DETERMINING THE VIABILITY OF WATERMELON EXOCARP AS A FEEDSTOCK FOR ETHANOL PRODUCTION

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ABSTRACT: *Fossil fuels are compounds of hydrocarbons comprising of coal, natural gas and oil. Over the years, their constant use as sources of energy have adversely impacted the environment and have greatly contributed to global warming which have led to the advocacy for renewable energy. Renewable energy is produced from sources that do not deplete or can be replenished within a human life time. Bio-energy is the energy derived from biological sources and types of bio-energy are bio-ethanol, biogas, and biodiesel. This research work is to produce bio-ethanol from watermelon exocarp. A total of 78.6 kg of watermelon waste was collected from tenboga market upper mission road, Benin City, Edo State. The water melon exocarp was processed and fed into the grinding machine for blending. A cloth sieve filter was used to obtain 60 litres of juice from the slurry. The juice was fed into the fermentation pot, which fermented for five days. Brewer's yeast (Saccharosomysis Cerevisae) and amylase of 11g each were added to the feedstock to facilitate the fermentation process. pH, conductivity, sugar content, refractive index and alcoholic content were observed daily and recorded during the period of fermentation. The beer was distilled at ethanol boiling point of 79 ^{0}C utilizing an indigenous bio-ethanol plant. It was recorded that 15 litres of ethanol with 35% alcoholic content was obtained from 60 litres of beer at the end of the distillation process. This therefore suggests that water melon waste can be harnessed as a viable feedstock for ethanol production.*

KEYWORDS*:* bioethanol, environment, water-melon, exocarp, physicochemical

INTRODUCTION

Petroleum based fossil fuels which is fast exhausting in the cause of meeting its continuously increasing demand for energy is highly detrimental to health and the environment [4]. Exploration and use of fossil fuel leads to greenhouse gas emissions that have negative effects on the environment. The use of petroleum based fuels increases

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the level of carbon dioxide (CO_2) in the atmosphere, resulting in global warming and climate change [3]. Due to the increasing energy demand and atmospheric contamination by combustion gases, which has led to environmental pollution/degradation, researchers and high tech energy firms are looking at sustainable avenues for new, safe, effective and more accessible energy sources [1]. Renewable energy is energy produced from sources that do not deplete or can be replenished within a human lifetime. The most common examples include; solar, wind, geothermal, biomass etc. Bio-energy is energy gotten from biological sources and the types of bio energy are bio-diesel, bio-ethanol and bio-gas. This paper will be duelling on bio-ethanol which is a renewable energy produced by microbiological way of converting simple sugar into ethanol and carbon dioxide by fermentation. It is a principal fuel that can be used as petrol substitute for vehicles [2].

This research work is designed to produce bio-ethanol from watermelon exocarp, reduce the percentage of environmental pollution caused by watermelon exocarp in our environment. It will also help to study the efficiency profile of watermelon exocarp as feedstock for fermentation process and to establish the position of bio-ethanol as a renewable resource in the energy mix and its sustainability as fuel.

METHODOLOGY

A total of 78.6kg of watermelon exocarp waste was collected from Tenboga market Upper mission road, Benin City, Edo state. The exocarp was cut into small sizes using a knife after which it was fed into the grinding machine for blending. The slurry produced from the grinding machine was sieved using a cloth sieve filter and a volume of 60 litres of juice was recorded.

Pix 1: water melon exocarp

Pix 2: processing water melon excarp

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Pix 3: Blending water melon exocarp

Brewer's yeast (Saccharosomysis Cerevisae) and amylase of 11g each were added to the juice and allowed to ferment. The juice from the exocarp was then fed into the fermentation pot and allowed to ferment for 5 days. Physicochemical analysis (pH, conductivity, sugar content, refractive index and alcoholic content) of the fermenting feedstock and distillate respectively were observed daily and recorded. The pH was determined using a digital handheld pocket size pH meter. The conductivity was carried out with a digital handheld conductivity meter, while sugar content and refractive index were measured using a portable refractometer (ATC). The alcoholic content was monitored using the Hydrometer (Alcohol meter). During the fermentation period, the room temperature of the workshop ($28^{O}C$) was used as the fermentation temperature. The fermented feedstock was then fed into the heating pot and distilled at $79^{O}C$ using an indigenous fabricated bio-ethanol plant

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RESULTS AND DISCUSSION

The result of physicochemical analysis of the fermenting feedstock and distillate are shown in tables 1 and 2 respectively.

Table 1 Physicochemical analysis of the fermenting feedstock.

FEEDSTOCK SAMPLE	TIME (H)	DATE (2019)	TEMP. (^0C)	pH	CONDUCTIVITY µS/CM	SUGAR CONTENT	REFRACTIVE INDEX	ALCOHOLIC CONTENT
DAY 0	2PM	12/12	28.00	4.40	58.00	4.60	18.00	BDL
DAY 1	2PM	13/12	28.00	3.90	59.00	4.50	17.00	BDL
DAY 2	2PM	14/12	28.00	3.60	60.00	4.40	16.00	BDL
DAY 3	2PM	15/12	28.00	3.50	60.50	4.20	15.40	BDL
DAY 4	2PM	16/12	28.00	3.40	61.00	4.00	14.00	BDL
DAY 5	12PM	17/12	28.00	3.40	62.00	4.00	14.00	BDL

BDL- BELOW DETECTABLE LIMIT

Table 2 Physicochemical analysis of the bio-ethanol distillate

PHYSICOCHEMICAL PARAMETERS	BATCH 1	BATCH 2	BATCH 3	BATCH 4	AVERAGE
PH	4.20	4.30	4.300	4.20	4.25
SUGAR CONTENT	8.40	8.00	8.20	8.00	8.15
REFRACTIVE INDEX	36.00	34.00	35.00	32.00	34.25
ALCOHOL CONTENT	35.00	35.00	35.00	35.00	35.00
CONDUCTIVITY	0.00	0.00	0.00	0.00	0.00

fermentation was complete. However the conductivity (58.00–62.00µS/cm) was observed to be increasing as the fermentation process progresses this also reveals that there is an

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increase in the formation of ions. The sugar content (4.60-4.00%BRIX) of the fermenting feedstock was also monitored and a decrease in the trend was observed from Day 0 to 5 this also confirmed the breakdown of complex sugar into simple sugars-glucose and fructose. The refractive index (18.00-14.00) of the feedstock was recorded to decrease as fermentation progresses this goes to show that the feedstock is denser due to formation of ions. Also the alcoholic content of the feedstock was observed to be below detectable limit.

Table 1 shows the physicochemical analysis of the feedstock during the fermentation period The pH was observed to be decreasing from (4.40–3.40) as the fermentation process progresses each day this confirms that fermentation was taking place accordingly. It was observed that the pH between day 4 and 5 respectively was same which confirms that Figures 1 and 2 below show the relationship between the pH and the conductivity of the fermenting feedstock on each day.

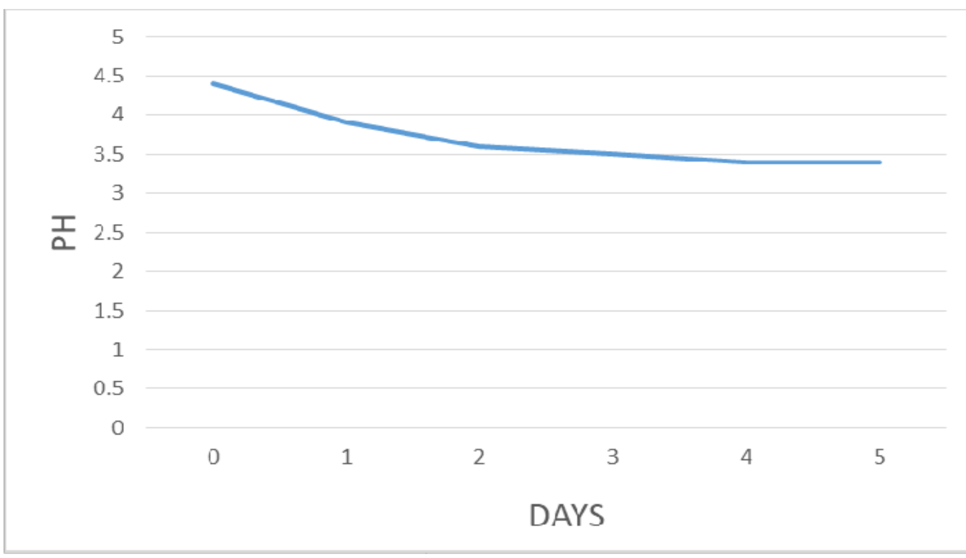

Figure 1: Days vs the pH of the fermenting feedstock

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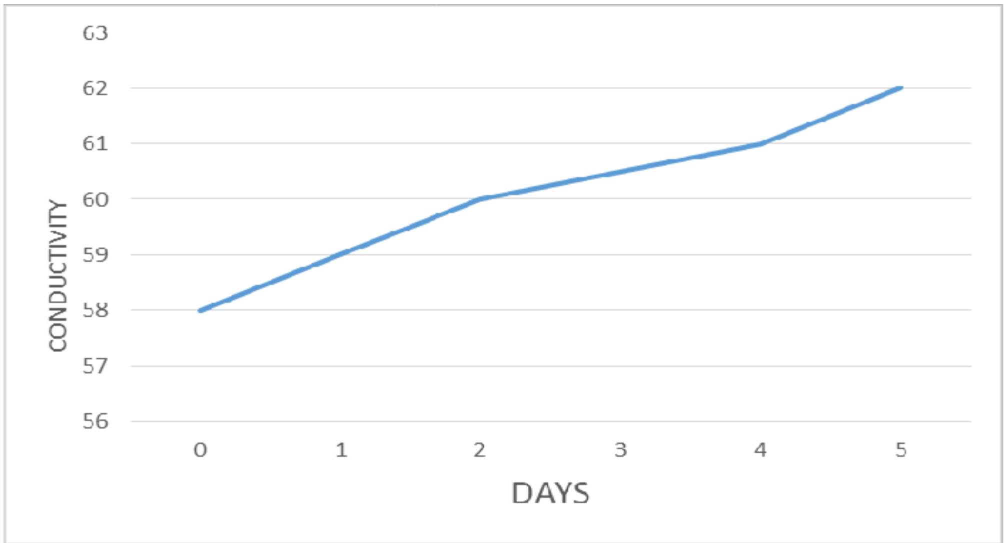

Figure 2: Days vs the conductivity of the fermenting feedstock.

The physicochemical analysis carried out on the distillate is displayed in table 2 above. The table shows that the distillation was carried out in batches. The pH of the bio-ethanol produced varied slightly for each batch of the distillate, this trend was also observed in the sugar content of the bio-ethanol distillate unlike the fermentation process where there was an obvious reduction as fermentation progressed. It is worthy of note that alcohol contains sugar conductivity of the bio-ethanol is zero this reveals the fact that there was no formation of ions. The alcoholic content in all batches was 35%. However, volume of distillate obtained from 60 litres watermelon exocarp was 15.0 litres of bio-ethanol with 35% alcohol content. The result obtained from this process goes to tell that if this feedstock is efficiently employed, reducing human and mechanical errors as low as possible; a higher yield of ethanol can be achieved as a renewable source in the energy mix.

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CONCLUSION

In recent time, renewable energy sources have come under scrutiny as a viable alternative to which corroborates with the physicochemical analysis displayed in table 2 above. The fossil fuel to run combustion engines. The abundance of agricultural waste in Nigeria is evident in the indiscriminate dumpsites along the streets, market places and farmlands. Visitation to Tenboga market Upper Mission roads Benin City, Edo State is a proof to this assertion. In this market watermelon waste are sorted almost on a daily basis before day are shaded for sale. It was observed that the average waste ratio is 1:20, that is for every 20 fruits of watermelon sorted to be sold, one fruit is discarded as waste and this is obviously due to lack of storage facilities as many of the fruits get over ripe or rotten due to transit from one zone of the country to another. Due to the environmental effect of water melon waste, the Environmental pollution and Remediation unit of the National Centre for Energy and Environment identified the potentials of harnessing this waste for bio-ethanol production

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