



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

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Project Title Trash to Treasure: Biofuel from Agricultural Waste by Saccharification and Fermentation Using an Arduino Ethanol Sensor	
<p style="text-align: center;">Abstract</p> <p>Objectives Fossil fuels are non-renewable, and combustion of fossil fuels releases pollutants and greenhouse gases into the atmosphere, causing global warming. Ethanol is a renewable and environmentally friendly biofuel. It reduces carbon dioxide emissions by 60% compared to petroleum. 95% of US ethanol is produced from corn grain. Corn is a food grain and uses valuable agricultural land, making scaling up production of ethanol impractical. The purpose of our project was to produce ethanol from everyday waste materials like fruit and vegetable peels, paper and cardboard, and yard waste.</p> <p>Methods Phase 1. Pretreatment: Feedstocks prepared by drying and grinding to increase surface area. Samples heated in water bath for 30 minutes to expose cellulose. Phase 2. Enzymatic Saccharification: 1 mL cellulase enzyme added to samples. Samples then placed in incubator at 50 degrees Celsius for 24 hours. Phase 3. Fermentation: 1 gram yeast added to samples. Samples placed in incubator at 37 degrees Celsius for 24 hours. Four trials conducted for each sample for a total of 28 tests. Samples with no enzymatic saccharification was used as control. Glucose and ethanol readings taken before and after each phase. Used glucometer to test glucose. Arduino-based ethanol sensor used to measure ethanol content.</p> <p>Results All the samples produced varying amounts of ethanol. The orange and lemon sample produced highest amount of ethanol: 1.70% (by volume). The mixture of cardboard and paper produced 1.54% ethanol (by volume). The leaves and twigs sample produced least amount of ethanol - 0.79% (by volume). We combined the two samples that produced the most ethanol. This mixture of orange and lemon peel with cardboard and paper produced 1.92% ethanol (by volume).</p> <p>Conclusions Our hypothesis was partially correct. We hypothesized that cardboard and paper would produce the most ethanol and leaves and twigs will produce the least ethanol. However, mixture of orange and lemon peels produced the most ethanol. The leaves and twigs produced the least ethanol. Ethanol from agricultural wastes is cost-effective, renewable, and abundant. We believe it is a viable alternative to petroleum from fossil fuels, and helps with reducing pollution and waste.</p>	
Summary Statement We produced ethanol biofuel from various waste materials through enzymatic saccharification with cellulase and fermentation with yeast using an Arduino-based ethanol sensor for measuring ethanol content.	
Help Received Mr. Eric Harness at BioCurious provided us with space and equipment. Our parents took pictures and supervised us during experimentation.	