



## Manufacture of Bio-ethanol from Waste Material (Cassava Peels) Utilizing Some Microbes

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### Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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### ABSTRACT

**Introduction:** There has been various report of the potential of manufacturing of bioethanol from the use of different microbial inoculants for the fermentation of different feedstocks has been previously described and carried out by various researchers. And bioethanol is considered as cheap and efficient biofuel, and environmentally friendly

**Aims:** The aim of this study is to manufacture bio-ethanol from waste material; such as cassava peel, which would serve as an alternate source of fuel.

**Methodology:** Cassava peels obtained from garri processing plant in Ado-Ekiti, Ekiti State, were washed, sun-dried, grounded into powdery form and then sieved with 1.5  $\mu$  nylon sieve. The powdery cassava peels obtained was cultured using the following inoculant combinations: A = 20 g + *Bacillus*; B = 20 g + *Pseudomonas*; C = 20 g + *Bacillus* + *Pseudomonas*; D = 40 g + *Bacillus*; E = 40 g + *Pseudomonas*; F = 40 g + *Bacillus* + *Pseudomonas*; G = 20 g + *Aspergillus niger*; H = 20 g + *Fusarium*; I = 40 g + *Aspergillus niger*; J = 40 g + *Fusarium*. The control was free of inoculated organism. The cultures were subjected to distillation process for on the 21st day; and the quantity of bio-ethanol manufactured in each group was recorded.

**Results:** The waste material (cassava peels) produced the highest bio-ethanol yield of 147 mL with *A. niger*, followed by the combination of *Bacillus* + *Pseudomonas* which yielded 108 mL of bio-ethanol. Low ethanol yields of 45, 83 and 94 ml/L were obtained from the cassava peels of in combination with *Fusarium*, *Pseudomonas* and *Bacillus* alone.

**Conclusion:** Microbes of choice in this study displayed great potential for manufacturing of bio-ethanol from cassava peels.

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## 1. INTRODUCTION

Sugar fermentation is the main process through which bioethanol fuel produced, although this can also be produced by the chemical process of reacting ethylene with steam. One of the best alternative fuels in order to beat severely the energy crises is from Biofuel. From biologically carbon fixation the energy is derived from Biomass [1]. The main contents of ethanol are sugar, starch or cellulose. The Bioethanol is one of the environment friendly fuels, the effects on environment is less because the Ethanol contains oxygen [2].

According to Byadgi and Kalburgi [2], bio-ethanol was described as a form of renewable energy that can be produced from agricultural feedstocks; and can be made from very common crops such as cassava, sugarcane, potato and corn. Bio-ethanol can be produced by means of different sources like organic waste materials, cellulosic biomass, and food waste. The cellulosic biomass, such as agricultural residue (cassava peels) and industrial waste are the most abundant and cheap source of renewable energy in the world [3].

There are various ways through which bio-ethanol can be produced; the most common way is via fermentation. The basic steps for large-scale production of ethanol are: microbial (yeast) fermentation of sugars, distillation, dehydration, and denaturing (optional). Prior to fermentation, some crops require saccharification or hydrolysis of carbohydrates such as cellulose and starch into sugars [2].

Bio-ethanol is considered a clean-burning, high octane number fuel that can readily substitute gasoline and its combustion results in significant reductions of toxic emissions [4]. When bio-ethanol is produced from renewable sources such as biomass it can both decrease urban air pollution and reduce the accumulation of carbon dioxide (CO<sub>2</sub>). Thus, replacement of gasoline with ethanol, derived from renewable biomass feedstocks that sequester CO<sub>2</sub> during growth, is expected to reduce CO<sub>2</sub> emissions by 90 ~ 100% [5].

Currently, bioethanol production is focused on sugar crops including sugar cane and sugar beets and also starch crops, including wheat, cassava, potatoes and sweet potatoes, which is

often based on excess agricultural production and it is generally recognized that this volume is too small in comparison with the anticipated levels of production required for total conversion of transportation fuel markets from gasoline to ethanol. However, this study aimed at manufacturing bio-ethanol from waste material; such as cassava peel, which would serve as an alternate source of fuel.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The research covers one location in Ado-Ekiti, Ekiti State, Nigeria where the waste cassava peels were obtained. Ado Ekiti is the capital and largest city of Ekiti State with Coordinate: Latitudes (7° 37' 23.84" N and Longitudes 5°13' 15.13"E)

### 2.2 Collection of Samples

The cassava peel was obtained from a cassava processing industry around Ado-Ekiti, Nigeria. The microorganisms used are *Bacillus cereus*, *Pseudomonas aeruginosa*, *Aspergillus niger*, *Fusarium oxysporum* and made obtained from the department of Science Technology (Microbiology Option), The Federal Polytechnic, Ado-Ekiti.

### 2.3 Preparation of the Cassava Peels

The cassava peels were washed under running tap water to remove sand and other impurities, sun dried for 7days under the sun, pounded into powder (flour) form with the use of mortar and pestle with a sieve. The flour was packed into sterile plastic container, sealed and labelled.

### 2.4 Fermentation

Twenty gram (20 g) of the sieve cassava peel was weighed into four (4) conical flasks and dissolved each in 500 ml of distilled water. And another 40 g of the sieved cassava peel was weighed into another four conical flasks; and also dissolved with 500 ml of distilled water; the flasks were covered with foil paper and well-tightened with paper tape, thoroughly shaken, and autoclaved for 15 minutes at 121°C.

At the eight flasks containing 20 g (4 flasks) and 40 g (4 flasks) respectively were inoculated with the following;

For 20g of flask.

- First flask – 10ml of *Bacillus*
- Second flask – 10ml of *Pseudomonas*
- Third flask – 10ml of *Bacillus* + 10ml of *Pseudomonas*
- Fourth flask – Control

For 40g of flask

- First flask – 10ml of *Bacillus*
- Second flask – 10ml of *Pseudomonas*
- Third flask – 10ml of *Bacillus* + 10ml of *Pseudomonas*
- Fourth flask – Control

The mixture in each conical flask was sealed with aluminum foil and cotton wool then sealed with paper tape to avoid contamination and kept for 21days at room temperature; after which the bioethanol was extracted using Soxhlet extractor.

For the other organism i.e. *Aspergillus niger*.

20g of cassava peels was weighed into three flasks and 40g in 3 conical flasks and the same procedure was carried out for the 6 flasks respectively and inoculated with the following.

For 20g of flask.

- First flask – 10ml of *Aspergillus niger*
- Second flask – 10ml of *Fusarium*
- Third flask – Control

For 40g of flask

- First flask – 10ml of *Aspergillus niger*
- Second flask – 10ml of *Fusarium*
- Third flask – Control

The mixture in each conical flask was sealed accordingly and kept for 28days at room temperature and the bioethanol was extracted using Soxhlet extractor.

## 2.5 Distillation

The filtrates were subjected to distillation process at 78°C which is the standard temperature for ethanol distillation. After distillation the product is obtained which is the alcohol.

## 2.6 Determination of Quantity of Ethanol Produced

Volume of distillates obtained were determined with a measuring cylinder and were expressed as quantity of ethanol produced in g/cm<sup>3</sup> by multiplying the volume of the distillate by the density of ethanol (0.8033 g/cm) as described by Humphrey and Okafoagu [6].

## 3. RESULTS AND DISCUSSION

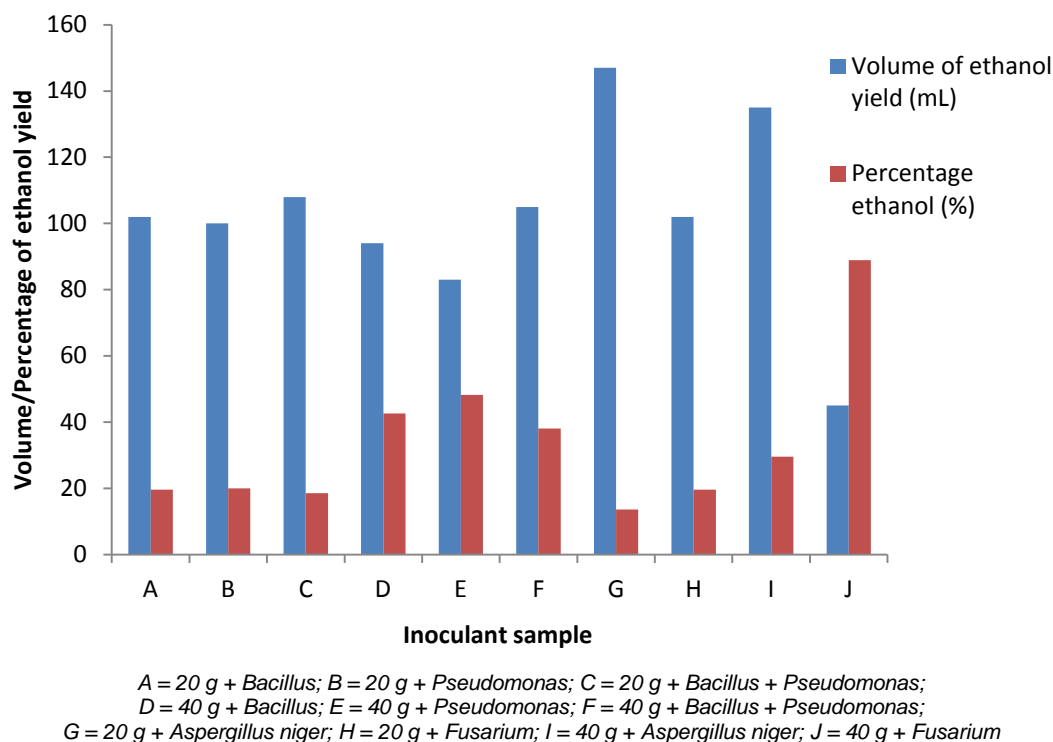
### 3.1 Results

The result from manufacturing of bio-ethanol in 20g sample (cassava peels) + *Bacillus* and *Pseudomonas* produced the highest volume yield while 20g sample + *Pseudomonas* produced the least (Fig. 1). The ethanol produced from 40g sample + *Bacillus* and *Pseudomonas* has the highest volume yield while 40g sample + *Pseudomonas* has the least volume yield, also production of ethanol from 20g sample + *Aspergillus niger* produced the highest volume yield while 40g sample + *Fusarium* produced the least volume yield. The volume of concentration yield obtained amongst the various organisms and the cassava peels, inoculum G (*Aspergillus niger*) consistently yielded the highest volume in all the inoculants while *Fusarium* produced the least in all inoculants and varieties of cassava grams.

### 3.2 Discussion

The microbes utilized in this study produced different amylolytic enzymes to different levels which acted on the cassava peel. Highest bio-ethanol yield of 147 mL was obtained from *A. niger* and a concentration of 13.6% (v/v) after distillation. This might be predicated upon the fact that *A. niger* possess more carbohydrates which is fermentable to bio-ethanol in the presence of the amylolytic microbes.

This result corresponds with the report in the study carried out by Sulphari et al. [7] which produced a higher yield due to the presence of cassava peel substrate and good pH conditions. The current result is higher than that obtained and reported by Khoja et al. [8], who obtained 9.3 (v/v) and 8.3% (v/v) of ethanol from sugarcane molasses using *Z. mobilis* and *S. cerevisiae* respectively.



**Fig. 1. The yield of bio-ethanol from the cassava peels sample treated with different inoculants**

Agulejika et al. [9] reported average yield in the concentration of bio-ethanol production, similarly; the result obtained for concentration of bio-ethanol manufactured in the present study is relatively high. This is likely to be due to the presence of more carbohydrate content in cassava peels than in cocoyam peels reported by Agulejika et al. [9].

The concentration of bio-ethanol manufactured in this study is lower than the 83% yield obtained and reported by Sivamani and Baskar [10] in cassava peel utilizing saccharification and fermentation mixture containing glucoamylase with optimum conditions of 69.82 g/L substrate concentration, 24.74% (v/v)  $\alpha$ -amylase concentration. Most often, the disparity in the yield of bio-ethanol could be attributed to the actual amount of carbohydrate present in the peel at the beginning of the manufacturing process.

#### 4. CONCLUSION

The result of this study affirms that bio-ethanol can be manufactured from cassava peels. The utilization of this agricultural waste material is worthwhile enterprise for bio-ethanol manufacturing; considering their cost efficient

and are also means of controlling environmental pollution.

#### DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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