Bioethanol production from Sweet Potatoes

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Abstract
In this study, sweet potato starch was used to produce ethanol. After undergoing purification by distillation, the ethanol produced during the fermentation process was characterized to ascertain its originality. The characterization of ethanol was done by determining some selected physical properties of ethanol and the values obtained were compared with standard physical property data for ethanol. The properties include Density, Viscosity, and Boiling point. The results obtained were as follows: 0.825g/cm3, 0.00143Pa.s, and 78.40℃ respectively. The results show that Ethanol can thus be produced from starch-containing food staples by fermentation.

KEYWORDS: Sweet Potato, Fermentation, Hydrolysis, distillation, Bioethanol

1.0 INTRODUCTION

The natural energy resources such as fossil fuels (petroleum and coal) are being utilized at a rapid rate and these resources have been estimated to last only for few more years (Chandel et al, 2007). From various alternative energy resources that can substitute natural energy resources, bio-ethanol is the most promising because it is of biological and renewable origin, normally derived from energy crops such as maize, sugarcane, cassava and sweet potato and by-products of agriculture and forestry (Ward et al. 2002). Bioethanol is an alcohol produced by fermenting and distilling various feedstocks (sugar, starch, and cellulose), which have been converted to simple sugars by enzymatic or acid hydrolysis (Larssen et al. 2003). Sweet potato (Ipomoea batatas L.) is one of the important starchy crops having a short growth cycle (90-120 days) and capable of growing in various agro-climatic conditions (Ray and Ravi 2005). The most important process development made for enzymatic hydrolysis of various starch-containing crops and biomass is the introduction of simultaneous saccharification and fermentation (SSF) process (Ward et al. 2006). Following the demand by the 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 considered because it is environmentally friendly. In this study, Potato starch will be used to produce ethanol.

2.0 Research methodology

The Sweet Potatoes (Ipomoea Batatas) tubers were purchased at Arta-Arta market located off Shell location road, Oyigbo, in Rivers State. The six samples of raw sweet potatoes were measured using a 2610g capacity Ohaus triple beam balance

2.1 Pre-treatment (Raw Materials Preparation)

The tubers were washed with tap water. Peeling with a knife was done to remove the bark, and were Sliced into smaller bits for size reduction and they were rewashed with tap water, and were Grated to obtain the marsh, and was subjected to Sieving through a muslin bag which served the purpose of a filter medium

Figure.1: Sweet Potato Pulp obtained after grating.

The filtrate (Starch milk) obtained was allowed to stand for 5 hours 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 before experimentation.

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2.2 Hydrolysis

Twenty (20) grams of sweet potato starch was weighed on a balance scale. The sample was slurred in 200ml of distilled water at room temperature. To obtain a homogenized slurry sample they were stirred, Addition of 20ml of dilute 0.05M H_2SO_4 to adjust the pH of each sample (from 7.5 to 6.0) using a syringe. The starch samples were left for 72 hours to observe hydrolysis.

2.3 Fermentation.

200mL of each of the sample slurry was obtained from the hydrolysis of the starch sweet potato. 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℃. After fermentation was complete, the fermentation mixture obtained from the samples was carefully decanted and labeled before distillation.

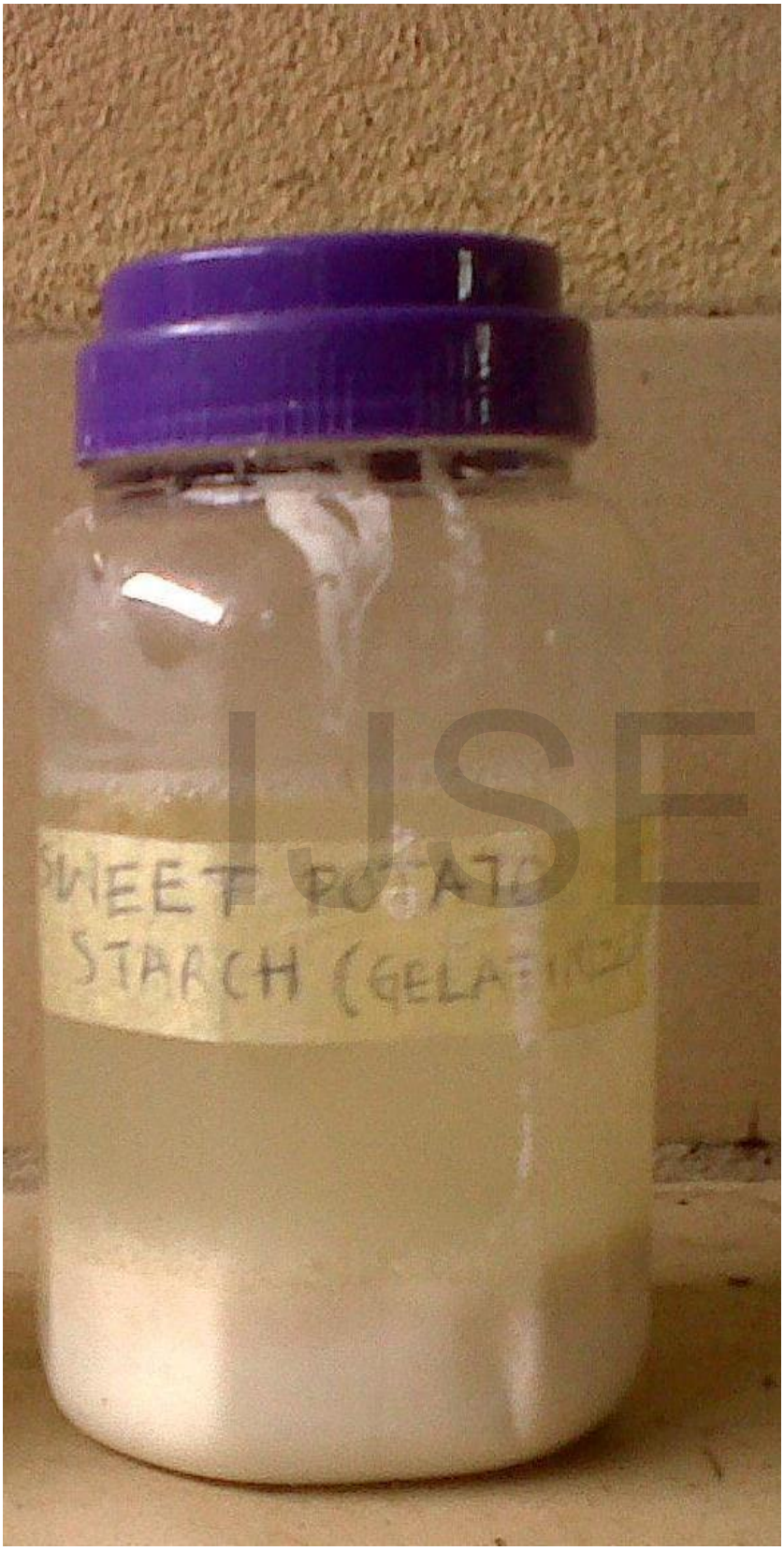

Figure .2: Fermentation Culture of Starch Substrates

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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 3: 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 the ethanol-water mixture from samples and that of the ethanol collected from samples are recorded.

2.4 Characterization of Ethanol Produced

2.4.1 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 the 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.

2.4.2 Determination of Boiling Point

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, the 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 remain 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 stop. The thermometer was read and the temperature was recorded. The temperature when this happens was the observed boiling point of the sample**.**

Figure 4: Ohaus Scale

3.0 Result and discussion

Table 1: Weights of Sweet Potato Specimen Used

S/N	Measured Weights (g)
Sample 1	211.45
Sample 2	363.30
Sample 3	185.70
Sample 4	322.50
Sample 5	301.60
Sample 6	254.60

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

	Sweet Potato Starch
Volume of Ethanol obtained after distillation	20.00mL
Weight of fermentation mixture	203.02g
Volume of fermentation mixture	160mL
Weight of wet starch cake	225.69g

Table 3: Summary of properties of Ethanol samples

S/N	Property	Units	Ethanol from sweet Potato
1	Density	g/cm	0.825
2	Viscosity at 20℃	Pa.s	0.00143
3	Boiling Point	℃	78.400

4. Discussion

Comparing the above results obtained from the experimental analysis, it shows that the density of ethanol produced from sweet potato is0.825g/cm3 which tally closely to that as referenced from standard physical property data for Ethanol given as 0.7890g/cm3.
For the viscosity which was obtained as 0.00143Pa.s. in comparison, with that obtained from data, which is given as 0.0012Pa.s at 20℃, it could be seen that the expected product of the distillation was obtained, though the value for the ethanol produced from the samples vary slightly from that shown in standard physical data for ethanol. Furthermore, the boiling point of 78.40℃ which is very close to that obtained from literature as 78.10℃.
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 experimenting.

5. Conclusion

It is evident, therefore, that:

- Sweet potato which is a food staple containing starch can be used as raw materials in the production of Ethanol by fermentation culture of yeast.
- The density of ethanol produced was 0.825g/cm3 which was very close to the literature value.
- The viscosity and boiling point of ethanol produced from the sample is closely similar to that cited from literature, 0.00143Pa.s and 78.40℃ respectively

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