International Journal of Current Research in Applied Chemistry & Chemical Engineering
Vol. 2, Issue 2 - 2018

VIABILITY OF THE INNER AND OUTER LAYER OF CASSAVA PEEL FOR BIOETHANOL PRODUCTION

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ABSTRACT

The potential of the inner and outer layer of cassava peel as a viable source for bioethanol production was determined. The carbohydrates content is one of the major component responsible for the production of the sugar needed for bioethanol production and its content shows the viability of the cassava peel in the production of bioethanol. The inner layer of the cassava peel has a carbohydrate content of 74.82, which is higher than the outer layer with carbohydrate content of 50.76%. The moisture content of the inner and outer part of the peels were 3.70% and 2.17%. This low moisture content of the inner and outer peel would help in preservation of feed stock in the industry. The brix level which measures the glucose content of the inner and outer layer of the cassava peel shows that the glucose content increases with increase acid concentration and time. This high glucose content shows the viability of the inner and outer peel of the cassava as potent source for bioethanol production.

KEYWORDS: Bioethanol, Glucose Content, Brix Level And Cassava Peel.

INTRODUCTION

Cassava (*Manihot esculenta*) is a tuberous root plant that is cultivated around the world as a primary source of starch and other low grade animal feed. Cassava is consumed in almost all the countries in Africa and is a major component of the diet constituting a significant source of dietary protein, minerals and vitamins [1]. Bioethanol is the ethanol obtained from starch through the hydrolysis and fermentation. Bioethanol is a principal fuel that can be used as petrol substitute for vehicle. It is a renewable energy source produced mainly by sugar fermentation process, although it can also be manufactured by the chemical process of reacting ethylene with steam [2]. The main sources of sugar required to produce ethanol come from fuel or energy crops. These crops include maize, cassava and cassava products, wheat crops, waste straw, guinea corn husk, rice husk, millet husk, sawdust and sorghum plant. Ethanol is a high octane fuel and has replaced lead as an octane enhancer in petrol [3]. During the processing of cassava fermented products, the root are normally peeled to remove the thin brown outer covering, and a thicker leathery inner layer [4]. However, these cassava peels continue to constitute waste in the cassava processing industry in spite of the potential of the use of the bye product as an animal feedstuff.

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 ISSN: 2581-5385

The cassava wastes generated at present pose a disposal problem and would even be more problematic in the future with increased industrial production of cassava products such as in gari production, cassava flour and dried cassava fufu [5]. Since these peels could make up to 10% of the wet weight of the roots, they constitute an important potential resource if properly harnessed by a biotechnological system [5]. Hence, this research is aimed at analyzing the inner and outer layer of cassava peel as potential material in the production of bioethanol.

MATERIALS AND METHODS

SAMPLE COLLECTION

The cassava was collected from cassava farm plantation in Okesin town popularly called Aba Okesin in Akure Ondo State.

SAMPLE PREPARATIONS

The cassava tubers were hand peeled using knife and sundried for seven days .The outer part of the peel was separated from the inner using hand and this was easy because the sample had been thoroughly dried. The outer part of the peel and the inner part were ground with the grinding machine, it was then homogenised and stored separately in two different air tight containers prior to analysis.

DETERMINATION OF PROXIMATE ANALYSIS

This involves the determination of the moisture, crude fibre, fat, protein, ash content, and carbohydrate content of the sample. These analyses were carried out using methods described in [6].

DETERMINATION OF LIGNIN CONTENT BY GRAVIMETRIC METHOD

1 g of both samples were weighed in two separate glass test tubes and 3 mL of 72% H2SO4 was added. The sample was kept at room temperature for 2 h with carefully shaking at 30 min intervals to allow for complete hydrolysis. After the initial hydrolysis, 84 mL of distilled water was added to the samples. The second step of hydrolysis was carried out in an autoclave for 1 h at 121 °C. The slurry was then cooled at room temperature. Then, the hydrolyzates were filtered through vaccum using a filtering crucible. The acid insoluble lignin was determined by drying the residues at 105 ^{o}C. The sample was later ashed in the furnace at 550ºC for 3hours after which it was cooled inside the desiccators and finally weighed. The ratio of the difference between the sample weight before and after the treatment to the weight of the dried sample is the % lignin (%w/w) of the sample.

DETERMINATION OF HEMICELLULOSES

1.5 g of both samples were weighed separately and was transferred into a 250 mL Erlenmeyer flask labeled as A and B. 150 mL of 500 mol/m^3 KOH was added. The hemicelluloses were then quantitatively precipitated by the addition of alcohol (ethanol). The precipitated hemicelluloses were isolated by centrifuging for 10 minutes. The isolated hemicellulose was washed with alcohol (ethanol) and ether and finally transfers into two different crucibles (A and B). The samples were dried in oven for 2hours at 105^{0}C. After this, they were transferred into desiccators and allowed to cool for 30 minutes after which their weights were taken. The difference between the sample weight before and after this treatment is the hemicellulose content (%w/w) of dry biomass

ACID HYDROLYSIS

This is done to break the starch into reducing sugar by acid. 3% of the sample was prepared by dissolving 3 g of the sample in 100 mL distilled water.1mL of hydrochloric acid was pipetted into 5 mL of the solution in a 50 mL conical flask and put into a water bath. The concentration of the acid used ,time of hydrolysis, and temperature of the water bath was varied by using 2 M, 4 M, 6 M of hydrochloric acid, the time used for the hydrolysis was 10, 20 and 30 minute while the

 ISSN: 2581-5385

temperature was varied by performing the experiment at 50^0C, 100^0C and 150^0C. Finally sodium carbonate was used to neutralize the hydrolyzate.

BRIX ANALYSIS

This was done with the aid of a refractometer to check the glucose content of the hydrolyzate from the acid hydrolysis .The sample was put on the sample port of the refractometer and the result was viewed through the screen .The adjustable knob was used to adjust the scale to zero after taking the readings while acetone was use to clear the previous sample from the sample port after taking the readings.

RESULTS AND DISCUSSION

Table 1: Proximate Composition of Cassava Peel

	%MC	%ASH	%CP	%FAT	%FIBER	%CHO
INNER	3.70±0.10	5.19±0.12	3.46±0.03	1.54±0.02	11.29±0.05	74.82±0.10
OUTER	2.17±0.08	12.55±0.05	2.96±0.12	1.07±0.10	30.49±0.01	50.76±0.07

Where:

%MC= Moisture content

%Ash content

%CP= Crude protein

% Fat= Fat content

% Fiber= Fiber content

%CHO= Carbohydrate.

THE PROXIMATE ANALYSIS OF THE INNER AND OUTER PART OF THE PEEL

The result of the proximate analysis is expressed in Table 1. The inner layer of the cassava peel has a carbohydrate content of 74.82, which is higher than the outer layer with carbohydrate content of 50.76%. The carbohydrates content is one of the major substance responsible for the production of the sugar needed for bio ethanol production and its content shows the viability of the cassava peel for the production of bioethanol. The high carbohydrate content of the inner part of the cassava peel implies that it sugar content would be high, and hence would be more viable in the production of bioethanol than the outer part. The fiber, ash, protein, fat, and moisture content were reported to be 30.49%, 12.55%, 2.96%, 1.07%, 2.17% respectively for the outer layer of the cassava peel. Also, the inner part of the peel was reported to have a fiber, ash, protein, fat, and moisture content of 11.29%, 5.19%, 3.46%, 1.54% and 3.70% respectively. The moisture content of the inner and outer part of the peels were 3.70% and 2.17%. This low moisture content of the inner and outer peel would help in preservation of feed stock in the industry. The moisture content is a measure of water present in the sample, and a low moisture content is an indication that it can be stored for a long time without the development of moulds [7].

 ISSN: 2581-5385

RESULT FOR THE INNER CASSAVA PEELS BRIX

Table 2a.Brix Level at 2M concentration of acid with different temperature and time

Concentration (M)	Time(Mins)	Temperature(^{O}c)	Brix Level (Sugar At 20^{o}c)
2M	10	50	2.9
2M	10	100	3.0
2M	10	150	3.6
2M	20	50	3.9
2M	20	100	4.2
2M	20	150	4.5
2M	30	50	4.6
2M	30	100	5.0
2M	30	150	6.1

Table 2b.Brix level at 4M concentration of acid with different temperature and time

Concentration (M)	Time(Mins)	Temperature(^{O}c)	Brix Level (Sugar At 20^{o}c)
4M	10	50	3.1
4M	10	100	3.5
4M	10	150	4.2
4M	20	50	4.5
4M	20	100	5.0
4M	20	150	6.0
4M	30	50	6.2
4M	30	100	6.5
4M	30	150	7.5

Table 2c.Brix level at 6M concentration of acid with different temperature and time

Concentration (M)	Time(Mins)	Temperature(^{O}c)	Brix Level (Sugar At 20^{o}c)
6M	10	50	5.9
6M	10	100	6.1
6M	10	150	7
6M	20	50	7.4
6M	20	100	7.8
6M	20	150	8.2
6M	30	50	9
6M	30	100	10.7
6M	30	150	11.2

 ISSN: 2581-5385

RESULTS FOR OUTER CASSAVA PEELS BRIX

Table 3a.Brix Level at 2M Concentration of acid with different temperature and time

Concentration (M)	Time(Mins)	Temperature(^{O}c)	Brix Level (Sugar At 20^{o}c)
2M	10	50	1.5
2M	10	100	2.0
2M	10	150	2.5
2M	20	50	3.0
2M	20	100	3.3
2M	20	150	4.0
2M	30	50	4.7
2M	30	100	5.2
2M	30	150	6.0

Table 3b.Brix Level at 4M Concentration of acid with different temperature and time

Concentration (M)	Time (Mins)	Temperature (^{O}c)	Brix Level (Sugar At 20^{o}c)
4M	10	50	2.5
4M	10	100	3.0
4M	10	150	3.7
4M	20	50	4.9
4M	20	100	5.6
4M	20	150	6.0
4M	30	50	6.8
4M	30	100	7.1
4M	30	150	8.0

Table 3c.Brix Level at 6M Concentration of acid with different temperature and time

Concentration (M)	Time(Mins)	Temperature(^{O}c)	Brix Level (Sugar At 20^{o}c)
6M	10	50	5.0
6M	10	100	5.4
6M	10	150	5.7
6M	20	50	6.2
6M	20	100	6.9
6M	20	150	7.3
6M	30	50	8.0
6M	30	100	8.7
6M	30	150	9.0

THE BRIX LEVEL FOR THE INNER AND OUTER LAYER OF THE CASSAVA PEEL

The brix level for the inner layer of the cassava peel is expressed in Table 2a, Table 2b and Table 2c. The brix level of the inner and outer layer of the cassava peel was determined at different concentration, temperature and time of hydrolysis. With increase in the acid concentration, time of hydrolysis and temperature, the brix level of the inner layer of the cassava peel increases. The highest brix level

 ISSN: 2581-5385

of 11.2 was observed at 6M concentration of the acid. This shows a high glucose content of the hydrolysate, and thus indicate the viability of the inner layer of the cassava peel in the production of bioethanol. Table 3a, Table 3b and Table 3c shows the brix level of the outer layer of the cassava peel. The brix level increases as the concentration of the acid increases. The highest brix level of the outer peel was 9.0 at 6M acid concentration used for the hydrolysis. In term of comparison, the brix level of the cassava outer peel is slightly lower than the brix level of the cassava outer peel layer. The brix level obtained at increased concentration shows the inner and outer cassava peel in the bioethanol production. Hence, bioethanol production would be more efficient using high concentration of hydrochloric acid, increased time of analysis and at increased temperature.

Table 4.Hemicellulose and lignin content of cassava peel

	Hemicellulose	**Lignin**
OUTER (%)	19 ± 0.02	15 ± 0.15
INNER (%)	17 ± 0.01	7 ± 0.10

LIGNIN AND HEMICELLULOSES CONTENT OF THE INNER AND OUTER PART OF THE PEEL

The lignin content for inner and outer part of the cassava peel was 7% and 15% respectively according to Table 4. Lignin is a natural, complex chemical compound which forms an integral part of the cell walls of plants. The lignin is the binding agent in all plant matters which binds all the component of plant together. The removal of lignin is essential in order to obtain starchy material for bio-ethanol production. This is achieve through series of pre-treatment which is very costly. However, since the lignin content is low in cassava peel, it will not undergo a vigorous pre-treatment that is costly.

The hemicelluloses content for the inner and outer part of the peel was 17% and 19% respectively has shown in Table 4. Hemicelluloses is a heterogeneous polymer which composes of various hexoses: glucoses, mannose and galactose and the two pentoxes: xylose and arabinose as well as glucuronic and galacturonic acid. The hexoses and pentoxes present in hemicellulose are important as they can contribute to the sugar required for conversion in the production of bio-ethanol.

CONCLUSION

The inner and outer part of the peel are made of natural polymer which can serve as a good source of sugar for bio ethanol production. Properties such as high carbohydrate contents relative to other contents such as protein, fat, ash, moisture and fibre content was observed in this project work. The high carbohydrate content is responsible for generating high sugar content necessary for bio-ethanol production. The hemicellulose content can also contributes to production of pentoses and hexoses which can lead to higher yield of sugar necessary for bioethanol production. Therefore, both parts of the peel have constituents that are suitable for bio ethanol production. Higher yield of sugar necessary for bio ethanol production can be obtain by increasing time of reaction, concentration of acid and temperature of reaction.

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 ISSN: 2581-5385