Textile Dye Pollution: Can Green Chemistry Fix the Problem with a Biomimetic Iron-Complex?

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Background: Water pollution by water-soluble dyes which by the textile industry is a major environmental problem leading to health hazards. Green chemistry proposes the use of hydrogen peroxide for oxidation. However, the oxidation process is slow. A catalyst is needed to activate hydrogen peroxide for the effective dye degradation. The purpose was to develop a biomimetic iron-catalyst using green chemistry concept to activate hydrogen peroxide. Hypothesis: If hydrogen peroxide and a biomimetic catalyst are used to degrade dyes through green oxidation chemistry, then higher and faster dye degradation can be achieved than if chlorine-based oxidation was used. Methods: A biomimetic iron complex was synthesized in multiple steps. First, an amide-based ligand was synthesized. This ligand was metallated with an iron precursor salt to obtain the water-soluble biomimetic iron complex. The biomimetic complex and a green primary oxidant, hydrogen peroxide, were used to bleach water-soluble orange IV and indigo carmine dyes. Spectroscopy of dyes before and after degradation with iron-catalyst was obtained. Results: Ultraviolet-visible spectra of dye samples showed that the dyes degraded faster with use of iron-catalyst. The maximum absorption wavelength for the orange IV and indigo carmine dyes were 442 and 609nm. The percentages of orange IV and indigo carmine dyes degraded were 82.22% and 99.48%. Conclusion: Biomimetic iron-catalyst was successfully synthesized using green oxidation chemistry. The iron-catalyst through the activation of hydrogen peroxide achieved a faster and higher percentage of dye degradation. This process helps solve the environment and public health water pollution problem by the textile dyes.

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