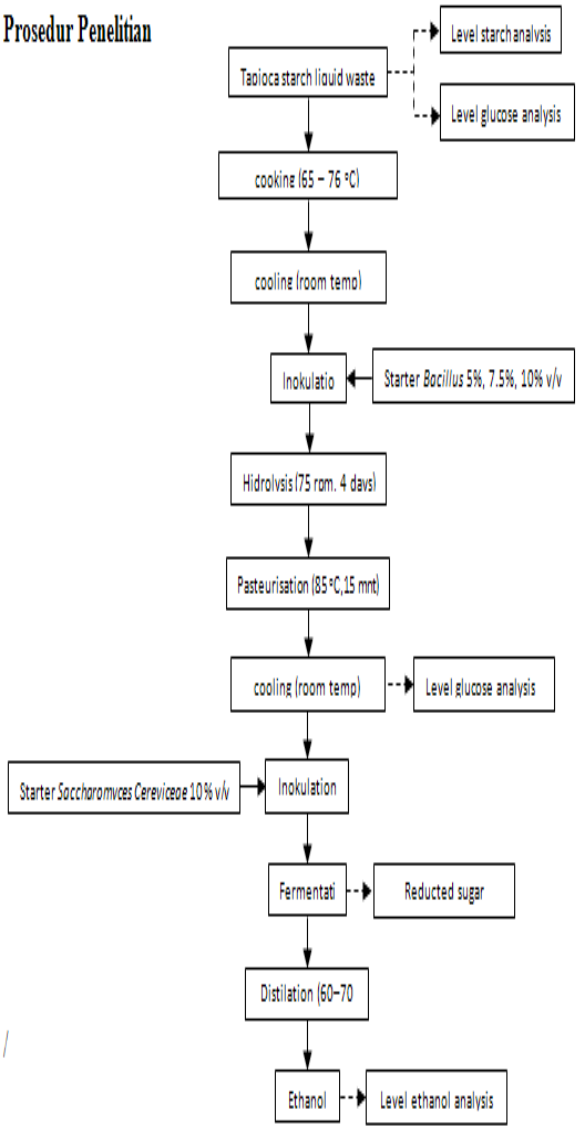
Condition
hydrolysis
• remained conditions
a. Tapioca starch Liquid waste volume = 2000 ml
b. Hydrolysis time = 4 Days
• variables
a. Bacillus (% v / v) = 5; 7.5; 10

fermentation
• remained conditions
a. Tapioca liquid waste volume = 200 ml
b. Saccharomyces Cereviseae = 10% v / v
• variables
a. Time Fermentation (days) = 5; 10; 15; 20; 25

distillation
• remained conditions
a. Tapioca liquid waste volume = 200 ml
b. Distillation temperature = 70 ° C



Sampel	*Bacillus* (% berat)	Kadar Glukosa (% berat)
1	8,14	1,72



RESULTS AND DISCUSSION

Analysis of Raw Materials (Liquid Waste tapioca starch)
Based on the results of analysis of starting material (tapioca starch liquid waste) obtained the following data:
Levels of Starch and Glucose Levels in tapioca starch Liquid waste

Hydrolysis Process Results

From the results obtained by analysis of bacillus and glucose levels were as follows:
Glucose levels in the Liquid waste tapioca starch with a ratio of the bacterium Bacillus

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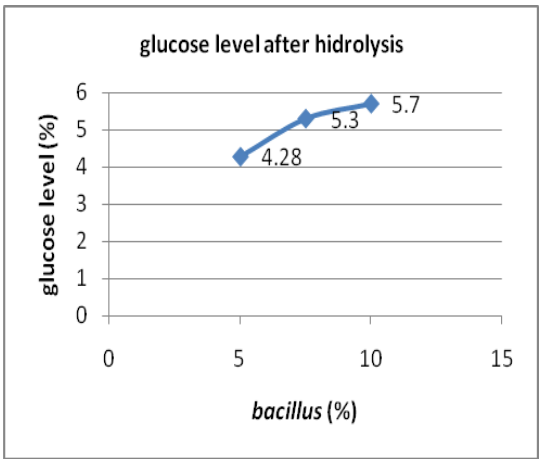
Sampel	*Bacillus* (% v/v)	Kadar Glukosa (% berat)
1	5	4,82
2	7,5	5,3
3	10	5,7

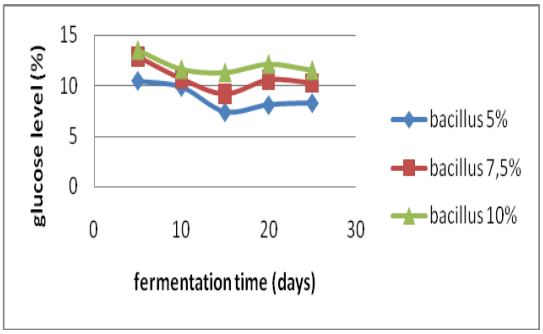


In table shows that in sample 1, the starch is converted into glucose by 40.79%, in sample 2 at 34.89%, and the third sample of 29.97%.

Fermentation results

From the results obtained by analysis of residual glucose and ethanol levels as follows: Effect of Bacillus and Long Fermentation Glucose Levels Against Time Generated on Fermentation

Bacillus (% v/v)	Fermentation Time (days)	Residual glucose level (% w)
5	5	10,5
	10	9,9
	15	7,4
	20	8,1
	25	9,3
7,5	5	12,9
	10	10,7
	15	9,2
	20	10,6
	25	10,3
10	5	13,5
	10	11,6
	15	11,26
	20	12,1
	25	11,5



In Table shows that the residual glucose levels ranged between 7.4% - 13.5%. Where the results of this study indicate that the bacillus of 10% with 5 day old fermentation, the highest glucose levels obtained at 13.5%.

In figure above can be seen that the longer the fermentation, the higher the residual glucose levels. It is also seen that the smaller the bacillus then acquired the remaining glucose levels are also increasingly randah.

At the time of fermentation of 5 days to 25 days, glucose levels remaining for all the bacillus is relatively decreased. This is because the longer the fermentation, the more glucose to be broken down by yeast into ethanol and organic acids that decrease levels of residual sugar. Where this is in accordance with the opinion Daulay (1991) that the sugar reduction will decrease over time because the fermentation of sugar will be broken down into alcohol and organic acids

Distillation Analysis Results

From the results obtained by analysis of levels of ethanol as follows:

Effect of Bacillus and Long Fermentation Against Ethanol Levels Generated on Distillation Process.

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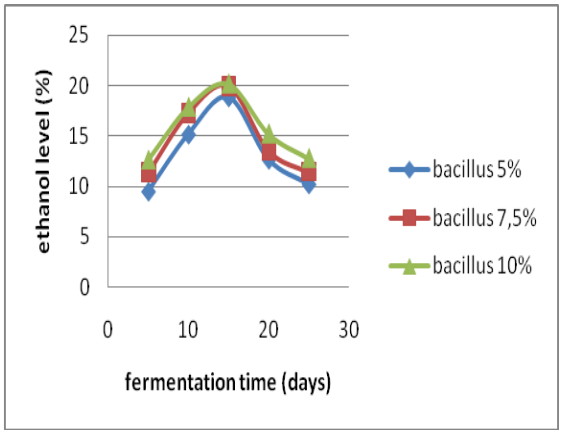
Bacillus (%)	Fermentation Time (days)	Ethanol Level (%)
5	5	9,49
	10	15,15
	15	18,83
	20	12,65
	25	10,21
7,5	5	11,3
	10	17,23
	15	19,92
	20	13,52
	25	11,37
10	5	12,59
	10	17,82
	15	20,14
	20	15,19
	25	12,76



In figure above can be seen that for all the bacillus had a greater tendency of its ethanol content with time of fermentation. The best results were obtained in 10% with long bacillus fermentation 15 days, levels of ethanol obtained by 20.14%, while the lowest result of the bacillus of 5% where the long fermentation of 5 days and levels of ethanol obtained at 9.49%. This is due at the beginning of fermentation, Saccharomyces Cereviceae require adaptation to a new liquid medium so that the ethanol produced is still small. For a long time 5 to 15 days of fermentation, ethanol content was increased slowly. While in the long fermentation after 15 days, its ethanol content decreases. This is due to microorganism growth rate decreased due to reduced nutrient supply and the accumulation of metabolic substances that inhibit growth. This is in accordance with the opinion Daulay (1991) that the rate of alcohol formation depends on microbial activity. Given the considerable substrate and fermentation time is long enough, the greater the chance of yeast to produce alcohol. And the production of alcohol will decrease with reduced carbon sources and microbial activity

CONCLUSION

In research that has been done can be concluded that the best conditions in the fermentation process liquid waste tapioca starch with yeast Saccharomyces Cereviceae is on day - 15 in which generated the highest ethanol content of 20.14% at 10% with bacillus residual glucose levels by 11, 26%.

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