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Comparative Study of Alcohol Produce from Two Species of Tubers

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Abstract
Ethanol is a primary alcohol among other type of alcohol and can be produce either industrially or by fermentation using appropriate enzymes. The fermentation method can be implemented with the use of sugarcane, grains, cassava and tubers like yam and more yield is attained when mixed together with sugar cane. This research is studying the fermentation method of producing alcohol from two tubers: Cocoyam and sweet potato using standard method. The produced alcohol was tested and the infra red spectrum was carried out. The results reveal that the alcohol produced was positive to all the test conducted. The peaks on the three spectrum indicate the present of alcohol, that is: It falls within 3200cm^{-1} -- 3550cm^{-1} indicating high concentration, with O – H stretching and C – H deformation at CH_3 -- C -- on peaks within 1470cm^{-1} -- 11430cm^{-1} and 1380cm^{-1} --- 1430cm^{-1} Those on ≈ 1050cm^{-1} and ≈ 1100cm^{-1} indicating the present of primary alcohol and secondary alcohol, other peaks were also similar. In Conclusion, there is present of alcohol in the samples and that government should used this natural blessing to set up industry.

Keywords: Alcohol, Fermentation, Analysis, Infra-Red Spectrum

Introduction

Ethanol are produce commercially majorly by fermentation and by synthetic processes The synthetic involve direct hydration of ethane and hydration of ethyne (acetylene). Fermentation is a term that has been applied to the decomposition of food stuff and is one of the oldest technique of food preservation. The best known example is alcoholic fermentation. In which sugar is converted into alcohol and carbon dioxide using yeast as catalyst as given in the equation.

$$C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_5OH + CO_2$$

The equation underlying the production of ethanol by fermentation is the catalytic conversion of glucose into alcohol by enzymes by present in yeast. Any source of carbohydrate such as sugar cane grains and yam tubers, among others can be fermented for production of alcohol.. The high demand for ethanol in diverse industry has necessitate research into alternative sources for ethanol production from a low cost and readily available raw material like cocoyam (eposo species) and sweet potato. This is with the view of making ethanol to be readily available and becomes economically cheap for small and large scale industries to patronize. Ethanol is an organic compound that has one or more hydroxyl (OH) groups attached to a carbon atom. In dilute aqueous solution it has a sweet flavor but in more concentrated solution, it has a burning taste. Alcohol are classified as primary, secondary and tertiary. This classification is based on the degree of substitution of the carbon to which the hydroxyl is directly attached. The most common once are the methanol and ethanol. Moreover, Bio-ethanol has already been commercialized in many countries when blended with gasoline, bio-ethanol yield gasohol which is use as octane number enhancer in a specifically designed ethanol engine. Most engine can accommodate gasohol containing less than 10% ethanol without modification. Bio-ethanol which is produced from fermentation of sugars obtained from biomass either in the form of sucrose, starch or lignocellulose is presently the most abundant biofuel for automobile transportation. Franksitun *et al*. (2008). Lignocellulose which include cassava roots, sugar cane, sweet potato are cheap renewable resource and available in

large quantity in many countries as potential for ethanol production that can be added into gasoline (Edmond Ammerman 1971). The increasing population at geometrical level and accusations of technology development and enlightenment necessitate the need for chemical industry of which alcohol is one of them because alcohol can be use to synthesis other chemical like acetone, acid and aldehyde and in biofuel production. Therefore the need to search for ways of generating alcohol so as to compensate the ever increasing technology advancement.

Cocoyam [Eposo species]: Cocoyam is the common name for some sprcies in the genus Aracea family. They are cultivated for the consumption of their tubers in Africa, Asia and lating Americaand are dark brown in color. They are use in the same ways as potato and yam. There are hundred of cultivars among the cultivated species. They grow in the low land tropic and contributed very well to the human diet in many regions. Cocoyam has a rough skin, that is not easily peeled away but becomes soften and easy to peel when properly boiled.

Potatoes: White potato, they are call *pomene de terre* in French, and potato in spanish. They belong to botanical family *Solanaceae*. The tuber is not root but underground thickening of the stalks. There are more than 1300 varieties, the potato is the most cultivated tuber in the world today. In Germany, each inhabitant eats an average of 70 kilos tuber per year. Potato is one of the tuber that provide high quality carbohydrate and protein but deficient of provitamin A, vitamin E and vitamin B_{12}. The carbohydrate in potato are comprises of starch, glucose, fructose and saccharose. The protein contain lysine majorly. The mineral present is rich in potassium and sodium and recommended for people with hypertension and having cardiovascular diseases. Potato is also rich in phosphorus, magnesium, zinc, copper and manganese. The second type called sweet potato, in French is called batata, in Spanish is boniato. It ia perennial herbaceous plant of the botanical family called *convolvulacede* with trilling vines reaching a height of 30cm to 1meter, Carbohydrate predominate the tuber like the yellow type, they are rich in beta carotene (provitamin A) also present in the yellow varieties.

Justfication: Reports from alcohol production has given room for knowing the important of alcohol industry, but few information is known about the various sources of production both from fruits, tubers and legumes. Therefore this study seek to investigate the hydrolysis of sugars sources from cocoyam (eposo species) and sweet potato using enzymatic method of fermentation and applying the efficiency in ethanol production for laboratory and industrial purposes.

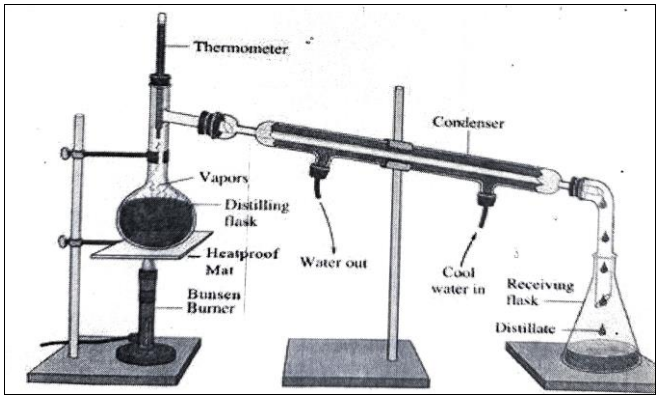
Experimental

Materials and Methods

Sample preparation: Mature Coco yam and sweet potato was harvested from my farm located at the university premises at The University of Technology Akure Ondo State. The tuber was cut out from the main stem stand, and that of the sweet potato was watched well with cleaned water and dried properly before taken to the laboratory for processing.

Methods: The cocoyam was de-husked and latter cut into pieces, about 500g of the cocoyam sample was blended with kenwood blender (M701), and store the slurry in a cleaned dried big PVC plastic, 500ml of distilled was added and 5g of sugar together with 15ml of 0.1M hydrochloric acid, the pH was tested and adjust to between 4.2 to 4.5, then few gram of yeast was added and left to ferment for 72hours inside a dark cupboard. After fermentation the mixtures was distilled for the alcohol present. b) 500g of the sweet potato tuber was also weight on a balance inside a cleaned dried big PVC plastic, it was cut into pieces, blended with kenwood blender M701) and pour into the plastic, 500ml of distilled water was added, together with 5g of sugar and 15ml of 0.1M of hydrochloric acid were added and the pH tested and adjust to between 4.2 to 4.5 before the few gram of yeast and was left to ferment for 72hours. Distillation was carried out after fermentation for the alcohol present. The two generate alcohol was store in a cleaned dried plastic container making ready for laboratory test and analysis with infra red spectrophotometer. The ethanol was redistilled using few gram of calcium oxide salt to get 99 -100%. Before the analysis.

Infra red spectrophotometer: The alcohol samples was analysed with spectrophotometer for the functional group.



Laboratory Test:

Specific gravity: A density bottle was weigh on an electronic weighing balance and the weight was noted as W_1, The bottle was filled with distilled water and weight. and noted as W_2. The bottled was cleaned and dried properly and cooled, latter the alcohol sample was pour inside to the mark and reweight as W_3, other samples were treated the same. The specific gravity was calculated with the formular. $\frac{W_3 - W_1}{W_2 - W_1}$ The experiment was conducted in triplicate for each sample.

Density: A measuring cylinder of 10ml capacity was weight on electronic balance and was noted as W_1

10ml of sample was pour insjde and reweigh noted as W_2. The density was calculated with the formular

$$\text{Density} = \frac{W_2 - W_1}{\text{Vol. of sample}}$$

Refractive Index: The refractive index was carried out using Abe Refractometer and was recorded in triplicate.

Total solid: The value was calculated from a data based on the respective refractive index values.

Boiling Point: The boiling point of samples was carryout out using boiling point electronic apparatus in the laboratory. Experiment was carried out in Triplicate.

Percentage Alcohol: The percentage alcohol was determined with the use of alcohol meter in the laboratory. It was carried out in triplicate.

Laboratory Test II: When reacted with sodium metal it generate an hydrogen gas like any other hydroxyl group like phenol and acid. B) Addition of sodium carbonate solution to the alcohol sample and heat give no reaction. C) Addition of 10ml of alcohol to few drop of neutral iron III chloride solution there was no reaction. D) $5cm^3$ of alcohol drop into equivalent volume of acetyl chloride inside a test tube and was rapidly fitted with a calcium chloride tube, a copious evolution of hydrogen chloride was observed which confirm the present of alcohol. $ROH + CLCOCH_3 \longrightarrow ROOCCH_3 + HCl$.

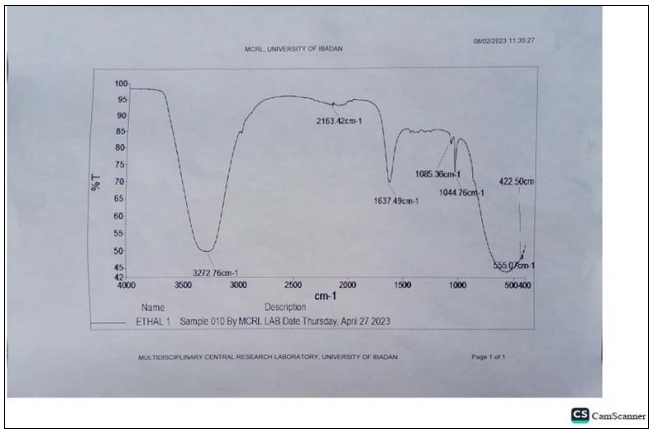
Total acidity: 50ml of the ethanol sample was measured with a cleaned measuring cylinder and pour inside a cleaned dried 250ml flask, heated on a heating mantle to boiled. The hot alcohol sample was tirated with 0.1M potassium hydroxide in a burette until permanent pink color appear. The acidity calculated as follows:

$$\text{Acid value} = \frac{5.61 \text{ X Titre value}}{\text{Vol. of sample.}}$$

Statistical Analysis: Statistical analysis was carried out using the SPSS version 2010 for window software package Mean concentration and standard deviations were calculated for each samples. The results were analyzed using single factor analysis of variance (ANOVA) while comparison of mean was done using Duncan Multiple Range test.

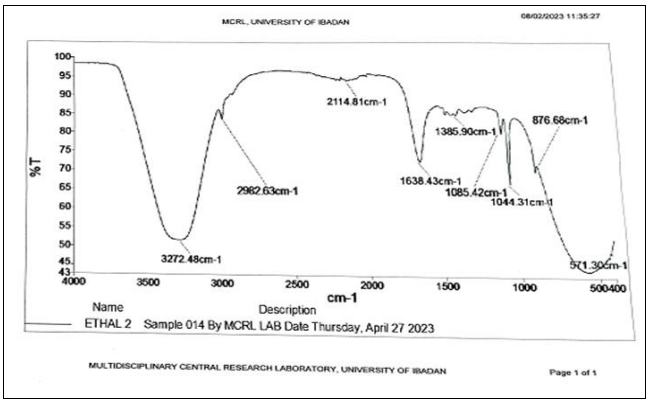
Results and Discussion

Ethanol from cocoyam (Eposo) spectrum 1



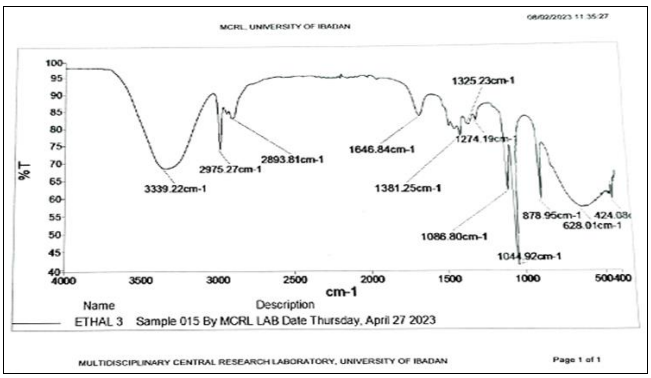
The ethanol spectrum above is for cocoyam [Eposo species] reveal high concentration of ethanol and it has a peaks at $3272.76cm^{-1}$ which is absorption due to intermolecular hydrogen bonding and within the standard range $3200cm^{-1}$ -- $3550cm^{-1}$. It has a C—0 stretching and 0 -- H deformation in plane and show the present of primary alcohol peaks at $1044.76cm^{-1}$ and secondary alcohol peaks at 1085.36cm-1and other peaks include $1637.49cm^{-1}$ and $2163.42cm^{-1}$. The high concentration was as a result of redistilling with second time and all the water present has been absorbed by calcium oxide salts.

Sweet potato Ethanol spectrum 2



The spectrum 2 is for potato ethanol, it reveals a high concentration peak at $3272.48cm^{-1}$ for ethanol with intermolecular hydrogen bond and within the standard $3200cm^{-1}$ --- $3550cm^{-1}$ and C-O stretching and O – H deformation in plane with peaks at $1044.92cm^{-1}$ indicating the present of primary alcohol and secondary alcohol peaks at $1085.42cm^{-1}$ and has a C -- H deformation of CH_3 --- C --- at $1385.90cm^{-1}$ other peaks include 1638.43cm-1, $2114.81cm^{-1}$ and a presence of C – H stretching for CH_3 - at $2982.63cm^{-1}$ with $876.68cm^{-1}$.

Boiled Potato ethanol spectrum 3



The above spectrum (3) for potato ethanol indicated peaks that are relevant for the presence of alcohol at $33339.22cm^{-1}$ for intermolecular hydrogen bonding and OH bond with broad peaks, intensity changes and increase in frequency on dilution. It also indicated the presence of chelate compound that peaks at $2975.27cm^{-1}$ and $2893.81cm^{-1}$. And peaks at $1044.92cm^{-1}$ shows the presence of primary alcohol and at $1086.80cm^{-1}$ and $1325.23cm^{-1}$ and $1274.19cm^{-1}$ with low peak indicated the presence of secondary alcohol and peaks at $1381.25cm^{-1}$ indicated the presence of CH_3 and CH_3--- C – deformation, also peaks at $2975.27cm^{-1}$ and $2893.81cm^{-1}$ shows the presence of chelate compound.

Table 1: Physical Properties of Synthesed Alcohol

	Cocoyam (Eposo)	Potato	Potato (boiled)
Refractive index	1.344±0.2	1.337 ±0.1	1.338±0.1
Specific gravity	0.9732±0.01	0.9730±0.01	0.9730±0.02
Density g/ml	0.9608±0.1	0.9606±0.1	0.9604±0,1
% Total solid	7.50±0.01	5.00±0.01	5.00±0.01
Boiling point °C	78.00±0.1	78.00±0.2	78.11±0.1
Flash point (Min.)	3.0±0.1	3.0±0.2	3.0±0.1
% Alcohol	99.6±0.1	95.0±0.1	96.0±0.1
Total acidity (M)	0.001±0.01	0.001±0.01	0.001±0.01
Color	colorless	colorless	colorless

Table 1 above reveal the physical properties of alcohol and it shows that the eposo ethanol has 1.344±0.2 as value for refractive index while that of sweet potato and boiled potato has 1.337±0.1 and 1,338±0.1 respectively. The density were 0.9608±0.1g/ml, 0.9606±0.1g/ml and 0,9604±0.1g/ml for Eposo, potato and boiled potato respectively. And their was, the same boiling point, with the % total solid for eposo was 7.50±0.01% and for potato and boiled potatoes as 5.00±0.01% and 5.00±0.01% respectively. The Specific gravity indicated: 0.9732±0,01 for eposo, and 0.9730±0.01, 0.9730±0.02 for potato and boiled potato respectively, but is higher than the value reported for water yam alcohol (0.847) by Hashimi (2021) [2]. All have the same boiling point. The color remain colorless while the percentage alcohol present are: 99.6±0.1% for eposo and 95.0±0.1% and 96.0±0.1% for potato and boiled potato respectively and the color was colorless for all samples. The flash point was 3minutes for the alcohols and the total acidity was 0.001±0.01M.

Laboratory Test: When reacted with sodium metal it generate an hydrogen gas like any other hydroxyl group like phenol and acid. It shows the present of alcohol. Other method for the test confirm the present of alcohol.

Conclusion

From the discussion above it was ascertained that alcohol was present in all the samples. The spectrum for all samples confirmed the its present, especially as primary alcohol. It has a potential, as raw material in the production of biodiesel. Therefore, planting of potato and eposo cocoyam must be encouraged by our famers not only for food but also for industrial use, by the Ministry of Agriculture.

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