

Introducing Biocatalysis in an Undergraduate Teaching Laboratory Using a Cyclopropanation Reaction

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Biocatalysis is the use of enzymes and proteins to perform chemical transformations. Enzymes and proteins are increasingly used in organic reactions due to excellent chemo-, regio- and stereo- selectivity, environmental sustainability, milder reaction conditions, improved productivity, simplified work-streams and greater economical saving potential. The purpose of this project is to design a biocatalysis experiment that we can incorporate into an undergraduate organic chemistry teaching laboratory. In recent years, there have been a number of studies reported regarding the use of heme containing proteins and enzymes in catalyzing non-natural C-C insertion reactions (1). In this study, we use commercially available wild-type bovine hemoglobin as a non-native biocatalyst to perform a cyclopropanation reaction with commercially available styrene and ethyl diazoacetate as the substrate. In order to identify the best reaction conditions, we optimized various conditions such as enzyme concentration, substrate concentration, substrate ratio, pH, and temperature. Reactions were done under aerobic, semi-aerobic, and anaerobic conditions. The catalytic activity of the hemoglobin enzymes, percentage conversions, and stereo selectivity of the reaction was determined by chiral gas chromatography standardized with a calibration curve. Our final optimized reaction conditions will be tested with a group of 90 undergraduate students. This experiment will be an inexpensive and sustainable way to introduce biocatalysis to an undergraduate teaching laboratory.

Keywords: biocatalysis · cyclopropanation · hemoglobin · enzyme optimization · organic chemistry

References

(1) Gober, J.; Brustad, E. Non-natural Carbenoid and Nitrenoid Insertion Reactions Catalyzed by Heme Proteins. *Current Opinion in Chemical Biology*. **2016**, 35, 124-132.