CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Geoffrey D. Young

Project Number
S0819

Project Title
One Man's Trash is Another Man's Treasure: The Conversion of Cellulosic Municipal Waste to Ethanol

Abstract

Objectives/Goals
My objective is to determine which cellulosic waste product (newspaper, grass and eucalyptus sawdust) produces the greatest amount of ethanol through concentrated acid hydrolysis. I believe that the grass samples will produce the most ethanol because the hydrolysis of newspaper and sawdust may produce toxins that inhibit yeast growth.

Methods/Materials
93% sulfuric acid was added to cellulosic waste to break down polysaccharides into monosaccharides which are fermentable by yeast. I used a ratio of 1 part feedstock to 2 parts acid. After 1 hour, I neutralized the pH of the hydrolyzed cellulose with a dilute of baking soda (30 grams baking soda to 800 mL water) yielding a pH of 5 to 6.5 for optimum yeast growth.
Sample solutions were put into airtight jars to which yeast, Saccharomyces cerevisiae, was added. Plastic tubing through each jar lid into a container of water maintained an anaerobic environment and allowed the release of carbon dioxide during fermentation. The jars were kept at 20 to 25° Celsius. At 36 hours a new supply of yeast, S. cerevisiae bavanus, was added. Total fermentation time was 108 hours.
I used four samples of each waste product and four controls which were identical to the samples but without a cellulosic waste.
At the beginning, at 36 hours, and at 108 hours of fermentation I measured temperature and pH. I used a hydrometer to measure specific gravity and potential alcohol.

Results
The grass produced the most ethanol with a mean .3076% alcohol followed by newspaper (.0681%) and sawdust (.0286%). T-tests confirmed the statistical reliability of my data.
Results supported the hypothesis that grass clippings would produce the most ethanol, but the control had the largest drop in specific gravity indicating it produced the most ethanol. I tested a second hypothesis to find which hydrolyzed cellulose was least detrimental to fermentation as compared to the control. T-tests showed that sawdust and newspaper harmed fermentation. There was no statistical evidence that the hydrolyzed grass inhibited fermentation. This again proved that grass was the best cellulosic waste for ethanol production.

Conclusions/Discussion
Ethanol from waste is potentially an efficient and environmentally sensible alternative fuel source and would help lessen our dependence on foreign petroleum. This experiment increased my understanding of biofuels and the need for cost-efficient energy alternatives.

Summary Statement
This project shows that after the fermentation of three hydrolyzed cellulosic municipal waste products, grass produced the greatest amount of ethanol followed by newspaper and eucalyptus sawdust.

Help Received
Jasun Tenenbaum, a chemistry student at UCI, helped refine my procedures for safety. My parents helped me stay safe and understand the more difficult concepts behind the project. My brother taught me about statistical analysis and t-tests which I applied to the project.