CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

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Project Number

J0520

Project Title

Increasing Cellulosic Bioethanol Production with Ultrasound and Cellobiase

Abstract

Objectives/Goals

The objective of this project was to determine how ultrasound would affect enzymatic production of glucose at varying temperatures.

Methods/Materials

Multiple trials of low concentration cellobiase (enzyme) mixture and 1.5 mM p-Nitrophenyl glucopyranoside were mixed together in a test tube and held in PID temperature-controlled water baths (10C,20C,30C,40C) for the assigned amount of time for the control sample. After each assigned time, the mixture in the test tube was pipetted into a cuvette with carbonate buffer (pH 9.5) and the absorbance of the resulting p-Nitrophenol was measured in a spectrometer set to 410 nm. This process was repeated with the same mixture pipetted into a test tube and held in a PID temperature-controlled 28 kHz ultrasonic bath. To ensure repeatable results, micropipettes and control samples were used and the spectrometer was calibrated before each set of measurements were taken. Using a standard dilutions plot made by diluting the substrate, the absorption, measured by the spectrometer, was then converted into concentration (nmol).

Results

For each temperature, the raw results were plotted and curve-fitted to find the rate of reaction (product generation/time) with and without ultrasound. The difference of rates with and without ultrasound were compared at each temperature and the variation in rates was found. The increase in difference of rates for each temperature tested (10C,20C,30C,40C) were 0.025 nmol/second, 0.040 nmol/sec, 0.021 nmol/sec, and -0.012 nmol/sec, respectively.

Conclusions/Discussion

I can conclude that surprisingly, at 20C, the ultrasound increased glucose production by 19% while at 40C, the ultrasound decreased production by 2%. When temperatures are lower, the kinetic energy of enzymes lower. Ultrasound increases mass transfer, prevents agglomeration of the enzyme, and breaks down the substrate resulting in increased reaction rate. When temperatures are raised without ultrasound, the kinetic energy of enzymes increases which increases the reaction rate. However, when ultrasound is added to the already high temperature, the mass transfer is enhanced and the enzyme becomes deformed so that it actually decreases the reaction rate. The information from this project can be scaled up to increase biofuel production at lower temperatures where it would be more beneficial to use ultrasound at the ambient temperature rather than processing at a higher temperature.

Summary Statement

I tested the effect of ultrasound on enzymatic (cellulase) production of cellulose (glucose) and found that at 20C, there was the greatest increase in product generated.

Help Received

My science teacher, Mrs. Nelly Tsai, advised me on how to conduct my experiment.