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Study of Bioethanol Production from Fermented Yam Peel

Ipeghan Jonathan Otaraku, Anaele John Vitus

Department of Chemical Engineering, University of Port Harcourt , Nigeria

ABSTRACT

In 2010 worldwide ethanol fuel production reached 22.95 billion U.S. liquid gallons (86.9 billion liters), with the United States as the top producer, accounting for 57.5 percent of global production. Following the demand by government of developed countries, for the addition of blends to gasoline in other to meet the stringent environmental laws, the production of ethanol is now being given consideration because it is environmentally friendly. In this study, yam starch was used to produce ethanol. After undergoing purification by distillation, the ethanol produced during the fermentation process, was characterized to ascertain its authenticity. The characterization of ethanol was done by determining some selected physical properties of ethanol and the values obtained was compared with standard physical property data for ethanol. The properties include Density, Viscosity, and Boiling point. The results obtained were as follows: 0.828g/cm3, 0.00127Pa.s, 78.620. The results shows that Ethanol can thus be produced from starch containing food staples by fermentation.

Keywords : Yam Peel, Fermentation, Ethanol

I. INTRODUCTION

Some Yam tubers affect human and animal when they are consumed in the raw form due to the toxic content in them, regardless of their high nutritional value (Afoakwa and Sefa-Dedeh, 2001). Yam tubers has sharp and bitter to the taste and they causes irritation and inflammation of the mouth and throat; when consumed , it can result in stomach upsets, vomiting and diarrhea (Medoua et al, 2007). Yam also contains several anti-nutritional factor, which consists of polyphenol, oligosaccharide (α-galactoside), lectins, proteases and amylase inhibitors, are widely distributed in most plants (Apata and Babulola,2012).

In the world today the largest natural energy sources has been from fossil fuels (petroleum and coal) and these fuels are being utilized in a rapid rate and due to the high rate of consumption of these resources, there are predictions that these fuels may last only for few more years (Chandel et al. 2007). Looking at different alternative energy resources that can substitute natural energy resources, bio-ethanol has shown to be the most promising because it is of biological and renewable origin, normally derived from energy crops such as yam maize, sugarcane, cassava and sweet potato and by-products of agriculture and forestry (Ward et al. 2002). Bio-ethanol is an alcohol produced by fermenting and distilling various feed stocks (sugar, starch and cellulose), which have been converted to simple sugars by enzymatic or acid hydrolysis (Larssen et al. 2003). Following the demand by government of developed countries, for the addition of blends to gasoline in other to meet the stringent environmental laws, the production of ethanol is now being given consideration because it is environmentally friendly. In this study, yam starch will be used to produce ethanol

II. RESEARCH METHODOLOGY

The Yam (Discorea Bulbifera) tubers were purchased at the Choba market in Choba village, Obio-Akpor, both in Rivers State. Before the raw materials underwent physical pre-treatment, the weight of the three yam samples used was measured using a 2610g capacity Ohaus triple beam balance.

Pre-treatment (Raw Materials Preparation)

The tubers were washed with tap water and were peeled with knife to remove the outer bark, sliced into smaller bits in order to reduce the size, further washing was done to remove dirt, then followed by grating to obtain the marsh, the marsh was sieved through a muslin bag which served the purpose of a filter medium. The filtrate (Starch milk) obtained was allowed to stand for 6 hours 30 minutes to obtain the slurred starch which settled at the bottom of the containing vessel. The wet starch cake of the samples was sun dried for five (5) hours and then packaged into a transparent plastic jar and labeled prior to experimentation.

Hydrolysis

Twenty (20) grams of yam starch was weighed on a balance scale. Each sample was slurred in 200ml of distilled water at room temperature. Homogenizing of slurry samples was done by stirring a slurry concentration of 20g/200ml. Addition of 20ml of dilute 0.05M H_2SO_4 to adjust pH of each sample (from 7.5 to 6.0) using a syringe. The starch samples were left for 72 hours to observe hydrolysis.

Fermentation

200mL of each of the sample slurry was obtained from hydrolysis of the starch, and then Inoculation of the hydrolyzed samples was carried out using a 5ml syringe. Varying weights in grams of baker's yeast in 5ml of distilled water was used as the inoculum. The inoculated samples were left standing for eight (8) days as fermentation was monitored at around 35-40°C. After fermentation was complete, the fermentation mixture obtained from the samples was carefully decanted and labeled prior to distillation.

Laboratory Distillation

Double distillation is used as the purification method for separating ethanol from water. The experimental set up for the first distillation is as shown in the figure below:

Figure 1 : Laboratory display of First distillation

A second distillation is carried out with the same apparatus and procedures but, this time temperature (about 78-80°C) was monitored by inserting a thermometer into the still head of the distillation flask. This is to obtain a purer Ethanol distillate with low water content. The volume of ethanol-water mixture from samples and that of the ethanol collected from samples are recorded.

Characterization of Ethanol Produced

Determination of Density

The mass of the beaker was measured when it is empty. Then the mass of the beaker was measured with a given volume of sample, and then mass of the fluid was determined by subtracting the mass of the empty beaker from the mass of the beaker with the samples. The density of the samples was determined by dividing its mass by its volume.

Determination of Boiling Point

A small volume (≈ 5 ml) of the liquid was placed in a round bottomed flask. A cork, sealed at one end, was placed open-end down into the liquid. And then the round bottomed flask was firmly attached to a thermometer with a cork, and this entire assembly, was clamped to a retort stand. The assembly was sat on a hot plate. As the temperature was slowly increased, a rapid evolution of bubbles from the end of the flask begins. Heating was continued for about 5-10 seconds to be sure that all of the air has been expelled from the flask, and the vapors of the liquid remains in the flask. The heat was then removed, and the assembly was placed in a water bath, and the capillary of the thermometer was carefully watched. Bubbles continue to be seen until the pressure exerted by the vapor of the liquid becomes equal to the atmospheric pressure. As the temperature decreases, the bubbles will slow down and at some point, the liquid will rise into the capillary. The boiling point of the sample was reached when the bubbles stops. The thermometer was read and the temperature was recorded. The temperature when this happen was the observed boiling point of the sample.

III. RESULTS AND DISCUSSION

Table 1 : Weights of Yam Specimen Used

S/N	Measured Weights (g)
Sample 1	446.30
Sample 2	490.45
Sample 3	396.59

Table 2 : Values of volume and weight of fermentation mixture and wet starch cake obtained

	Yam Starch
Volume of Ethanol obtained after distillation	74.00mL
Weight of fermentation mixture	232.78g
Volume of fermentation mixture	136mL
Weight of wet starch cake	292.55g

Table 3 : Summary of properties of Ethanol samples

S/N	Property	Units	Ethanol of Sample A
1	Density	g/cm	0.828
2	Viscosity at 20°C	Pa.s	0.00127
3	Boiling Point	°C	78.620

Discussion

Comparing the above results obtained from the experimental analysis, it shows that the density of the yam sample 0.828g/cm3 which tally closely to that as referenced from standard physical property data for Ethanol given as 0.7890g/cm3.

For viscosity, the results as indicated for the yam samples 0.00127Pa.s In comparison, with that obtained from data, which is given as 0.0012Pa.s at 20°C, it could be seen that the expected product of the distillation was obtained, though the value for the samples vary slightly from that shown in standard physical data for ethanol. Furthermore, boiling point of the sample 78.62°C which is very close to that obtained from literature as 78.10°C.

The discrepancies in the values obtained from the experiments may be traced to parallax errors in reading values from apparatus, and impurities such as water found on the wall of experimental apparatus including handling of samples in the course of carrying out the experiment

IV. CONCLUSION

1. Yam which is a food staples containing starch can be used as raw materials in the production of Ethanol by fermentation culture of yeast.
2. For 1kg of yam starch fermentation mixture used, 317.90cm3 or 3.179m3 of ethanol is produced
3. For 1kg of yam wet starch cake used, 2.530m3 of ethanol is produced
4. The density of ethanol produced from the samples is closely similar to that cited from literature, as 0.828g/cm3.The viscosity and boiling point of ethanol produced from the samples is closely similar to that cited from literature, as 0.00127Pa.s and 78.62

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