3RD INTERNATIONAL COURSE-BASED UNDERGRADUATE RESEARCH EXPERIENCE (CURE) CONFERENCE

RKGP JOURNALS

Simulating enzyme activity: A comparison of synthetic, household, and natural catalysts

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Course-based undergraduate research experiences (CUREs) provide authentic research opportunities for all students in a course, rather than only those who can secure individual research positions. This presentation describes a three-session CURE module implemented in General Chemistry I (CHEM 107) at Bowie State University, an HBCU, designed to engage first-year students in comparative catalysis research while reinforcing core chemical concepts. Students investigated the central research question: "How do different types of catalysts compare in their ability to decompose hydrogen peroxide, and what factors affect their effectiveness?" Over three 100-minute laboratory sessions, students systematically tested synthetic chemical reagents (Fe^{3+}, Mn^{2+}, Cu^{2+}, Au^{3+}), household consumer products (mouthwash, dish soap, contact lens solution, laundry detergent), and natural enzyme extracts from fresh produce (potato, carrot, zucchini, banana). Students designed controlled experiments, collected quantitative data on reaction kinetics, performed statistical analyses, and evaluated the cost-effectiveness of catalysts across various categories. Results from two course sections (N = 52 students) revealed significant variation in catalytic efficiency both within and between catalyst categories. Synthetic catalysts demonstrated the highest peak intensities (Fe^{3+} at 1 M: intensity 3.7 - 4.0) and longest reaction durations (up to 11.87 min), establishing performance benchmarks. Household products showed unexpected catalytic activity, with contact lens solution and dish soap producing moderate effects (intensity 1.67 - 2.17), though considerably weaker than synthetic standards. Natural enzymes from potato and carrot exhibited robust catalase activity comparable to dilute synthetic catalysts (intensity 2.0 - 3.83, duration 8 - 13 min), while others showed minimal activity. A cost analysis revealed that while synthetic catalysts performed best, household products and natural sources offered viable alternatives for applications that did not require maximum efficiency.

Keywords: Catalysis, hydrogen peroxide, chemical kinetics, enzyme activity.