Trash to Treasure: Production of Bioethanol Derived from Dessert Waste

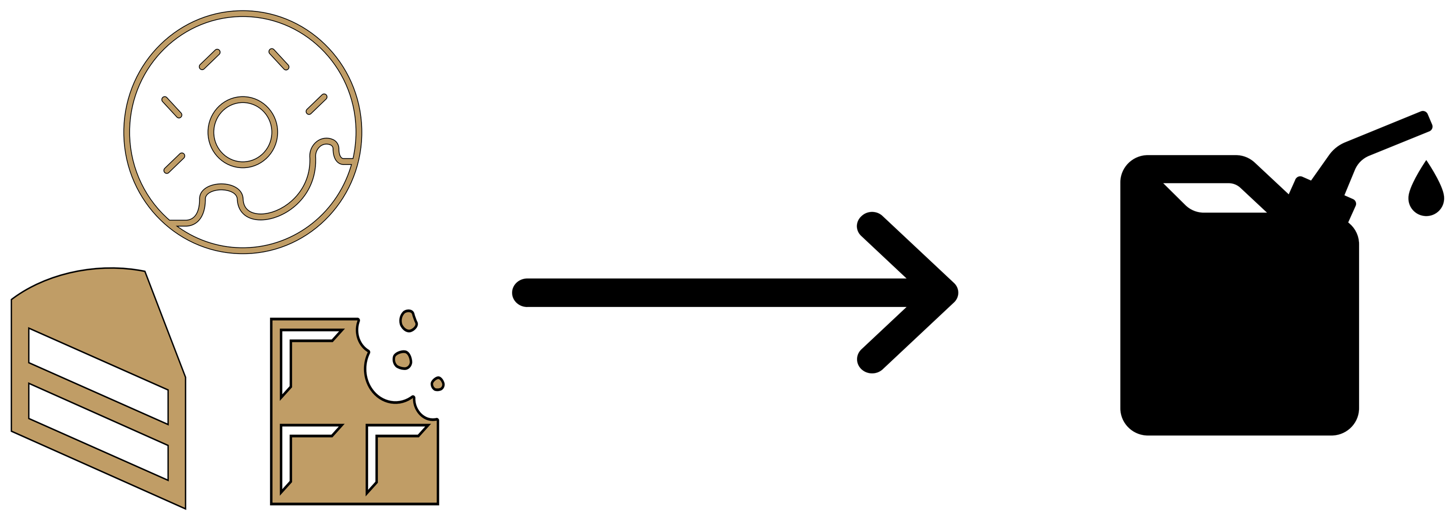
Cody Kroetsch

Introduction

More than 2 billion tons of municipal solid waste (MSW) is generated globally each year (Yatoo et al., 2024). Food and green waste contribute to 44% of the total global waste. With fossil fuels being limited in supply, biofuels are a viable option for alternative fuel and energy sources. Embracing MSW as a source for generating alternative fuels not only diminishes reliance on fossil fuels but also creates opportunities to reduce the amount of food waste entering landfills. Biofuels can contribute to a circular economy by upcycling a common waste product and generating value in an otherwise disregarded source (Sarker, T. R et al, 2024). A promising direction of research is the conversion of dessert biowaste into biofuels. Dessert waste can be processed into bioethanol through physical and chemical treatment methods, along with a fermentation process using *Saccharomyces cerevisiae* (EC-1118), an alcohol-tolerant strain of yeast. We partnered with Conestoga College's Bloom Restaurant to collect discarded dessert, as a food source with high sugar content, for conversion to ethanol. The investigation was a proof-of-concept for side stream valorization of restaurant waste into an upcycled product.

Objective

The primary objective of this research was to optimize ethanol production from dessert leftovers from Conestoga College's Bloom Restaurant using a yeast fermentation process.



Batch Conditions

Batch #	Biowaste Constituents (1)	Biowaste : Water Ratio	Yeast Dosage	Total Pasteurization Duration	Pasteurization Temperature (held for 15 mins.)	Fermentation Duration (days)
Batch 1	All desserts	1:1	2 g/L	45 mins	50℃	8 days
Batch 2	All desserts	1:3	2 g/L	45 mins	50℃	8 days
Batch 3	All desserts	1:5	2 g/L	45 mins	50℃	8 days
Batch 4	All desserts, except danishes and croissants	1:1	0.2 g/L	90 mins	70℃	14 days

(1) Biowaste constituents were all desserts provided by Bloom Restaurant which included danishes, brownies, chocolate, croissants, fruit, and marshmallows.

Materials and Methods

Collection of Dessert Biowaste

Dessert biowaste was delivered from Bloom Restaurant, consisting of fruit-filled danishes, chocolate squares, and marshmallow squares.

Biowaste Sorting

Biowaste was sorted to ensure standardization of waste to water slurries.

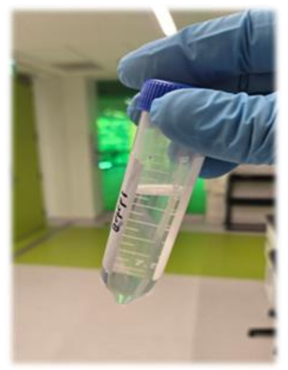
Physical Pretreatment

Biowaste was blended into a slurry solution with distilled water. The slurries were all pH tested and adjusted to a pH ~4. Slurries were then heat-pasteurized.

Biowaste Fermentation

Saccharomyces cerevisiae strain of yeast (EC-1118) was used for the fermentation process to convert the sugar present in the slurry into ethanol.

Filtration and Alcohol Recovery



The fermented solution was centrifuged, clarified with bentonite, and filtered with cheesecloth. The solutions were then distilled using a rotary evaporator to isolate ethanol as a distillate.

Analysis of Ethanol

Samples of the fermented solutions were analysed to quantify ethanol using gas chromatography mass spectrometry (GC/MS).

Results

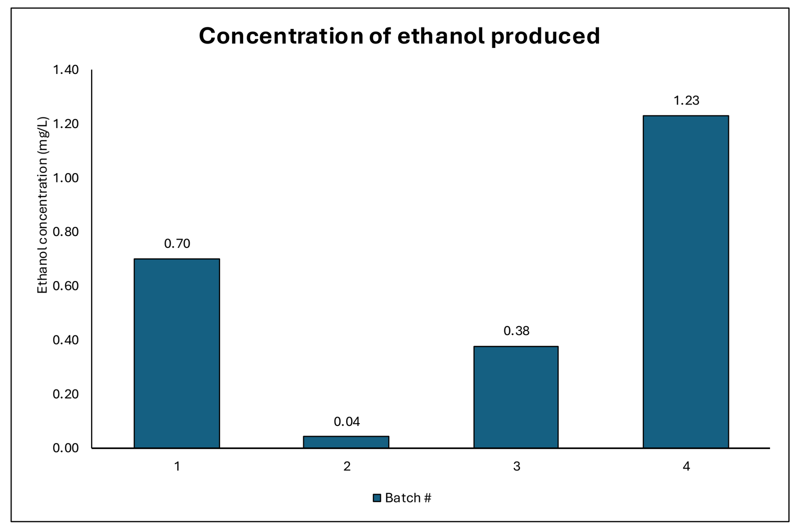


Figure 1. Average ethanol concentration from fermented biowaste.

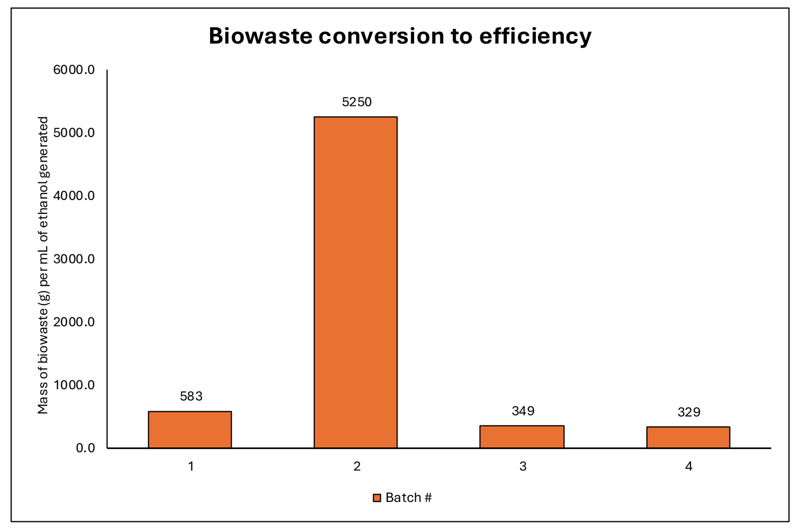


***Figure 2**. Mass of biowaste per mL of ethanol generated.*

Discussion

Batch 1 and Batch 4 had the highest ethanol concentrations (Figure 1), possibly due to increased biowaste-to-water ratio (Table 1). High sugar desserts used in Batch 4 likely contributed to highest ethanol concentrations. Batch 3 and 4 were the most efficient at producing ethanol, based on the amount of biowaste used to produce 1 mL of ethanol (Figure 2). However, Batch 3 used 10 x more yeast and 1.6 x more water (Table 1) in only half the time. Therefore, for commercialization, the selected parameters used (Batch 3 vs. Batch 4) depend on whether time is a consideration or reduced inputs are preferred.

Conclusions

- A range of high-sugar dessert items were successfully used to produce ethanol.
- Biowaste constituents, biowaste dilution, yeast dosage, and fermentation time all contribute to ethanol production rate.
- This study reinforces the potential role of MSW in shaping a more circular and sustainable economy.

Future Research

Development of new methodologies will aid in the production of biofuels from food waste.

- Optimizing fermentation temperature, pH, fermentation time, aeration, and moisture content.
- Optimizing pretreatment conditions,
- Nutrient additions to support yeast colony.
- Enzyme additions to breakdown complex starches and carbohydrates.

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References

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BioHub@conestogac.on.ca