**TITLE**

**ETHANOL PRODUCTION FROM YAM (*DISCOREA SPP)* PEELS**

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**Abstract**

This work is concerned mainly with the production of ethanol from yam (Discoria spp) peels. The yam tubers were bought from Eke Oko Market, in Orumba North L.G.A. Anambra State. The tubers were peeled and the peels washed, milled & weighed. To 1000g of the powdered wort, distilled water was added, mashed & filtered. Yeast & malt were added to the filtered wort and allowed to stand for three days for fermentation. The fermented wort was distilled to collect a colourless liguid as the distillate. This distillate was neutral to litmus test, soluble in water, forms esters with acetic acid and positive to lucas test showing it to be a primary alcohol-ethanol.

**CHAPTER ONE**

**INTRODUCTION**

* 1. **Background of the study**

Yams (Discorea spp) of the family Diocoreaceae are members of the flowering plant. They are monocots, related to palms, grasses and archids. Most yam species grow in the tropics and subtropics area with fairly heavy total annual rainfall, but with a definite day season. During the rainy season, they produced one or more underground tubers to store food and water through the dry season the tubers are thickened stems. Most yam plant have small flower with one plant having only male or female flower (Kay, 1987).

The tubers of most species of yam are poisonous to humans. The cultivation of most yams is very labour intensive. Cultivated yams generally do not produce seed and so tubers or pieces of tuber must be planted in prepared soil, most often in wounds to grow new plants.

Yams are nutritious food, providing carbohydrate, some protein, and mineral like phosphorus and potassium besides the use as food, yams have been symbolically associated with culture and ritualism in some parts of Africa, Asia and Latin Americas.

According to Ogbuka (2005) Ethanol can be produce from starch –containing substances like maize, cassava and yam. Ethanol is a monohydric alcohol that is colourless and flammable, it is a 2 –carbon alcohol with molecular formular CH3 CH2 OH, its empirical formular is C2H6O. An alternative notation is CH3CH2 OH which indicates that the carbon of a methyl group (CH3) is attached to the carbon of an ethylene group (CH2-) which is attached to the oxygen of a hydroxyl group (OH). Ethanol is a colourless liquid that burns with a smokeless blue flame. It has a choking smell and a boiling point of 780c. They are characterized by the possessing of phydroxyl group (OH) as their functional group. Alcohols can be classified as primary, secondary and tertiary. The primary alcohols have only one or no alkyl group attached to the hydroxyl bonded carbon atom, the secondary alcohol contain two alkyl group attached to the hydroxyl bonded carbon atom while the tertiary alcohol contains three alkyl groups but no hydrogen attached to the hydroxyl- bonded carbon atom while the tertiary alcohol contains three alkyl groups but no hydrogen attached to the hydroxyl-bonded carbon atoms:

According to West et.al (2007) ethanol is a principle fuel that can be used as petrol substitute for vehicles. It is a renewable energy source produced mainly by sugar fermentation process. It is used in preservation of specimen, food e.t.c and even as a raw material in the manufacturing of chemicals and pharmaceuticals like trichloromethane

* 1. **Statement of the Problems**

Alcohol has been known to be produced from fossile like maize, cassava, even yam tuber but there is still need to search for other sources considering the usefulness of ethanol source, hence the need for this study. Furthermore, yam peel are regarded as waste after using the main yam tuber, therefore there is need to source for alcohol in this peel which either are throw away. This study will also reduce environmental pollution which is caused by the yam peel.

* 1. **Objectives of the Study**

Objectives of this study include:

* To extract ethanol from yam peel
* To carry out qualitative test on the produced ethanol
	1. **Significant of the Study**

The knowledge from this study will help in creating awareness to the government as well as the society at large on the need to grow more yams. Finally this study will also help the society to know that ethanol is not just present in the yam tuber alone but also in the peels (yam peels)

* 1. **Scope of Study**

This study is concerned with the production of ethanol using yam peel which involves

* Collection and identification of the sample
* Preparation of the sample
* Production of ethanol from the sample
* Qualitative tests on the produced ethanol.

**CHAPTER TWO**

**LITERATURE REVIEW**

**2.1**  **Origin and History of Yam**

Yam (Diocorea spp) is an annual perennial tuber bearing and climbing plant belonging to the family of Diocerecaea. Some species of yam originated from Africa before spreading to other parts of world while some originated from Asia and have spread to Africa (Halm et.al, 1987).

Today, yams are grown widely throughout the tropics and they have a large biological diversity including more than 60 species worldwide (Burkill, 1960; coursey, 1967) but only six species are widely cultivated in west and central Africa. The cultivated species are D. alata, D. bulbifera, D. dumetonum, D. esculerta, D. cayenensis and D. rotundata. Wild types also exist and maybe used as food after undergoing processing during the hunger season (Tettech and Saakwa, 1994).

**2.2** **Description of Yam**

Yams are monocots, related to lilies and grasses. Native of Africa and Asia, yam tubers vary in size. It can grow up to 1.5 meters (4.9 feet) in length and weight up to 7.6 to 15.2cm (3.0 to 6.0 inch) high. The vegetable have a rough skin which is difficult to peel, but which soffers after heating.

**2.3** **Taxonomy of Yam**

Yams are members of the flowering plant genus Dioscorea

Kingdom : Plantae

Division : magnoliophyta

Class : liliopsida

Order : Dioscoreales

Family : Dioscoreaceae

Genus : Dioscorea

**2.4** **Harvesting of Yam**

Yam in West Africa are typically harvested by hand using sticks, spades or diggers (linus opera, 2003) Wood-based tools are preferred to metallic tools as they are less likely to damage the fragile tubers; however, wood tools need frequent replacement. Yam harvesting is labour intensive and physically demanding. It involves studing, berding, squatling and sometime sitting on the ground depending the size of mound, size of tuber or depth of tuber penetration. Care must be taken to avoid damage of tuber because damaged tubers do not store well and spoil rapidly.

**2.5 Nutritional Composition of Yam**

 Yam tuber is the most economically utilized part of the yam plant. Its chemical composition varies with species. It may vary down to the environmental condition of the places cultivated (onwuene, 1978). Yam is essentially starchy food. Its greatest single component water accounting for about 65.85% of the fresh weight. Carbohydrate on the other hand is the major component most of its species contain carbohydrates which are mainly starch. i.e annylopetic branched chain existing in the cells in form of starch granules (Uguru, 1993), sugar and protein are only in a quantity of about 2.3 respectively, with protein being mainly sulpha containing amino-acid most of which are caused of the tuber is chilled (Puiseglore, 1976).

**TABLE 1: Chemical composition of yam**

 (D. rotunatol) (whit yam)

Component % Composition

Energy 112kg

Moisture 70.2

Protein 35

Fat 0.1

Fibre 0.5

Ash 1.0

Total carbohydrate 25.2

Source: Walsh, (2003)

Furthermore, most yam tend to be rich in thianuin, riboilailin, nialin etc (Egbe et. al, 1984)

**2.6 Diseases of Yam**

 Yam are being affected by the following diseases:

* Anthracnose (scorch) (colletofrichum gleosporides: - It is a small, dark brown spot or black lesions on leaves which may be surrounded by a chlorotic halo; leaf necrosis; die back of stem; withered leaves and scorched appearance. It can be by using plant yam varieties that are resistant to anthracnose such as TDA 291.
* Dry rot disease (caused by yam namatode) (scutellonema):- the infected tubers show dry rot of I to 2cm initially this dry for is of cream and light yellow lesan appear just below the outer skin without any external symptom. It can be managed by using disease free tuber/setts for planting
* Yam mosaic disease:- the common symptom are infected leaves show yellow and green patterns (called mosaics) between the veins (called vein banding). It can be managed by the use of healthy and disease free tubers or setts for planting and also collecting of crop debris and destroying them.

**2.7 Uses/Importance of Yam**

* Tuber is the main part of the yam plant which has high carbohydrate content (low in fat and protein) and provides a good source of energy.
* Unpeeled yam has vitamin C
* It is medicinal because it is use as a heart stimulant (attributed to its chemical composition, consist of alkaloids of saponin and sapogenium);
* It is used in the industry in production of starch.
* It is used in rituals and festivals

**2.8 Alkanols**

Most common aliphatic alkanols contains only bond hydroxyl group in each molecule they are referred to as monohydric alkonals form a homologous series with the general formular CnH2n+1.OH. Since the group CnH2n+1 is the alkyl group and can be represented generally by R the general formula of the monohydric alkanols can also be written as R0H. The name of each homologue is divided by dropping the end e of the corresponding alkene and replacing it with ol the IUPAC and common name of first few members of the alkanol series is shown in table 2.

**Table 2:** the IUPAC and common names of the first few members of the monohydric alkanol series (Ababio, 1990,)

Molecule Formula Structural Formula LUPAC Name Common Name
CH4O CH3 OH Methanol Methyl alcohol

C2H6O CH3CH2 OH Ethenal Ethyl alcohol

C3H8O CH3 (CH2)2 OH Propan-1-ol n-propyl alcohol

C3H8O CH3CHOHCH3 pron-2-0 lso-propyl alcohol

C4H10O CH3 (CH2)3OH Butan-1-ol n-butyl alcohol

**2.9 Types of Alcohols**

According to Ogbuka (2005) alcohols are classified according to the members of hydroxyl groups present per molecule, namely; monohydric alcohol e.g CH3CH2OH, dihydric alcohol e.g OH-CH2-CH2-OH e.g 1,2 – ethane d, ol or ethylene, polyhydric alcohol e.g OH-CH2-CHOH CH2OH e.g glycerol or propane-1,2,3, triol.

1. **Monohydric Alkanols**

According to stroke, (1972), the monohydric alcohols occur in nature in combination with carboxylic acid as esters-these compounds are responsible for much of the taste and smell of flowers and fruit. These characteristics odour make the valuables ingredients for perfume.

The monohydric alkanols form homologous series with the general formular CnH2n+2O, which is written more satisfactory as CnH2n+1 OH, since their functional group is the hydroxyl group. For example, CH2OH (methanol), CH3CH2OH (ethanol). The monohydric alcohols are subdivided into primary secondary and tertian forms. The three classes of alcohol show different chemical properties when oxidized. A primary Alkanol has only one alkyl group attached to the carbon atom that carries the hydroxyl group, a secondary alkanol has two while a tertiary alkanol has three. The examples are shown below;

H H CH3

CH3 C OH CH3 C CH3 CH3 C OH

H OH CH3

Primary alcohol Secondary alcohol Tertiary alcohol

**2.10 Description of Ethanol**

Ethanol also commonly called alcohol, ethyl alcohol, and drinking alcohol, is the principal type of alcohol found in alcoholic beverages, produced by the fermentation of sugar by yeasts. The molecule is a simple one being an ethyl group linked to a hydroxyl group. Its structural formula CH3 CH2OH is offer abbreviated as C2H5OH / C2H6O Ethanol is a volatile, flammable, colourless liquid with a slight chemical odor.

It is used as antiseptic, a solvent, a fuel and due to its low freezing point, the active fluid in many alcohol thermometers.

**2.11 Properties of Ethanol**

**2.11.1 Physical Properties of Ethanol**

* Ethanol is a colourless, volatile liquid and possessed of a characteristic smell (Holderness and Lambert, 1976).
* It is readily soluble in water in all preparation (due to the presence of the hydroxyl group)
* It has a boiling point of 78oC
* It has no action on litmus paper.

**2.11.2 Chemical Properties of Ethanol**

**Combustion**:- Alcohol burns readily in oxygen to produce carbon dioxide and water C2H5OH+3O3  2(O2+3H2O, other reaction of alcohols are characterized by functional group (-OH) Which may involve either cleavage of ROH.

Both may produce a mixture of substitution and elimination products that depends essentially on the nature of the alkyl group to which the hydroxyl group is bonded (Ogbuka, 2005) these reaction are

**Oxidation**

Ethanol is readily oxidized to ethanol by worring with potassium heptaoxodichromate (vi) solution, which has been acidified with dilute

**2.12 Preparation of Ethanol**

* By the hydrolysis of alkyl halide with agueous alkali or silver oxide suspended in water

RX+ NaOH ROH + Nax

RV + NgOH ROH +Agx

e.g C2H5Br + NaOH wash C2H5OH + NaBr

* Hydrolysis of ester with alkali this is simply saponification of ester

R’COOR2 + KOH R’COOR + R2OH

CH3COOC2H5 + NaOH boil CH3 COONa + C2H5OH

* By fermentation process.

Ethanol can be obtained by fermentation process. Fermentation is the decomposition of complex organic compound into simple compounds through the agency of enzymes.

Enzymes are organic catalysts secreted by living cells. The starting material is always starch (C6H10O5)n, which is obtained from sources depending on the particular country. Common sources of starch are corn of various sorts, wheat, barley, potatoes molasses e.t.c (Ogbuka, 2005).

**2.13 Uses of Alkanols (Ethanols)**

* Ethanol is an important solvent used to dissolved resins varishes, lacques, soaps perfumes, dyes, drug, and flowing extracts.
* It is a raw material used in the manufacturing of many inracing core and in rocket.
* Preservation of specimen food etc
* Ethanol is present in many alcoholic beverages such as bee, wines and spirits (e.g whisky gin brandy, ram etc).
* Sterilization process for example for example cleaning the skin before injection.

**CHAPTER THREE**

**MATERIALS & METHODS**

**3.1** **Materials**

**3.1.1 Apparatus**

* Measuring cylinder
* Liebig condenser
* Thermometer
* Stainless knife
* Corks
* Conical flask
* Distillation flask
* Weighting balance
* Distilled water
* Container
* Beaker

**3.1.2 Reagents**

* Lucas reagents
* Acetic acid

**3.2** **Collection of the Sample**

The yam tubers were bought at Eke Oko market, in Orumba North L.G.A, Anambra State.

**3.3** **Preparation of the Sample**

**3.3.1 Peeling**

The yam tubers were peeled with a stainless knife.

**3.3.2 Washing**

The yam peels were washed in clean water to remove sand and other dirt particles.

**3.3.3 Milling**

The yam peels were milled with greater machine into a powdered form.

**3.3.4 Weighting**

The milled yam peel was weighted using a celebrated weighing balance.

**3.4 Isolation of the Sample**

**3.4.1 Mashing**

Mashing is an enzymatic process that involves hydrolysis of starch containing substances to fermented sugar. 1000g of yam peel flour was transferred into 1500ml of water in a container. The flask was shaken to make the content homogenous.

**3.4.2 Mashing filtration**

The resulting wort was filtered with Muslim cloth to remove insoluble materials.

**3.4.3 Fermentation**

The wort was transferred into a container (fermentor). Yeast & malt were added to the wort in order to enhance fermentation after which it was tightly covered and was allowed to ferment and stand for 3days.

**3.4.4 Distillation**

Distillation was used to separate ethanol from the fermented wort. 300g of the fermented wort was poured into the distillation flask. Thermometer was fixed into the cork which was used to cover the mouth of the distillation flask. Heat was applied to the distillation flask at a temperature of 500c and allowed to stand for 15mins. The temperature was further raised to 600c and allowed to stand for another 15mins. Again the temperature was further raised to 780c and allowed to stand for another 15mins, at each given minutes the temperature was maintained. At this point the distillate was collected with a beaker placed at the mouth of the Liebig condenser attached to the distillation flask as shown in fig. 3.1. After which the residue in the distillation flask was decanted and again the process was repeated for the remaining fermented wort, so as to achieve a considerable amount of distillate (ethanol).

The flow chart for the ethanol production starting from yam peels is shown in fig. 3.2 below.

Peeling

Washing

Milling

Weighting

Mashing

Mashing filtration

Fermentation

Distillation

Analysis

**Fig.3.2 flow chart on the production of ethanol.**

**3.5 Qualitative Test**

Some qualitative tests were carried out on the produced ethanol to ascertain its quality.

Such tests include:

1. **Litmus test:** Wet red & blue litmus paper were dipped into the sample & the result were observed & recorded.
2. **Lucas test:** Two drops of zinc chloride was reacted with the sample. The result were observed &recorded.
3. **Ester formation:** Few drops of acetic acid was reacted with the sample the result were observed &recorded.

**CHAPTER FOUR**

**RESULT**

The result of ethanol production and some qualitative test – physical & chemical test are presented in tables 1, 2&3 respectively.

**Table 1: Result of ethanol production from yam peels**

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Quality of yam peels used | 1000g |
| Weight of ethanol produced | 6.8g |

 Percentage of ethanol produced = 6.8 × 100 = 0.68

 1000 1

* The percentage of ethanol produced is 0.68%

**Table 2: The physical properties of the produced ethanol**

|  |  |
| --- | --- |
| **Properties** |  **Value** |
| Appearance | Colorless |
| Litmus test (red &blue) | Neutral |
| Boiling point | 80 + 20c |
| Solubility | Highly soluble in water |

**Table 3: The chemical properties of the produced ethanol**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Test** | **Observation**  | **Inference**  |
|  | Sample + ignation  | Burns with blue flame | Ethanol present |
|  | Sample +zinc chloride | The aqueous layer remains clear | Presence of primary alcohol |
|  | Sample + acetic acid | A sweet smelling aroma with a chocky smell | Presence of ester formed from ethanol |

**CHAPTER FIVE**

**DISCUSSION, CONCLUSION AND RECOMMENDATION**

**5.1 Discussion**

According to table1, ethanol can be produced from yam peels. These shows that yam peel can serve as a substitute to other crops that contains starch early used for ethanol production. It has been recorded that ethanol can be produced from starch containing substance like yam, cassava e.t.c (Ogbuka, 2005). Thus yam peels which hither to be regarded as waste can be another source of ethanol production even though the quality is small.

The result from table 2 equally showed the physical properties of the produced ethanol which conforms to the properties of ethanol in general and which is in agreement to that of the produced ethanol. The boiling point of ethanol is 780c but from our result it varies between +2 which is similar to the boiling point of ethanol.

From the result in table 3, the produced ethanol shows positive result to Lucas test indicating presence of primary alcohol positive result to combustion indicating an organic compound and finally shows positive result to acetic acid reaction indicating the presence of ethanol which reacts with acetic acid to form esters.

**5.2 Conclusion**

This work has shown that yam peels in a suitable raw material for the production of ethanol. This is due to its starch content though the product is low but still manageable.

Finally the physical & chemical properties of the produced ethanol are similar to those isolated by other sources.

**5.3 Recommendation**

Based on the finding of this study, the following recommendations are hereby made:

* Yam peels should not be thrown away but rather be used in production of ethanol.
* Industrialist should be encouraged to establish industries for ethanol production from yam peels.
* More yam farms should be established in the country to increase ethanol production.

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