Application of Photo-responsive Surfactants

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Introduction

In Professor Lee's chemical engineering lab, they focus on using surfactants to achieve various goals.

Surfactants:
- Surface cleansing agents
- Lower the surface tension
- Amphiphilic molecules, having hydrophobic tails and hydrophilic heads

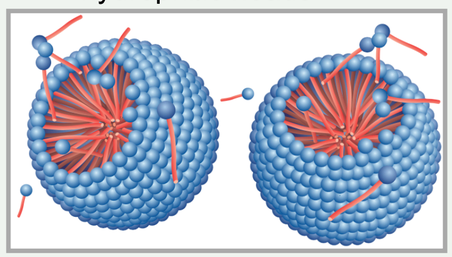

Figure 1: Surfactant molecules combine to form circular structures called micelles. The blue portion of each surfactant is the hydrophilic head and the orange portion is the hydrophobic tail.
PC: DataPhysics Instruments GmbH

Photo-responsive Surfactants:
- AzoTAB
- Responds to light, different structures under UV and visible light

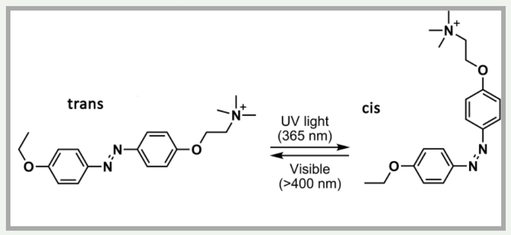

Figure 2: AzoTAB structure; trans structure under visible light and cis structure under UV light
PC: Maria Balasoiu from the Joint Institute for Nuclear Research

Enzymes:
- Type of protein that catalyzes metabolic reactions by lowering the activation energy needed
- Specific research uses the enzyme β-glucosidase
  - Degrades cellobiose into two glucose molecules

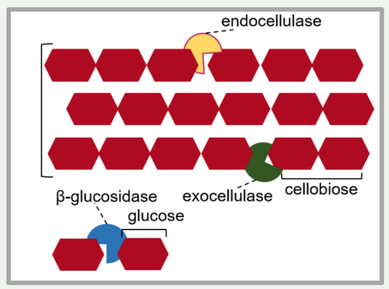

Figure 3: A diagram of the three cellulase enzymes and their respective substrates. At the bottom, the enzyme β-glucosidase is shown.
PC: Zumra Seidel, PhD

Protein-surfactant Interactions:
- Hydrophobic *trans* azoTAB isomer binds to and unfolds proteins
- Protein conformational changes controlled by light

Objectives & Impact

Producing Bioethanol Faster and Cheaper

- Bioethanol is a relatively new renewable energy source derived from biomass (crops, corn, grass, etc.) and has shown to be far less toxic than fossil fuels.
- The third step of producing bioethanol, when the enzyme β-glucosidase catalyzes the hydrolysis of glucose, is shown to be very inefficient.
- By using AzoTAB and its interactions with β-glucosidase under different conditions, we are able to manipulate, control, and improve enzymatic activity.

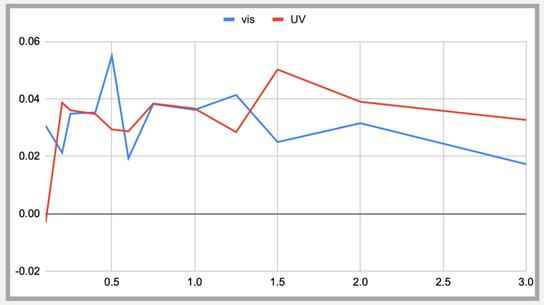

Figure 4: A graph depicting the rate of glucose production in both UV (red line) and visible (blue line) light depending on the concentration of the surfactant.
PC: Jasper Chan

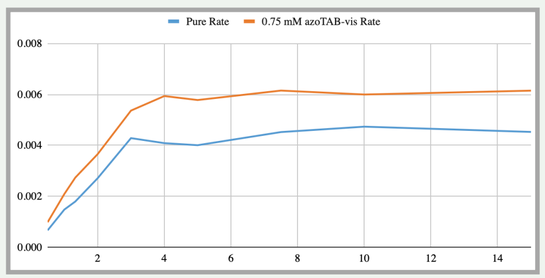

Figure 5: A graph depicting the two rates of glucose production: the blue line represents the pure rate (without surfactants) and the orange line represents the rate with 0.75 mM concentration of AzoTAB under visible light.
PC: Jasper Chan

Relativity to my STEM Coursework

My research focused on topics in chemistry and biology. My previous knowledge from taking AP Biology allowed me to easily understand concepts such as enzyme behavior.

However, coming from a performing arts high school where STEM curriculum is limited, this experience exposed me to countless new concepts in chemical engineering, such as the various uses of surfactants.

What's Next
I look forward to taking more advanced STEM classes in college and to use this knowledge and the skills I gained from SHINE to conduct my own research in the future.

Skills Learned

Reading and finding research articles:
- I learned to utilize the IMRAD approach when tackling research articles.
- Since our research involved complex topics such as AzoTAB activity, I had to dig deeper and use databases such as the USC library database and Google Scholar to find specific research articles.

Lab safety:
- During my first week at SHINE, I attended the USC Lab Safety training where I learned about different equipment, PPE, waste disposal, lab symbols, etc.

Nelson-Somogyi method:
- Since my research required me to determine the efficiency of the enzyme β-glucosidase, one way was to find the amount of glucose, a product of the reaction, left in the solution.

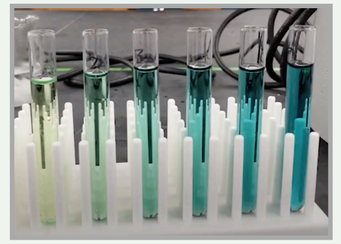

Figure 6: Test tubes with solutions in them that have undergone the Nelson-Somogyi method; the darker the solution, the higher the concentration of reducing sugars
PC: BU Biochemistry Laboratory

Excel:
- I familiarized myself with Excel and its functions after having to format and analyze data from both reactions under UV and visible light. For example, I found slopes, averages, and standard deviations.

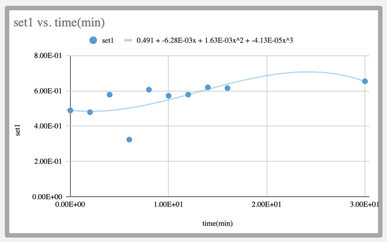

Figure 7: One of the many charts I created to determine the slope of glucose production. In this case, this is data set one when the surfactant concentration is 0.1 mM under UV wavelength of 760-500 nm.
PC: Jasper Chan

Acknowledgement

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