Spectral Analysis on the Influence of Nipa sap to Biomass ratio with commercial S. cerevisiae for the production of Bioethanol

Christia Marie C. Bacus[a]*, Ferdinand Michael B. Calo Jr.[a], and Romnick B. Unabia[b]

[a]*Department of Physics, Caraga State University-Main Campus*

Ampayon, 8600 Butuan City, Philippines

[b]*Premier Research Institute of Science and Mathematics, Mindanao State University - Iligan Institute of Technology. A. Bonifacio Avenue, 9200 Iligan City, Philippines*

69

Abstract

The current technologies for energy production employ nonrenewable energy sources such as petroleum-based and fossil fuels which could lead to imminent catastrophic environmental impacts. Hence, it is essential to develop clean energy technologies to address these problems. As a result, non-edible biomass sources like nipa palm are being investigated as sources for sustainably producing bioethanol. This study is initiated to evaluate the feasibility of nipa sap and palm biomass as a sustainable feedstock for ethanol production by determining its absorbance and transmittance using spectral absorption measurement. Initial fermentative analysis using commercial Saccharomyces cerevisiae showed that nipa saps could be a potential source for bioethanol production. Moreover, the addition of biomass to the fermented nipa sap shows an increase in the intensity in the UV-Vis spectra which would indicates slight increase in its concentration. Thus, controlling the ratio of nipa sap and biomass shows a promising contribution in the increase of the concentration of the produced bioethanol.

Introduction

Why alternate fuels?

- Depleting fossil fuels
- Growing population
- Increasing demand for transportation fuel
- CO_2 emissions

Why bioethanol?

- Tested transportation fuel
- Carbon neutral
- Renewable and Sustainable
- Agricultural waste (cellulose) as a precursor

Bioethanol feedstock

❑ Nipa palm

✓ consists of nipa sap and nipa biomass

✓ Biofuel crop

❑ Nipa sap

✓ a fluid produced from nipa palm

✓ It contains 89.61 percent carbs, 5.98 percent protein, and 44.58 mg of calcium per kilogram [1].

✓ The conversion of materials containing between 68 and 85 percent carbohydrate yields 5.8% ethanol [2].

❑ Nipa lignocellulose

✓ nipa have the content of cellulose and hemicellulose were 28.9-45.6 wt% and 21.8-26.4 wt%, respectively [3].

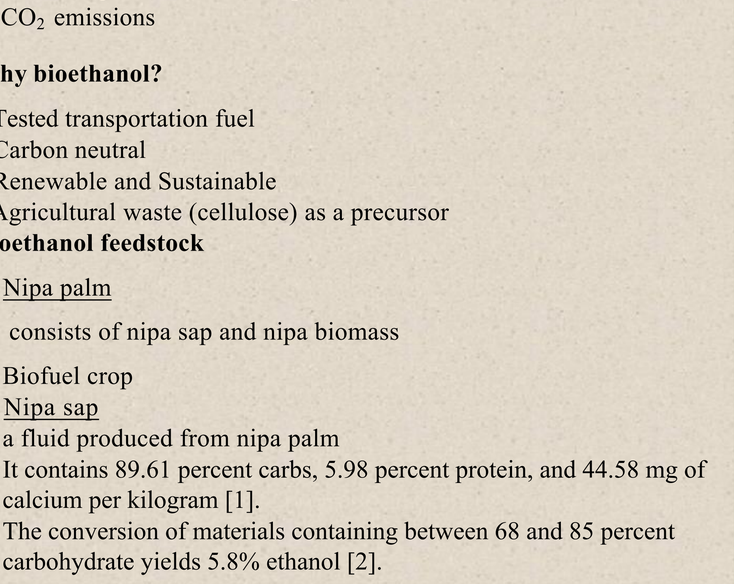
✓ The greater content of cellulose and hemicellulose in a material shows that materials were more potential to be converted into bioethanol [4].

❑ UV-Vis spectroscopy

✓ measures the amount of discrete wavelengths of UV or visible light

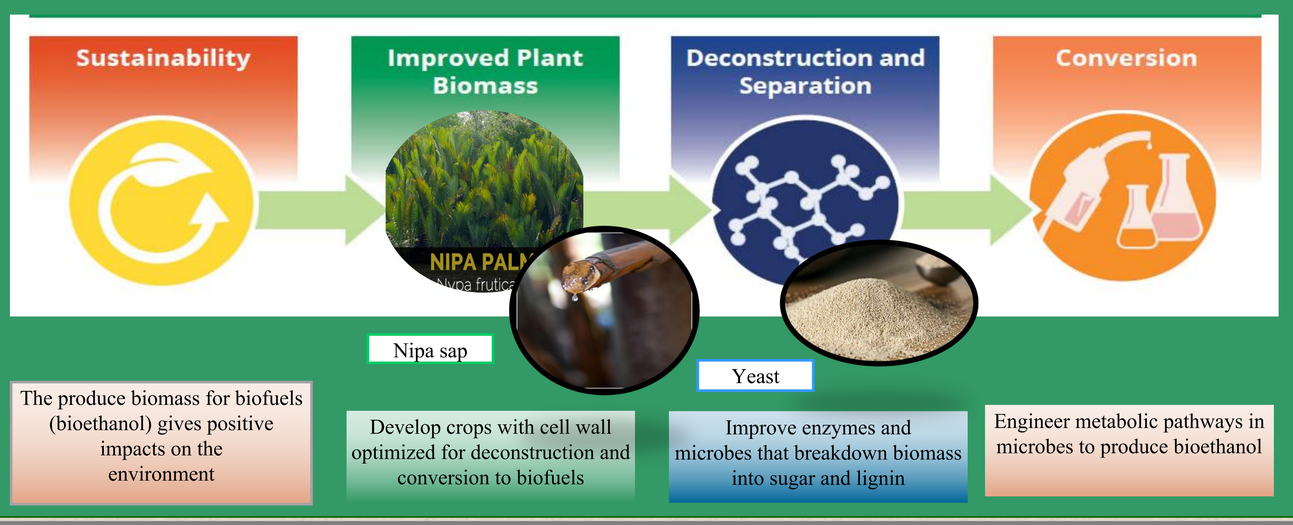
✓ to analyze or identify different substances by locating the specific wavelengths corresponding to maximum absorbance [5].

Experimental



Fermentation with varying *Saccharomyces* cerevisiae yeast concentration
Sugar sources: Nipa sap
Fermentation broth: Yeast + nipa sap + biomass
Yeast ratio: 1%wt, 3% wt%, and 5%wt
Biomass ratio: 25% wt%, 50%wt, and 75%wt
Temperature: room temperature
Distillation using Rotary evaporator: 55 rpm
Temperature: 50-60 degrees celcius

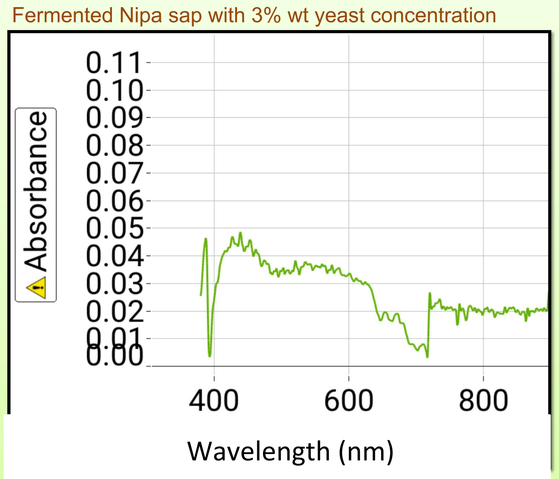
Bioethanol production process



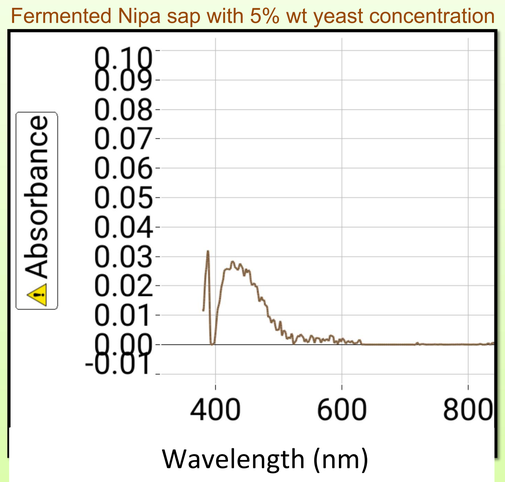
Results

Absorption spectrum of fermented nipa sap with varying yeast concentration and with biomass

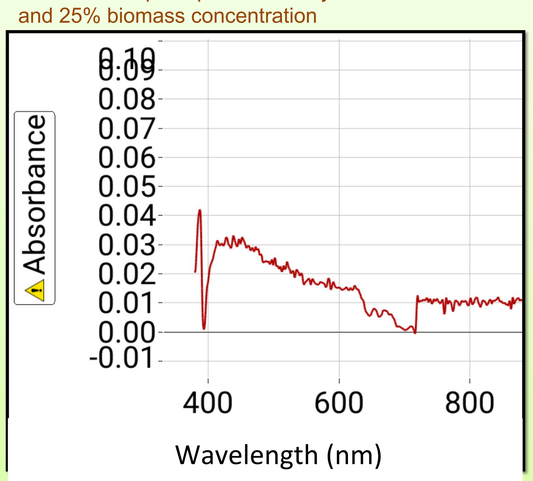
Fermented Nipa sap with 3% wt yeast concentration



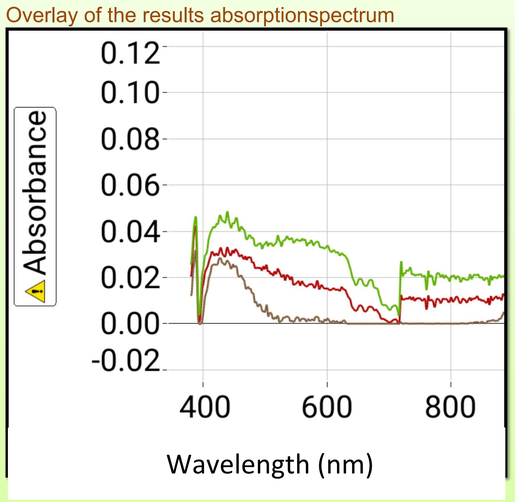
Fermented Nipa sap with 5% wt yeast concentration



Fermented Nipa sap with 3% wt yeast concentration and 25% biomass concentration



Overlay of the results absorptionspectrum



Summary

✓ The fermentation of nipa sap with varying yeast concentration was characterized by UV-Vis spectroscopy wich shows an absorption peak around 400nm associated to ethyl alcohol. With the increasing concentration of added yeast to nipa sap there is an increase in absorbance. Therefore, the fermentation of nipa sap- using commercially available yeast yield ethanol. Moreover, with the addition of biomass there is a decrease in absorbance peaks due to the total volume of fermented nipa sap absorb by the biomass.

References

[1] "Potensi Nipah (Nypa fruticans (Thunb.) Wurmb.) sebagai Sumber Pangan dari Hutan Mangrove." http://repository.pertanian.go.id/handle/123456789/2160 (accessed Sep. 13, 2022).
[2] E. Jr, R. E. Ragas, and R. Junio, "Morphological and sap yield variation in Nipa (Nypa fruticans Wurmb.)," *Asia Life Sci.*, vol. 21, Jan. 2012.
[3] P. Tamunaidu and S. Saka, "Chemical characterization of various parts of nipa palm (Nypa fruticans)," *Ind. Crops Prod.*, vol. 34, no. 3, pp. 1423–1428, Nov. 2011, doi: 10.1016/j.indcrop.2011.04.020.
[4] N. Sarkar, S. K. Ghosh, S. Bannerjee, and K. Aikat, "Bioethanol production from agricultural wastes: An overview," Renew. Energy, vol. 37, no. 1, pp. 19–27, Jan. 2012, doi: 10.1016/j.renene.2011.06.045.
[5] M. Picollo, M. Aceto, and T. Vitorino, "UV-Vis spectroscopy," Phys. Sci. Rev., vol. 4, no. 4, Mar. 2019, doi: 10.1515/psr-2018-0008.