Original Research Article

Production of Bioethanol from Cassava Peels Using Some Microorganisms

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ABSTRACT

Introduction: The potential of bioethanol production using 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 produce bioethanol as an alternative source of fuel using cassava peels as raw materials.

Methodology: Peels obtained from garri processing plant in Ado-Ekiti, Ekiti State, were washed, sun-dried, ground into a fine texture and sieved with 1.5 µ nylon sieve. The sieved material 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 not inoculated with organism. The cultures were distilled on the 21st day and the quantity of ethanol produced in each treatment group recorded.

Results: Cassava peels gave the highest ethanol yield of 147 mL using *A. niger*. Similarly, the second highest ethanol yield of 108 mL using the combination *Bacillus* + *Pseudomonas*. 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. The yield reported in this study competes favorably with those reported from cassava peels, potato peels and millet husks using other inoculant treatments by other researchers.

Conclusion: Inoculants used in this study thus showed great potential for bioethanol production from cassava peels.

Keywords: Bacteria, Bioethanol, Cassava, Fermentation, Fungi

1. INTRODUCTION

Sugar fermentation is the main process through which bioethanol fuel produced, although this can also be manufactured by the chemical process of reacting ethylene with steam. The main sources of sugar required to produce ethanol come from fuel or energy crops. These crops are grown specifically for energy use and include cassava, corn, maize and wheat crops, waste straw, willow and popular trees, sawdust, reed canary grass, cord grasses, and sorghum plants. Fukushima and Yamade [1] ventured into research and development of the use of municipal solid wastes to produce ethanol fuel. Bioethanol comes from a renewable resource i.e. crops and not from a finite resource and the crops it derives from can grow well, like cereals, sugar beet and maize). Bioethanol is also biodegradable and far less toxic that fossil fuels. Bioethanol is produced using familiar methods, such as fermentation, and it can be distributed using the same petrol forecourts and transportation systems as before [1].

The processing of cassava tubers yields the following by- products that can be valuable livestock feeds when properly processed: Cassava peels can represent 5 to 15% of the root [2]. Cassava sievate or garri sievate is the by-product of the production of garri (also spelled

gari or gary), a popular West African food. Tubers are peeled, crushed and then fermented [3]. Cassava stumps are the ends trimmed off the cassava tubers as they are manually prepared for onward transmission into the rotary washer and peeler [2]. Cassava whey is the liquid pressed out of the tuber after it has been crushed mechanically. The whey and the pomace may be mixed together to form an effluent (or slurry) [2].

The process of bioethanol production generally involves pretreatment, hydrolysis of biomass to fermentable sugars followed by fermentation of such sugars to ethanol [4]. In a study, waste of cassava peel (*Manihot esculenta*) was hydrolyzed by using sulphuric acid. Yeast isolated from Durian fruit (*Durio zhibetinus*) was also reported to be used in the experiment for fermentation and the concentration of sulphuric acid of hydrolysis process was fermented by yeast for 1; 2; 3; 4; 5; 6; 7; and 8 days [4]. This study therefore aimed to produce of bioethanol as an alternative source of fuel using cassava peels as raw materials.

2. MATERIAL AND METHODS

2.1 Study area

The study area is Ado-Ekiti, Ekiti State, Southwestern Nigeria. 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 to remove sand and other impurities, sun dried for 7days under the sun, pounded into powder (flour) from using 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^{o}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 filtrate was distilled at 78^{o}C (standard temperature for ethanol distillation). This was done for each fermented sample. After distillation the product is obtained which is the alcohol.

2.6 Determination of quantity of ethanol produced

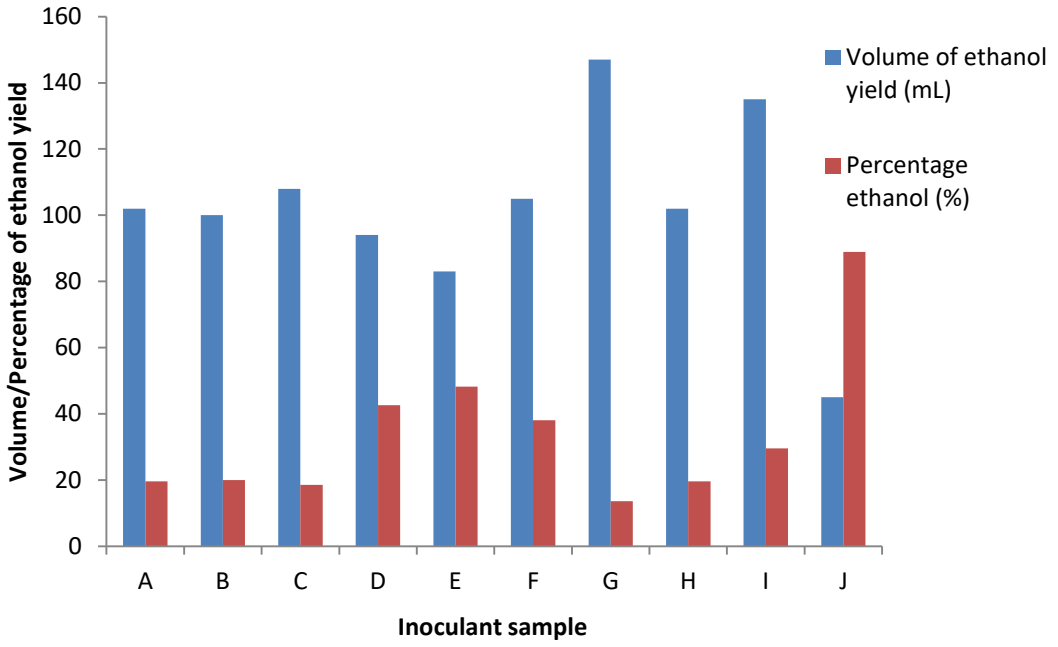
The volume of the distillate collected was determined using a measuring cylinder and expressed as quantity of ethanol produced in g/cm^3 by multiplying the volume of the distillate by the density of ethanol (0.8033 g/cm) as described by Humphrey and Okafoagu [5].

3. RESULTS AND DISCUSSION

3.1 Results

The result from the production of ethanol from 20g sample (cassava peels) + *Bacillus* and *Pseudomonas* produced the highest volume yield while 20g sample + *Pseudomonas* produced the least (Figure 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 concentration yield obtained amongst the inoculants and varieties of the cassava peels gram, inoculum G (*Aspergillus niger*) consistently produced the highest volume yield in all the inoculants while *Fusarium* produced the least in all inoculants and varieties of cassava grams.



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

Figure 1: Ethanol yield from the cassava peels sample treated with different inoculants

3.2 Discussion

The microorganisms expectedly produced different amylolytic enzymes and to different levels which acted on the cassava peel. The highest ethanol yield of 147 mL was obtained from *A. niger* and a concentration of 13.6% (v/v) after distillation. This could be attributed to the presence of more carbohydrates from *A. niger* which is fermented to ethanol in the presence of the amylolytic microorganism. This result is in line with the work of Sulfahri *et al*. [6] that gave a higher yield because of the presence of cassava peel substrate and good pH conditions. The present result is higher than that obtained by Khoja *et al*. [7], who obtained 9.3 (v/v) and 8.3% (v/v) of ethanol from sugarcane molasses using *Z. mobilis* and *S. cerevisiae,* respectively.

The average percentage concentration of ethanol obtained in the present study is relatively high as compared to the average yield reported by Agulejika *et al*. [8]. They reported an average ethanol concentration yield of 16%. This is likely to be due to the presence of more carbohydrate content in cassava peels than in cocoyam peels. The present report is also higher than the 8.5% given by Adetunji *et al*. [9] using *A. niger* and *Fusarium* spp. on cassava peel slurry. On the other hand, the percentage concentration of ethanol obtained in

the present study is much lower than reports by Oyeleke and Jubrin [10] of 67.7 and 63.8% when *A. niger* and *Bacillus* were used simultaneously on guinea corn husk and millet husk, respectively. It is also lower than the 83% yield reported by Sivamani and Baskar [11] in cassava peel using a saccharification and fermentation mixture containing glucoamylase with optimum conditions of 69.82 g/L substrate concentration, 24.74% (v/v) α-amylase concentration. Sometimes, the differences in ethanol yield may be attributed to the actual amount of carbohydrate present in the peel at the start of the experiment.

4. CONCLUSION

The result of this study confirmed that ethanol can be produced from cassava peels which are agricultural wastes. The use of cassava and its peels is a worthwhile venture for ethanol production; considering their cost and because it is a means of controlling environmental pollution since bioconversion of cellulosic biomass into fermentable sugar for production of ethanol was done using cellulose degrading microorganisms, thus making bioethanol production economical and environmentally friendly and also renewable.

COMPETING INTERESTS

Authors have declared that no competing interests exist. 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.

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