2014 1st International Congress on Environmental, Biotechnology, and Chemistry Engineering
IPCBEE vol.64(2014) © (2014) IACSIT Press, Singapore
DOI: 10.7763/IPCBEE. 2014. V64. 20

Studies on Green Fuel Generation from Renewable Resources

Dishary Banerjee [1+], Lima Chaudhuri [2], Mayurketan Mukherjee [2], Snehadri Chatterjee [1], and Tapan Kumar Ghosh [3]

[1] Undergraduate Student, Heritage Institute of Technology, Kolkata
[2] Graduate Student, Heritage Institute of Technology, Kolkata
[3] Assistant Professor, Heritage Institute of Technology, Kolkata

Abstract. Fossil oil supplies have permitted an exponential rise in human populations across the world and are consumed in every aspect of modern life. But the impending shortage of fossil fuels and the environmental problems have aroused some other alternative forms of energy. As a consequence, the demand for alternative renewable sources have been intensified in substitution of the rising demand for energy and raw materials[1]. The aim is to develop a method for the production of ecofriendly fossil fuels since the other industrial methods used for the fossil fuel development with increasing greenhouse gases emission scenario and anthropogenic activities poses a huge challenge to our agriculture, water resources and economy. In this sense, the project aims to study the characteristics of cashew apple bagasse and to verify its potential uses for ethanol production. At the initial stage, physicochemical characteristics of the cashew bagasse are carried out, following which it was incubated with *Saccaromyces cerevisiae* at 37 ℃ for around 48hours for the verification of the capacity of the biomass for ethanol production.

Keywords: ecofriendly, ethanol, cashew apple bagasse

1. Introduction

Fossil oil supplies have permitted an exponential rise in human populations across the world and are consumed in every aspect of modern life. Oil use is unequal: the USA consumes about 22 barrels of oil per person per year while the consumption of some developing countries is as low as 3 barrels of oil per person per year. China's population, a quarter of the world's total, is expected to increase by an extra 200m people by 2030. To raise their living standards to a European level is likely to increase Chinese oil demand fivefold. This could mean that their increased demand alone would be the equivalent of about 46% of today's total global demand for oil.

At the same time, even the (very conservative) International Energy Agency predicts a fall in global oil production to about half today's levels by 2030, as fossil oil reserves are depleted further (the world passed the point of peak oil production in the mid 2000s). Today's global inequalities in wealth and access to resources are only likely to increase – with severe implications for the health and material well-being of whole nation states.

Responses to declining fossil fuel sources must be completely sustainable, yet also easily replace the many uses of fossil oil. Producing biofuel from a waste product like cashew apple bagasse is expected to reduce human dependence on fossil oil with benefits that address issues of:

- Climate change
- Energy security
- Sustainability

+ Corresponding author. Tel.: +919674778566 ;
E-mail address: disharybanerjee0409@gmail.com

1.1. Peak oil and its future

Bio-fuels, synthetic fuels, natural gas liquids, electric cars, even sustainable agriculture — all of these are responses to the impending fossil fuel crises. Shell Oil engineer M. King Hubbert first noted in the 1950s that all oilfields have a period of increasing production as they are brought online, a period of plateau or peak of maximum production, followed by a period of declining production. In graphical terms, the production versus time tends to follow a bell-shaped curve. Furthermore, what's true of a single oilfield is also true for any given geographical area, such as the US, for which there is very good data, and the world as a whole [2].

In 1956, Hubbert predicted that US lower 48 oil production would peak in 1970, and it did. [2]. From 1971 onwards, US oil production entered into a steep decline of about 3% per year. As predicted by Hubbert's curve, the US lower 48 states now produce less than half as much oil as in 1970 (5 million barrels per day versus 10 in 1970) and no amount of drilling or technological advance – or indeed "fracking" has reversed the trend.

In this context, the biomass comes as one of the sources having this potential, because when produced sustainably, can dramatically reduce emissions of greenhouse gases compared to fossil fuels, as the only carbon-rich material available on the planet, which can be used for energy, heat, liquid and gaseous fuels, and also serves as a raw material for chemicals and materials.

Brazil is enjoying a comfortable position in the world with the technology of ethanol production. In this sector, the United States is currently the largest producer, except that the bioethanol produced from corn (cost three times higher than derived from cane sugar), followed by Brazil which uses cane sugar, with an ethanol production of 27.7 billion liters, respectively, in the harvest of 2008/ 2009. [3]

The lignocellulosic biomass represent an abundant source of sugars which can be converted to products of industrial interest such as ethanol by biotechnological processes. This biofuel is currently produced from virtually raw beet and starch, cane sugar and maize, respectively. However, researchers are developing new processes for the most economically viable use of the component of lignocellulosic biomass such as agricultural residues (straw and bagasse of sugar cane, wheat straw and corn stover) and forest residues (dust and waste wood), for production of fuel ethanol (second generation ethanol) [4].

The cashew bagasse is a lignocellulosic waste that is composed mainly of cellulose, hemicellulose and lignin. In this context, this work was to study the characterization of the cashew apple pomace and predetermine their potential for ethanol production.

2. Materials and Methods

The investigation was conducted at the Fermentation Laboratory of Heritage Institute of Technology, Kolkata, West Bengal, India.

2.1. Obtaining a raw material

Fresh cashew apple bagasse was used obtained from Midnapur, West Bengal, India.

2.2. Preparation of raw material

The cashew apple bagasse was washed thoroughly in distilled water in room temperature. After washing, it was placed in sterilized petriplates and dried in a hot air oven at different temperatures and different time intervals as shown in table 1. It was immediately grounded in a mixer and stored in polypropylene bags for subsequent uses.

2.3. Characterization of cashew apple bagasse : physicochemical analysis

Samples of cashew apple bagasse dry were taken for its characterization which was to analyse for moisture, solid content, glucose estimation, cellulose, lignin and hemicellulose content.

2.3.1. Moisture content

Dry cashew apple bagasse was weighed before it was kept in the incubator for different time interval and various temperatures as shown in table 1. The sample was measured immediately after taking it out of the incubator. The difference in the weights determines the moisture content of the samples.

Table 1: Temperature and time intervals for drying process

Serial No.	Temperature (℃)	Time (hrs)	Moisture Content(%)
1.	60	4	5.26
2.	80	6	4.18
3.	100	8	3.76

2.3.2. Total solid content estimation

The total solid content was estimated with the following formula as :

$$T = \frac{M_{final}}{M_{initial}} * 100 \; ; \; M_{final} = final\ moisture\ content\ after\ drying$$

$$M_{initial} = initial\ moisture\ content\ before\ drying$$

$$T = total\ solid\ content$$

2.3.3. Glucose estimation

The DNS method was employed to estimate the concentration of reducing sugars in the sample. The absorbance is measured at 540nm. The sugar content of the sample was estimated from the glucose standard curve.

2.3.4. Cellulose estimation

2.3.4.1. Principle:

Cellulose undergoes acetolysis with acetic acid/nitric reagent forming acetylated cellodextrine which gets dissolved and hydrolysed to form glucose molecules on treatment with 67% H2SO4. This glucose molecule is dehydrated to form hydroxymethyl furfural which forms green coloured product with anthrone and the colour intensity is measured at 630nm.

2.3.4.2. Materials:

1. Acetic/ Nitric Regeant: 150ml of 80% acetic acid and 15ml of concentrated nitric acid are mixed

2. Anthrone: 200mg anthrone is dissolved in 100ml of ice cold 95% H2SO4. It is prepared fresh and chilled for 2hrs before use

3. 67% sulphuric acid.

2.3.4.3. Procedure:

(a) 3ml acetic/nitric acid reagent is added to a known amount of the sample in the test tube and mixed in a vortex mixer.
(b) The tube is placed in a water bath at 100 ℃ for 30mins.
(c) The contents are cooled and centrifuged for 15 to 20mins
(d) The supernatant is discarded.
(e) The residue is washed with distilled water.
(f) 10ml of 67% H_2SO_4 is added and is allowed to stand for 1hr.
(g) 1ml of the above solution is diluted to 100ml.
(h) 10ml of Anthrone reagent is added to 1ml of this diluted solution and mixed well.

(i) The tubes are heated in boiling water for 10mins.
(j) It is cooled and the colour is measured at 630nm. The blank is set with anthrone and diluted water.
(k) 100mg cellulose is taken in a test tube and it is proceeded from step
(l) for standard curve. Here, instead of taking 1ml of diluted solution, a series of volume is taken.

2.3.5. Estimation of lignin

(a) The sample should be grounded finely.

(b) Approximately 200mg of sample is accurately weighed to the nearest 0.1mg into a beaker.

(c) 1ml of 72% H2SO4 is added to 100mg of the sample.

(d) The moisture is placed in a water bath at 30 ℃ and it is stirred frequently to assure complete solution.

(e) After exactly 1hr, it is diluted and transferred to a 125ml flask using 28ml of water for each 1ml of acid.

(f) Secondary hydrolysis is in an autoclave at 120 ℃ for 1hr.

(g) The hot solution is filtered and the lignin residue is washed with hot water to remove the acid.

(h) The crucible containing the samples are then dried to constant weight at 105 ℃ and are weighed to the nearest 0.1mg lignin is expressed as a percentage of the original sample.

(i) The lignin can be asked and the content can be corrected for acid insoluble inorganogenesis if these are suspected or known to be present.

2.3.6. Estimation of hemicellulose

Hemicellulose was extracted at three different conditions:

(a) 0.5M NaOH at 55 ℃ for 2hrs from the water treated bagasse.

(b) 2.0M NaOH at 55 ℃ for 2hrs of 3.0% H_2O_2 treated bagasse.

(c) Successive extractions used 0.5M NaOH treated bagasse with different concentrations of H_2O_2 at 55 ℃ for 2hrs at pH 11.5.

2.4. Characterization of the ethanol production

Saccaromyces cerevisiae was cultured in a yeast extract peptone dextrose agar media overnight. The water treated cashew apple bagasse was autoclaved and then it was incubated with the yeast for around 48hrs at 30 ℃ for the bioethanol production. The alcohol was distilled and the alcohol was estimated by measuring the specific gravity.

3. Results and Discussions:

Different physicochemical characterization of cashew bagasse were carried out during our experimental work. The results are summerized below in table 2 and table 3.

Table 2. Physicochemical parameters analysis:

Sl. No.	Parameters analysed	Result
1	Moisture (%) Content	6.74%
2	pH	4.01

The experimental was carried out at temperature of 70 ℃ and pH of 4. The moisture content measured was 6.74% whereas when the temperature was at 65 ℃ the measured moisture content was 6.99% at the same pH. Glucose and cellulose estimation were carried outfor pretreated cashew bagasse and it was found to be 0.83% and 6.33% respectively. The hemicellulose was calculated at two different conditions, one for water treated bagasse and the other for hydrogen peroxide treated bagasse. The percentage hemicellulose content was found to be 40% and 37% respectively which is quite higher than the data presented by other authors.[5]. Chemical analysis of cashew bagasse shows that the lignin content was 16.5%.

Table 3:The chemical composition of dried and crushed cashew bagasse:

Sl. No.	Parameters analysed	Result
1	Glucose Content(%)	0.83
2	Cellulose content(%)	6.33
3	Hemicellulose Content (%)	(i)water treated-40% (ii)H_2o_2 treated-37%
4	Lignin Content (%)	16.5

Below in figure 1, the chart shows the total composition of the cashew apple bagasse.

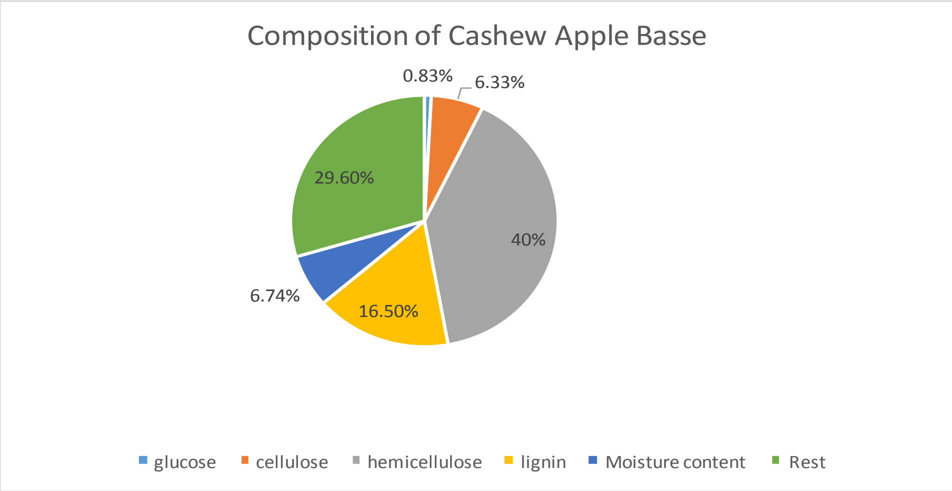

Fig. 1: Total composition of the cashew bagasse

Anaerobic fermentation was carried out on the pretreated cashew bagasse in presence of yeast at a pH of 4.01 and temperature of 30±2 ℃. The experiment was continues for around 48hrs. Amount of alcohol produced at the end of the experiment was 12%.

Above mentioned results show that the cashew apple bagasse may be a promising renewable raw material for the production of green fuel in future.

4. Conclusion

Depending on the results presented here, it can be concluded that the apple bagasse proves to have a huge potential for bioethanol production.

5. References

[1] C. Piccolo and F. Bezzo, " A techno-economic comparison between two technologies for bioethanol production from lignocellulose", Biomass and Bioenergy, Vol. 33, 2009, pp. 478-491.

[2] M. King Hubbert, "Nuclear Energy and the Fossil Fuels", Drilling and Production Practice, American Petroleum Institute, 1956

[3] L.A.B Cortez, " Bioethanol de cana-de-acucar : P&D para produtividade e sustentabilidade" 1st Edition, Blucher, 2010

[4] Y.I.Zheng, Z. Pran, R. Zheng and D.Wang, " Enzymatic saccharization of dilute acid pretreated saline crops for fermentable sugar production," Applied Energy, Vol 86, No. 11, 2009, pp 2459-2465

[5] Flavia Cristina dos Santos Lima, Flavio Luiz Honorato da Silva, Josivanda Palmeira Gomes, Jose Mariana da Silva Neto, " Chemical Composition of the Cashew Apple Bagasse and Potential Use for Ethanol Production" Advances in Chemical Engineering and Science, Vol: 2, No: 4, 2012 pp. 519-523