Should Common CT Invasive Plants Be Used as Biofuels?

NRCA Student: Grace McGonagle[1]

Community Partner: Dr. Mathieu Freeman[1]

[1] Greens Farms Academy

INTRODUCTION

Biofuels are popular alternatives to fossil fuels. Any organic material that containins glucose can be fermented to produce ethanol and carbon dioxide. This ethanol can then be used in its pure form for biofuel or blended with petrol, vegetable oil, or animal fat to become more combustible and efficient for use (1).

Burning biofuel produces less air pollution and is cheap, renewable, and carbon neutral (2). Additionally, waste products can be used to produce biofuel.

Invasive plant species are not native and damage the environment, economy, or public health of an area. In Connecticut, two important invasive plant species include Spearmint *(Mentha lamiaceae)* and Bamboo (*Bambusoideae* Spp.*)* (Fig 1). Currently, there is controversy about using invasive plant species as a source of biofuel, in place of common sources, such as corn.

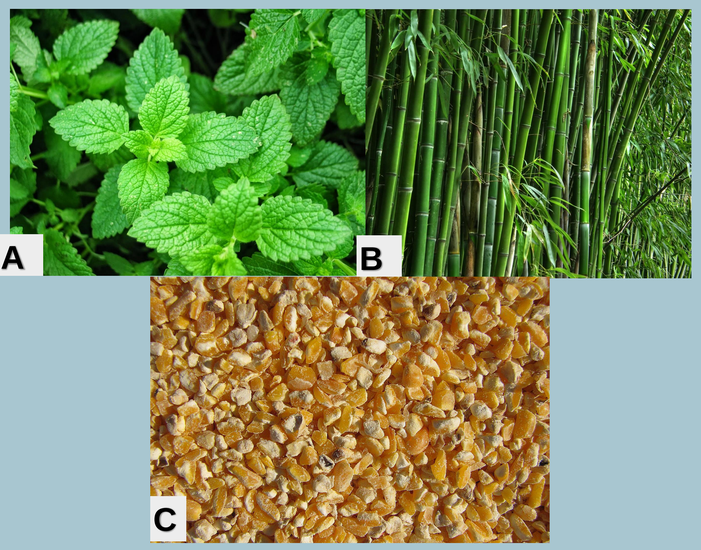


Fig 1. A: Spearmint (*Mentha laminaceae)* and B: Bamboo (*Bambusoideae*); both invasive plant species in CT; C: Cracked Corn, commonly used for biofuel production

PURPOSE OF THE STUDY

This study will help assess whether invasive plant species should be utilized for the production of biofuels. Plants will be compared based on their efficiency of ethanol production, and will investigate spearmint, bamboo, and corn.

MATERIALS AND METHODS

Fermentation

- Bamboo (*Bambusoideae*) and spearmint *(Mentha lamiaceae)* were harvested from Audubon Forests in Southport, CT
- 50 g of each plant sample (Bamboo, Spearmint and Corn) were chopped/crushed using a food processor (“dry milling process”)
- Plants were separately “jet-cooked” (7 minutes at 120 °C) with 1 cup of distilled water in each pan
- 1 teaspoon of amylase was added to each container (Figure 2A)
- Plant mixtures placed in “Ultrasonic Cleaner” for 1 hour at 28 °C (Fig 2B)
- 4.8 g of yeast was added to each container
- Containers were tightly sealed and placed in a dark cabinet, fermenting over the course of 3 days at 30-32 °C and agitated once per day to prevent yeast from settling
- After 1 week, samples were opened to release accumulated CO_2, and plant material was strained from the remaining liquid.

Fig 2. A: Separate plant containers after being processed and jet-cooked; B: The bamboo mixture being shaken by the Ultrasonic Cleaner to spread the amylase and break down the cell walls.

Distillation

- Each liquid sample was added to a distillation flask, and boiled individually between 78.3 ºC and 100 °C (Fig 3).
- The ethanol that boiled off each sample was collected in a graduated cylinder. A fractioning column was used to prevent water from boiling off and collecting in the graduated cylinder.
- Distillation was then repeated. The resulting ethanol of each sample was measured and compared.
- After collecting this data, the density of each sample was measured to ensure that the sample was comprised of ethanol (Ethanol Density: .79 g/mL)

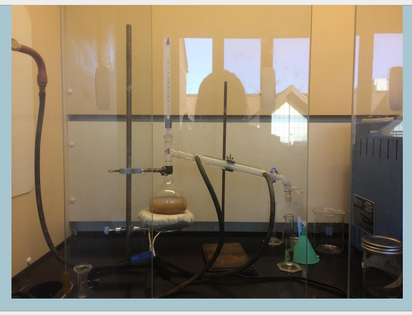
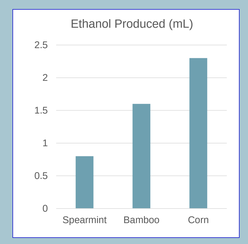


Fig 3. The Spearmint mixture is being distilled. Since this is the first distillation, a large ethanol/water mixture has collected in the graduated cylinder.

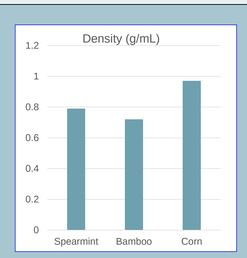
RESULTS

While corn appears to have the highest ethanol yield, the density of this solution shows that it is not purely ethanol, and likely contains a volume of water. As such, it did not produce ethanol the most efficiently, and both bamboo and spearmint produced higher ethanol yields.

	Ethanol Produced (mL)	Density (g/mL)
Spearmint	0.8	0.79
Bamboo	1.6	0.72
Corn	2.3	0.97



A



B

C

CONCLUSIONS

- By density and volume, bamboo produced the highest yield of ethanol, indicating that Bamboo would be a more effective source for biofuel than commonly used Corn.
- Beneficial plants (including crops and medicinal plants) are wasted to produce biofuel, and are not likely the most efficient options.
- Using invasive plant species as a biofuel source would both help to manage these harmful plants while providing an alternative energy source.
- More studies should be conducted to determine additional factors including economic, technological, processing, and ease of harvest to further investigate biofuel plant sources.

ACKNOWLEDGEMENTS

I would like to thank both Abby Beissinger, the director and coordinator at the NRCA, as well as my community partner, Dr. Mathieu Freeman, who have both encouraged and guided me through this project.

REFERENCES

1. Office of Energy Efficiency and Renewable Energy. “Biofuels Basics.” *Department of Energy*.
2. Quinn, Lauren. “Can We Harvest Invasive Species of Biofuels?” Renewable Energy World. N.p., 25 Nov. 2013. Web. 15 July 2017.
3. GreenFacts. “Liquid Biofuels for Transport Prospects, Risks and Opportunities.” *Biofuels*: 1. *What Are Biofuels*?, GreenFacts Scientific Board, 2017.
4. K. Van Meerbeek, et. Al. “Biomass of Invasive Plant Species as a Potential Feedstock for Bioenergy Production.” Biofuels, Bioproducts, and Biorefining, Volume 9 (2015): 273-282.
5. Quinn, Lauren. “Can We Harvest Invasive Species of Biofuels?” Renewable Energy World. N.p., 25 Nov. 2013. Web. 15 July 2017.
6. Shechter, David. “BEE International Blog.” *What Is The Cell Wall Made Of & How Do You Break It Down*?, BEE International: Next Generation Homogenizers, 24 Oct. 2016.