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Comparative Study on the Production of Bioethanol from Nigerian Red and White Cocoyam Peels.

Adolphus Charlie M, Ikenyiri, Patience N. and Dagde, Kenneth K.

Department of Chemical/Petrochemical Engineering, Rivers State University, Nkpolu Oroworukwo Port Harcourt, Nigeria.
Email: Charlie.adolphus@yahoo.com

ABSTRACT

Cocoyam is a regular name for more than one equatorial root plant vegetable crop that belongs to Arum and Araceae family, they are herbaceous perennial plants grown primarily for their edible roots. The enzymatic production of Bioethanol from Red and White cocoyam peels was examined using Saccharomyces cerevisiae. Saccharomyces cerevisiae was further used to ferment the substrates after the material pre-treatment of both the Red and White cocoyam peels at 28^0C for 7 days. The fermented liquid was distilled at 78^0C and the quantity of Bioethanol produced determined: The use of saccharomyces cerevisiae for fermentation of 100g, 80g, 70g, 60g, and 50g of Red and White cocoyam peels yielded a volume of 87ml, 67ml, 58ml, 49ml, and 41ml of bioethanol from Red cocoyam peels, while the bioethanol from white cocoyam peels yielded 84ml, 66ml, 59ml, 48ml and 39ml respectively. The distilled Bioethanol were characterized and their properties were compared with standard properties of ethanol. The Boiling point, refractive index, specific gravity, density and the pH value of bioethanol produced from Red and White cocoyam peels where 78^0c, 1.3614, 0.833, 0.7981g/cm^3, and 6.45 for bioethanol produced from Red cocoyam peels and 78^0c, 1.3614, 0.866, 0.7894g/cm^3, and 6.40 for bioethanol produced from White cocoyam peels. This study reveals that Bioethanol can be produced from Red and White cocoyam peels with maximum yields of 87ml and 84ml respectively from red cocoyam peels and white cocoyam peels as a result of the presence of higher starch contents when Aspergillus Niger and saccharomyces cerevisiae were used.

Keywords: Bioethanol, Fermentation, Distillation, Production,

1. INTRODUCTION

Cocoyam is the name of several equatorial root and vegetable plants. It belongs to the arum family (also known as Aroids and the family name Araceae).

Cocoyam is a perennial herb belonging to the Araceae family. It mainly grows edible roots, although all corridors of the factory are edible. Cocoyam grown as food crops belong to the Colocasia or Xanthosoma category, and both consists of a large global tuber (expanded underground bearing trunk) from which a Beaucoup-sized leaf grows. Cocoyam is currently the third largest tuber crop of yam and cassava in Nigeria and is a reasonable substitute for yam, especially in southern Nigeria (Azeez and Madukwe, 2010). Since cocoyams are an important source of nutrients, they are used as a raw material for the production of biofuels in food and biotechnology (Owusu Darko, 2014), (Braide Braide & Nwaoguikpe, 2011 and Adelekan, 2012), and they also have recovery Sexual prospects. Alcohol fermentation is a biochemical process caused by the action of yeast, which converts natural sugars in any starch-containing material into alcohol and releases carbon dioxide under controlled environmental conditions (Miller & Lisky, 1976, Okafor, 1987; Saraswati, 1988; Saucedo, 1992; Dubey, 2005; Okorondu, 2009. The starch-containing raw material is first hydrolyzed into fermentable sugars, and then fermented with the required yeast species to produce ethanol (Kuboye & Akinrele, 1971; Suraswati, 1988; Jaleel, 1988). Bioethanol production is a technical method that converts monosaccharides into ethanol and carbon dioxide (Damaso, et al 2004).

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Bioethanol is a biofuel that can be used as a gasoline substitute for automobiles, generators, motorcycles, etc. (Aro, 2005). Ethanol is a renewable energy produced mainly through the fermentation process of sugar, but it can also be produced through a chemical process in which ethylene reacts with steam (Anuj, 2007). The sugar sources needed to make ethanol come from fuels or plants, such as corn, cassava, yam, rice husk, rice, wheat crops, sawdust, and sorghum. Ethanol is a high-octane fuel that has replaced lead as an octane accelerator in gasoline (Oghgren, 2006). By mixing ethanol with gasoline, we can oxidize the fuel mixture, make it burn more completely and reduce pollutant emissions. The inedible parts of cassava play a very important role in

generating sustainable energy because they produce relatively little biomass, are easily hydrolyzed and have a high dry matter content (Kosugi, 2009). The usual mixture is 10% ethanol and 90% gasoline (E).The internal combustion engine does not need to be modified to use ethanol, and the vehicle warranty is not affected. Ethanol made from biomass is the only liquid fuel that does not cause the greenhouse effect. (Adeletian and Nuwamanya, 2010, Anuj, 2007).

2.0 MATERIALS AND METHOD

Six hundred grams of Red Cocoyam (Xanthosomasagitilfolium) and white cocoyam (Colocasiaexculenla) were collected from Agricultural Development Programme (ADP), Port Harcourt, Rivers State.

The organisms used is Saccharomyces cerevisiae. These was collected from stock cultures in the Microbiology Laboratory of Rivers State University in Port Harcourt, Rivers State, Nigeria.

2.1 Equipment and Apparatus

i. Simple distillation apparatus.

ii. Round bottom flask; used for heating of the samples during the distillation process.

iii. Thermometer; used to measure the temperature of the heating source during distillation.

iv. Liebig condenser; Condenses the vapour given off during distillation.

v. Measuring cylinder; used in measuring the volume of the sample.

vi. Conical flask; Used for keeping the samples during the hydrolysis and fermentation process.

vii. Analytical Weighing Balance; Used to measure the mass of the sample.

viii. Flat Bottom Flask; Used for collecting the bioethanol during the distillation process.

2.2 Bioethanol Production

The methods used for production of bioethanol includes; material pre-treatment, fermentation and distillation process.

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Material Pre-treatment

The peels of the Red and White Cocoyam were washed to remove sand and other impurities and dried under the sun for 4 days to remove the moisture content. The dried peels of both cocoyam specie were grinded into a fine particle. The particles were then weighted in grams for the fermentation process.

Fermentation

In the fermentation process, different quantities of the substrate (ground red and white cocoyam peels) where weighed and inserted into a conical flask (i.e. 100g, 80g, 70g, 60g and 50g for each specie of the cocoyam peels. Sterile distilled water was added to make up to mark and the flask plugged with sterile cotton wool wrapped in aluminum foil to avoid contamination.

Freshly harvested cells of saccharomyces cerevisiae was aseptically added into a set of flask s containing the hydrolyzed supertants. (100g, 80g, 60g, 70g and 50g superlatant) of both Red and white cocoyam peels were corked using cotton wool, (aerobic), shaken and incubated at room temperature (28^{o}C) for another seven days. The flasks where shaken thoroughly for the seven days to produce a homogenous solution and even distribution of the organisms in the substrate.

Distillation

This was carried out using a simple distillation apparatus. The fermented liquid was transferred into a round bottom flask and placed on the heating mantle fixed to a distillation column enclosed in running tap water. Another flask was fixed to the other end of the distillation column and the ethanol was collected at 78^{o}C (standard temperature for ethanol production). This was done for each of the fermented supernatant.

3.0 RESULTS AND DISCUSSION

3.1 Physiochemical Properties of Tested Bioethanol

As compared to standard ethanol, a summary of results of bioethanol and ethanol properties data for the tested fuels are presented in table 4.1

Table 3.1: Properties of bioethanol compared to standard properties of ethanol

S/NO	Parameters	Standard Result of Ethanol at 20^0C	Experimental Result of Bioethanol from Red Cocoyam	Experimental Result of Bioethanol from White Cocoyam
1	Boiling point	78^0C	78^0C	78^0C
2	Refractive Index at 20^0C	1.3614	1.3614	1.3614
3	Specific gravity	0.79	0.833	0.866
4	Density	$0.789g/cm^3$	$0.7981g/cm^3$	$0.7894g/cm^3$
5	pH value	7	6.45	6.40
6	Appearance	Colourless	colourless	colourless
7	Solubility in water	Miscible	Miscible	Miscible

The result of this study confirmed that ethanol can be produced from red and white cocoyam peels which are agricultural waste. The Results showed that the physiochemical properties of the Bioethanol produced conformed with the properties of the standard ethanol compared with standard ethanol.

3.2 Bioethanol Produced from Red and White Cocoyam Peels

Figure 3.1 shows the mass (g) and volume (ml) of bioethanol produced from Red and White cocoyam peels when fermented with saccharomyces ceresisiae.

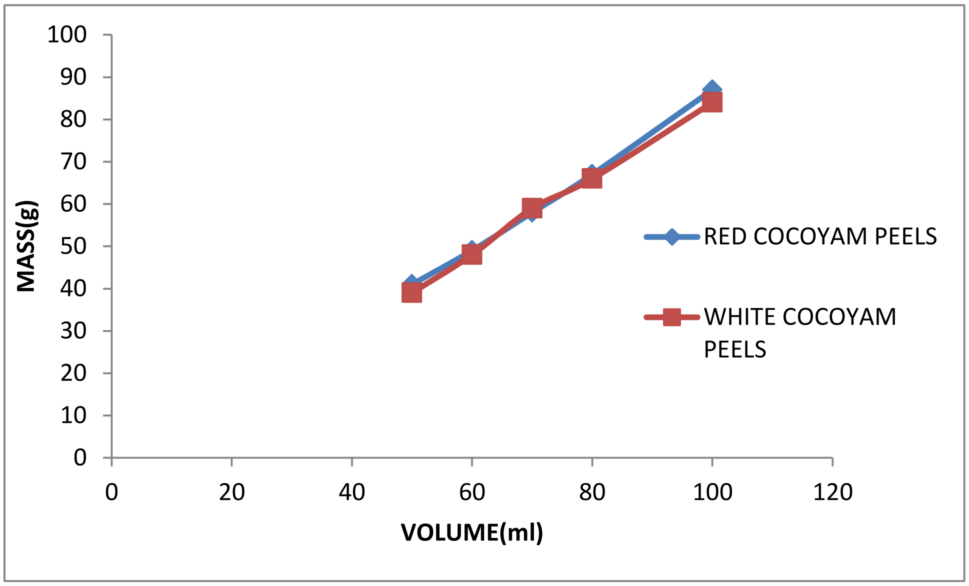

Fig 3.1: A plot of Volume of Bioethanol produced for Red and White cocoyam peels.

Figure 3.1, introduces the comparison between the volumes and masses of bioethanol produced from red and white cocoyam peels. Comparing the volume of bioethanol produced in millimeter(ml) with mass in grams ranging from 0 gram to 100grams on the Ordinate at an interval of 10grams, and the volume on the abscissa axis, ranging from 0ml to 120ml with an interval of 20ml.

We observe that the threshold volume of bioethanol from both red and white cocoyam peels effect from 39ml on the abscissa.

Results from Figure 3.1 showed the average quantity of bioethanol from 50g, 60g, 70g, 80g, and 100g of Red and White cocoyam peels to be 41ml, 49ml, 58ml, 67ml, and 87ml for Red cocoyam peels and 39ml, 48ml, 59ml, 66ml and 85ml for white cocoyam peels.

The result also revealed the maximum yield of ethanol from 100g of red cocoyam peels to be 87ml volume while 100g of white cocoyam peels yielded 85ml. This is due to the presence of more carbohydrate which can be fermented to ethanol in Red cocoyam peels than in white cocoyam peels.

The graph showed that there was an increase in the quantity of bioethanol produced as the weight of the substrate increased. This result confirms that bioethanol can be produced from Red and White cocoyam peels.

3.3 Volume of Bioethanol Produced with Time for 100g of Red and White Cocoyam Peels

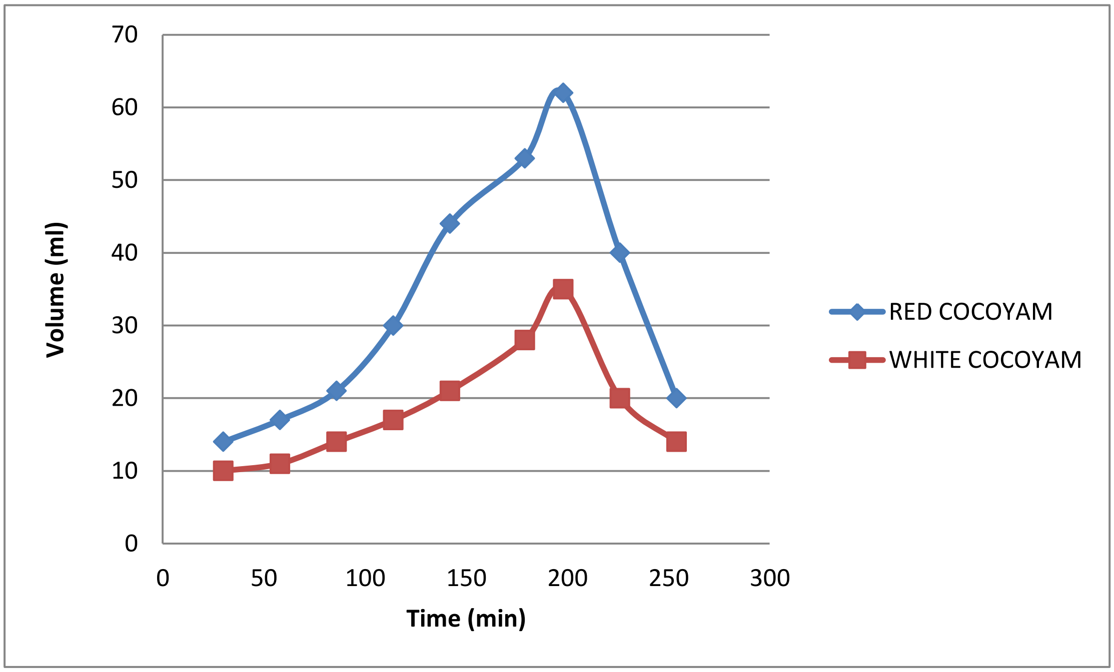

Fig 3.2: A plot of volume of bioethanol produced (ml) for 100g of red and white cocoyam peels against time(mins)

Figure 3.2 introduces the analysis of volume against time of ethanol produced from Red and White cocoyam peels. On comparing the volume of both ethanol produced with a range value from 0 ml to 70ml against time completed with a time range value from 0 minute to 300 minutes on the ordinate and the abscissa axes respectively. It is seen that Red cocoyam peels produces ethanol in greater volume than white cocoyam peels in the same time range.

Results from Figure 3.2 showed the average quantity of bioethanol produced from 100g of Red and White cocoyam peels. From the graph, Figure.3.2 showed that there was an increase in the quantity of bioethanol as the time was increased, the peak of production of bioethanol from the 100g of Red and White cocoyam peels were in 198 minutes, producing 62ml of bioethanol for Red cocoyam peel and 35ml of bioethanol for white cocoyam peels. The consistent increase in bioethanol production from the graph Figure. 4.2 started decreasing from 200 to 254 minutes. The fall in bioethanol production was due to the reduction of the starch and carbohydrate content in the Red and white cocoyam peels during the distillation process.

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3.4 pH Value of Ethanol from Red Cocoyam Peels

p^H is a measures of how acidic or basic a solution is. The range goes from 0 to 14, with 7 being neutral, p^H of less than 7 indicate acidity, whereas a pH greater than 7 indicates base.

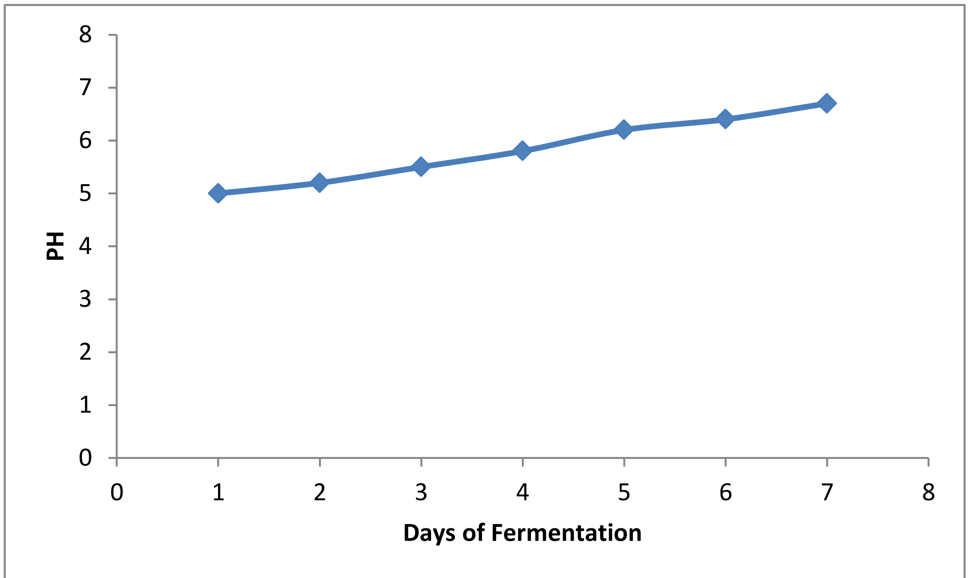

Fig 3.3: A plot of p^H of Bioethanol from Red Cocoyam During days of Fermentation

From figure 3.3, it can be seen that as the days of fermentation increases, the pH decreases, as fermentation progresses the pH becomes less acidic due to yeast metabolism and the bye product been excreted into the solution. Ueda et al (1981) observed a similar trend. In their study, they reported that the rate of fermentation ceased after seven days of fermentation.

3.5 pH Value of Ethanol from White Cocoyam Peels

pH is a measures of how acidic or basic a solution is. The range goes from 0 to 14, with 7 being neutral, pH of less than 7 indicate acidity, whereas a pH greater than 7 indicates base.

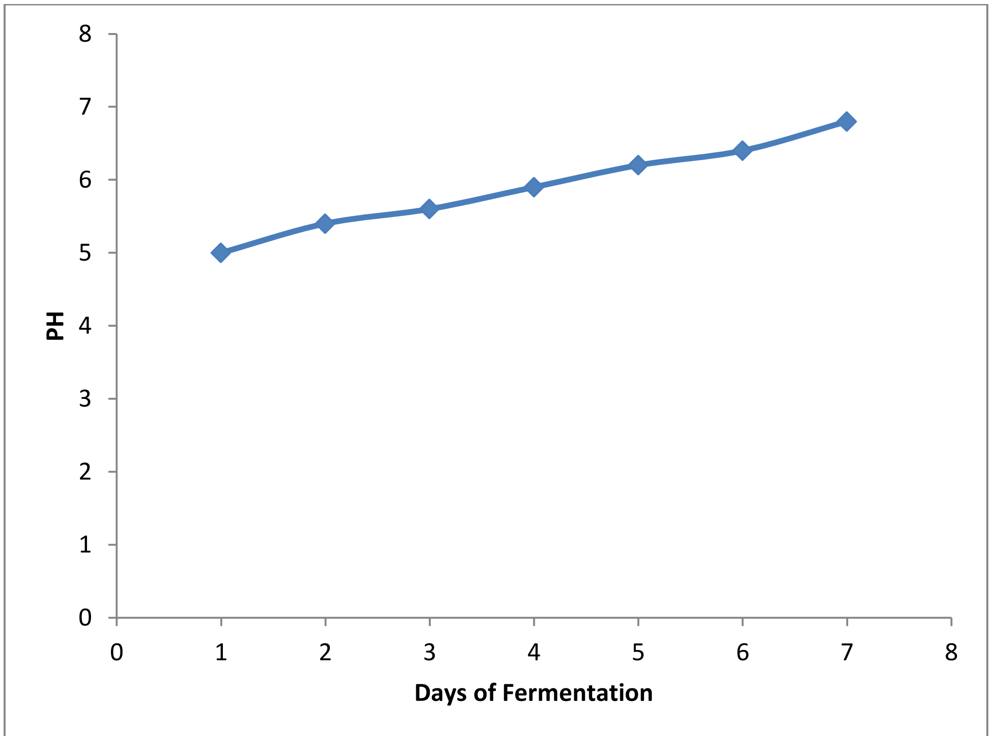

Fig 3.4 A plot of pH of Bioethanol from White Cocoyam During days of Fermentation

From figure 3.4, it can be seen that as the days of fermentation increases, the p^H decreases, as fermentation progresses the p^H becomes less acidic due to yeast metabolism and the bye product been excreted into the solution. Ueda et al (1981) observed a similar trend. In their study, they reported that the rate of fermentation ceased after seven days of fermentation.

The result of this study confirmed that ethanol can be produced from red and white cocoyam peels which are agricultural wastes. More ethanol was produced from red cocoyam peel than from white cocoyam peels, thus making red cocoyam peels a better alternative to white cocoyam peels. The use of red cocoyam peels is a worthwhile venture for ethanol production, considering their cost and because it is a means of controlling environmental pollution since bioconversion of cellulosic biomass into fermentable sugar for production of ethanol was done using cellulose degrading microorganisms, thus making bioethanol production economical and environmentally friendly and also renewable.

4.0 CONCLUSION

The results showed that the physiochemical properties of the bioethanol produced conformed with the properties of standard ethanol.

The study also showed that the biopethanol produced from the red cocyam peels is more than that of white cocoyam peels, due

The pH value decreases as fermentation increases and makes it less acidic due to the presence of yeast metabolism.

The use of red cocoyam peels is a worthwhile venture for ethanol production , considering their cost and because it's a means of controlling environmental pollution, since there could be conversion of cellulosic biomass fermentable sugar.

Alcohol industries have always competed with consumers of food items such as cassava, corn, sugar cane, yam etc in the quest to obtain its major raw materials. This competition has contributed to the shortage of these food items in the market.

Red and white cocoyam peels on the, has contributed to the environmental wastes and hazards experienced by our people because of poor management of waste products in Nigeria. This research work has shown the usefulness of red and white cocoyam peels by using it as a major raw material in the production of ethanol. Based on the fermentation of the hydrolysate with saccharomyces cerevisiae after seven days resulting in the maximum bioethanol production.

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The yield of alcohol from red and white cocoyam peels affected by host of factors, temperature, pH values, amount of cocoyam peels used, enzymes, catalyst etc 100g, 80g, 70g and 50g of red cocoyam peel yielded 87ml, 67ml, 58ml, 49ml, 41ml while 100g, 80g, 70g and 50g of white cocoyam peel yielded 84ml, 66ml, 59ml, 48ml and 39ml volume of ethanol respectively.

It is an indication that saccharnomyces cerevisiae was able to synthesis hydrolysate, the following can be concluded.

The physical properties of the ethanol produced conformed to that of standard ethanol in terms of pH viscosity, distillation range and flash point.

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