Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 3159-0040
Vol. 1 Issue 4, November - 2014

Waste To Wealth: Production of Bioethanol From Pineapple Waste

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ABSTRACT- Ethanol fuel is ethanol (ethyl alcohol), the same type of alcohol found in alcoholic beverages. It can be used as a fuel, mainly as a biofuel alternative to gasoline. In conclusion of the 1800ml of batch prepared 1754ml filtrate was obtained after fermentation indicating a 97%. Of the 1754ml was distilled and 634ml was obtained at first distillation showing a 36% of the fermented material. Each sample was distilled for 2hours 30mins and for the 9 samples it took a total of 21 hours. The work is not an end in itself tremendous improvements can be made to make it profitable and viable in Nigeria which is blest with a lot of natural resources rich in carbohydrate (sugar).

KEYWORDS: Bioethanol, Batching; Fermentation; Distillation; Filtrates

I INTRODUCTION

Nature has provided countless potential solutions in organisms as diverse as cows and microbes, and that offers tremendous hope' (1).
Ethanol fuel is ethanol (ethyl alcohol), the same type of alcohol found in alcoholic beverages. It can be used as a fuel, mainly as a biofuel alternative to gasoline, and is widely used in cars in Brazil. Because it is easy to manufacture and process and can be made from very common crops such as sugar cane and corn, it is an increasingly common alternative to gasoline in some parts of the world. (2).

The oil crises of the 1970 rekindled interest in the use of renewable fuels and the following main factors sustained this interest to date.

- Prices of petroleum products have been on the increase since the time of the oil crises.
- Uncertainties in oil supplies due to political instability and conflicts in some oil producing areas of the world.
- Growing anxiety over the future security of the world s' supply of crude because petroleum resources are limited in stock.
- The biofuels have a lot of advantages over the fossil fuel in terms of environmental impact.

Considering table 1, it is observed that some countries of the world has embraced biofuel production with respect to the environmental advantages over fossil fuel, with US leading the pack and Brazil following.

Table1: Showing Ethanol production in 15 top producing countries.

Total Annual Ethanol Production (All Grades) by Country (2004-2006) Top 15 countries (Millions of U.S. liquid gallons)					**Annual Fuel Ethanol Production by Country (2007) Top 15 countries/blocks (Millions of U.S. liquid gallons)**		
Rank	Country	2006	2005	2004	Rank	Country	2007
1	United States	4,855	4,264	3,535	1	United States	6,498.6
2	Brazil	4,491	4,227	3,989	2	Brazil	5,019.2
3	China	1,017	1,004	964	3	European Union	570.3
4	India	502	449	462	4	China	486.0
5	France	251	240	219	5	Canada	211.3
6	Germany	202	114	71	6	Thailand	79.2

7	Russia	171	198	198	7	Colombia	74.9
8	Canada	153	61	61	8	India	52.8
9	Spain	122	93	79	9	Central America	39.6
10	South Africa	102	103	110	10	Australia	26.4
11	Thailand	93	79	74	11	Turkey	15.8
12	United Kingdom	74	92	106	12	Pakistan	9.2
13	Ukraine	71	65	66	13	Peru	7.9
14	Poland	66	58	53	14	Argentina	5.2
15	Saudi Arabia	52	32	79	15	Paraguay	4.7
	World Total	13,489	12,150	10,770		World Total	13,101.7

Source:(3,4)

II WASTE/SOLID WASTE

Waste Management is a global environmental issue (5). According to (5,6,7,8,9), solid wastes were defined as useless, unwanted, unused or discarded materials resulting from normal community activities i.e. human and animal activities. They are substances or objects regarded as worthless and unwanted to the owner and hence disposed.

Currently the world population is 6.5 billion; it is growing by another 76 million per year. According to the United Nations (11) the world will add another 2.6 billion people by 2050. The global population growth of nearly 50 percent in the next 45 years will challenge policy makers around the world as never before. No issue will test the mettle of leaders more than accommodating and feeding an extra 2.6 billion people by 2050.

According to World Bank report (12) the solid waste generation in Nigeria per person per day is an average of 0.45kg. Calculating using the population above for 2010-2025 as 148.5 million gives us 66.8 million kg of waste per day, for a month it is 2 billion kg of waste and for a year it is 24 billion kg of wastes. Such quantity of waste is a task and one way to deal with this is trying to get something out of it.

The purpose of this research is to produce Biofuel (Bio-alcohol) from agricultural waste primarily from pineapple peels. All over the world you hear slogans like 'from waste to wealth'. This is a major challenge for mankind, what do we do with the enormous quantities of waste produce every day?

III MATERIALS AND METHODS

This section on materials and methods will be highlighting the materials which were employed in the cause of the research and also the process and method used in the production of ethanol from Pineapple waste which is the essence of this work.

If the raw material contains sugar not starch, the batch does not have to be treated with enzymes. The sugar, as in sugar cane is ready to be fermented to alcohol by the yeast without pretreatment. The batch may be cooked briefly to sterilize it before adding the yeast.

A. Materials Used

The materials used for the production of bioethanol from Pineapple wastes are:

- Pineapple wastes
- Sugar syrup from the Pineapple waste
- Stove for heating
- Resort stand fitted with clamp
- Round bottom flask
- Condenser
- Hoses
- Measuring cylinder
- Baker's yeast
- Funnel
- Plastic containers/bottles
- Cellophane
- Weigh
- Sieve
- Scale Wine Hydrometer
- Thermometer

B. Batching

The Pineapple wastes is collected and weighed to be 11kg. After which it is grated and mixed with 1 litre of water and then sieved.
The filtrate is heated on the stove for 5-6 hours in which sugar syrup is obtained. The sugar content of the syrup was determined using a scale wine hydrometer to be 50g of sugar in 100ml of solution. Upon weighing the sugar syrup was 2.1kg.

The sugar syrup is diluted before the yeast is introduced because any sugar content above 20g per 100ml will kill the yeast. This is why sugar is used as preservative.

The sugar syrup sugar content is diluted and reduced to
It was made up of three batches with each batch contains three samples

Table 2: Showing the make up of the batches.

Batch	Yeast content (g)	Sugar content (g/100ml)
1A	0	5
1B	1	5
1C	2	5
2A	0	10
2B	1	10
2C	2	10
3A	0	20
3B	1	20
3C	2	20

C. Fermentation

10ml of the yeast mixture was introduced into each batch i.e. 10ml of the mixture contains 1g of yeast, while 20ml contains 2g of yeast.10g of yeast was mixed with 100ml of water. The water was first boiled at 100^{o}c for 30 minutes after which it was allowed to cool to around 37oc. 100ml of water is measured and poured into cellophane; 10ml of the sugar solution and yeast are added.
The mixture is mixed from the external with a hand and as soon as the mixture starts bubbling, then the yeast is growing. It is then measured and added to the batches.
The batches are left for bout 3-4 days at a room temperature, which ranges from 28^{o}c (82^{o}F) to 34^{o}c (93^{o}F). Each batch is agitated regularly to ensure that the yeast mixes and ferments the sugar.
During fermentation heat is produced, it should be stirred and when carbon dioxide is been produced it means it is making alcohol.
The mash should contain about 8-10% alcohol after about 4 days. If it does not, either something was wrong in the batching or the fermentation is not complete. All sugar in the batch should be gone when fermentation is complete.

Distillation

Te cold mash is put into a round bottom flask and heat is applied from a stove and condenser, thermometer, cork fitted to the flask.

The mixture contains water and alcohol, which is heated. Alcohol evaporates first because it boiling point (78^{o}c) is lower than water which boils at 100^{o}c. the alcohol vapour rises in the column, condenses and is collected as liquid in a glass bottle. The distillation process is timed and recorded; when it gets to 100^{o}c mark at which it remain constant for some time it is dismantled for another batch to be distilled.
The first distillate contains high water-ethanol combination called an Azetrope. To further increase the ethanol content we have to re-distill as the case maybe.

IV RESULTS ANALYSIS AND DISCUSSION

This chapter deals with the result of the experiment carried out, the tables and graphs from the fermentation and distillations of the batches.

Results of the First Distillation

Table 3: Show the values of the first distillation of batch 1

0g of Yeast (1A)		1g of Yeast (1B)		2g of Yeast (1C)	
Time (AM)	Temp. (^{o}c)	Time (PM)	Temp (^{o}c)	Time (PM)	Temp (^{o}c)
4.15	32	8.10	30	5.35	32
4.25	46	8.20	46	5.45	46
4.35	68	8.30	68	5.55	66
4.45	96	8.40	100	6.05	98
4.55	98	8.50	100	6.15	100
5.05	98	9.00	100	6.25	100
5.15	100	9.10	100	6.35	100
5.25	100	9.20	100	6.45	100
5.35	100	9.30	100	6.55	100
5.45	100	9.40	100	7.05	100
5.55	100	9.50	100	7.15	100
6.05	100	10.00	100	7.25	100
6.15	100	10.10	100	7.35	100
6.25	100	10.20	100	7.45	100
6.35	100	10.30	100	7.55	100

Table 4: Showing the values of the first distillation of batch 2

0g of Yeast (2A)		1g of Yeast (2B)		2g of Yeast (2C)	
Time (PM)	Temp. (^{o}c)	Time (PM)	Temp (^{o}c)	Time (AM)	Temp (^{o}c)

3.05	32	12.35	30	7.30	32
3.15	46		40	7.40	40
3.25	68	12.45	48	7.50	50
3.35	96		80	8.00	60
3.45	98	12.55	98	8.10	84
3.55	98		98	8.20	96
4.05	100	1.05	100	8.30	98
4.15	100	1.15	100	8.40	98
4.25	100	1.25	100	8.50	98
4.35	100	1.35	100	9.00	98
4.45	100	1.45	100	9.10	100
4.55	100	1.55	100	9.20	100
5.05	100	2.05	100	9.30	100
5.15	100	2.15	100	9.40	100
5.25	100	2.25	100	9.50	100
		2.35			
		2.45			
		2.55			

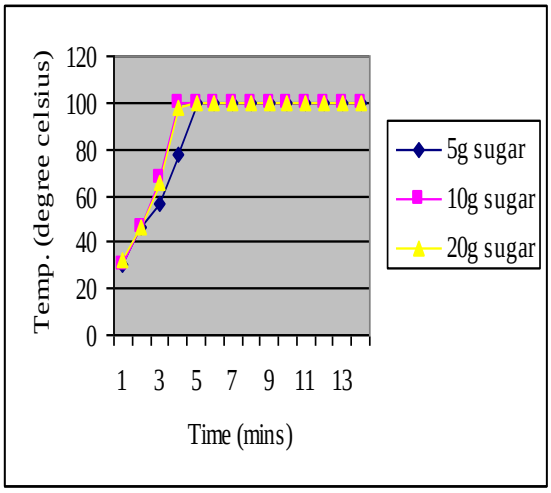

Fig 1: Showing Graph of batch 1distillation

Table 5: Showing the values of the first distillation of batch 3

0g of Yeast (3A)		1g of Yeast (3B)		2g of Yeast (3C)	
Time (PM)	Temp. (^{o}c)	Time (PM)	Temp (^{o}c)	Time (AM)	Temp (^{o}c)
7.50	32	5.15	30	4.50	28
8.00	40	5.25	42	5.00	48
8.10	58	5.35	54	5.10	58
8.20	78	5.45	56	5.20	68
8.30	94	5.55	62	5.30	94
8.40	96	6.05	70	5.40	96
8.50	98	6.15	86	5.50	98
9.00	100	6.25	96	6.00	98
9.10	100	6.35	96	6.10	100
9.20	100	6.45	96	6.20	100
9.30	100	6.55	98	6.30	100
9.40	100	7.05	98	6.40	100
9.50	100	7.15	100	6.50	100
10.00	100	7.25	100	7.00	100
10.10		7.35	100	7.10	100

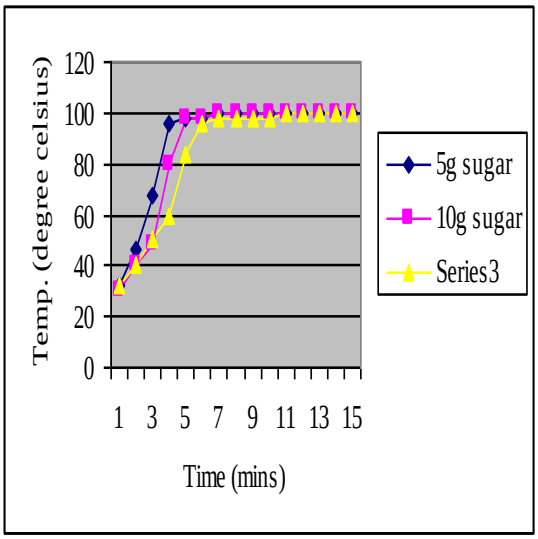

Fig 2: Showing Graph of batch 2 distillation

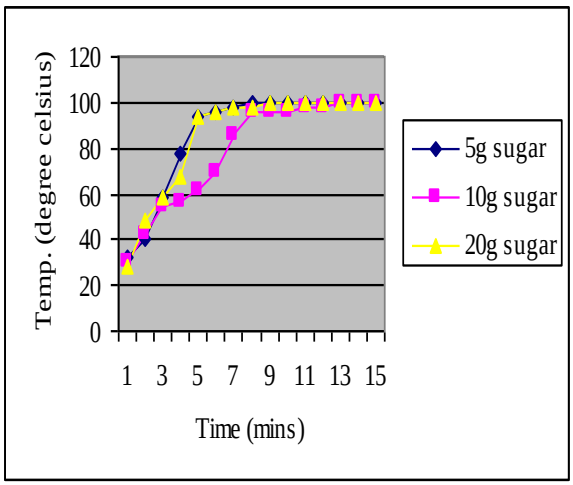

Fig 3: Showing Graph of batch 3 distillation

Table 6: Showing the quantity of liquid obtained after fermentation and first distillation

Batch	Qty before fermentation	Qty after fermentation	Qty 1st distillation	Qty left
1A 1B 1C	200ml 200ml 200ml	190ml 198ml 198ml	72ml 91ml 70ml	105ml 95ml 110ml
2A 2B 2C	200ml 200ml 200ml	190ml 193ml 200ml	75ml 70ml 57ml	110ml 105ml 130ml
3A 3B 3C	200ml 200ml 200ml	193ml 197ml 195ml	86ml 55ml 58ml	98ml 129ml 126ml

V ANALYSIS AND DISCUSSION ON FIRST DISTILLATION

The tables and graphs above give us the table of values (time i.e. 2hours 30mins for distillation of each sample and the corresponding temperatures) and the graphical presentation of the values in the first distillation of the 3 batches.

In tables 3 and Fig 1 it can be observed that during distillation the temperature of the samples in batch 1 got to the 100^{o}c mark much quicker. This suggests that the quantity of the ethanol present is low.

In table 4 and fig 2 it is observed that during the distillation the samples in batch 2, that the temperature of the samples got to the 100^{o}c mark different time. From the table and graph there is the inference that there is more ethanol present in batch 2 than batch 1. On more careful observation it is discovered that batch 2C contains more ethanol than the other samples in this batch by reason of the length of time it took to get to the 100^{o}c mark.

In table 5 and fig 3 it is observed during distillation of the samples that it took longer time for these samples to reach the 100^{o}c mark than the samples in batches (1) and (2). It was further observed that sample 3B took a longer time to reach the 100^{o}c mark, indicating that it contains more ethanol than the rest and suggests that the yeast fermented more of the sugar in the sample.

Table 6 gives the quantity (ml) of the initial batches with sugar and yeast combination which is allowed to ferment, the quantity of the filtrate after fermentation, the quantity of the distillate after first distillation after 2hours 30minutes and the quantity remaining after distillation.

VI CONCLUSION

In conclusion of the 1800ml of batch prepared 1754ml filtrate was obtained after fermentation indicating a 97%. Of the 1754ml was distilled and 634ml was obtained at first distillation showing a 36% of the fermented material. Each sample was distilled for 2hours 30mins and for the 9 samples it took a total of 21 hours.

The work is not an end in itself tremendous improvements can be made to make it profitable and viable in Nigeria.

This work has researched into the possibility of converting Pineapple wastes into bioethanol. In today's world bioethanol is been used as fuel for automotives and are environmental friendly than fossil fuel currently used. It also help reduce wastes which are deposited in drains and inside city centres causing flooding, and other environmental problems. Considering that Pineapple is cultivated in Nigeria especially in the rain forest region, the wastes and possibly wastes from other sugar containing fruits can be used t empower and benefit the economy.

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