Porphyrins are molecular complexes that are critical for the proper function of many important biological macromolecules such as hemoglobin and myoglobin. The goal of this research is to monitor the transformations and differences that occur with the addition of metals and ligands to a model porphyrin compound called tetraphenylporphyrin. During this work, a series of metalloporphyrin complexes were prepared, with changes to both metal centers and ligand attachments at those centers. Specifically, iron, zinc, cobalt, and manganese metalloporphyrins have been synthesized and identified via electronic absorption spectroscopy.

In order to bind the metal to tetraphenylporphyrin, the reactants were placed in a round bottom flask with N,N-dimethylformamide as a solvent. The porphyrin and metal were heated to help drive the reaction to completion. As the solvent boils, its vapor rises into the condenser, returning it back to its liquid state, and flows back into the reaction flask. Refluxing helps maintain the concentration and temperature of the reaction mixture (see Figure 4.)

Due to the high cost of TPP, a cheaper way of synthesizing TPP was found and used. Using a method developed by Adler, benzaldehyde, propionic acid, and pyrrole were all combined in a reflux apparatus and reacted to give TPP. The crystals were verified via their 1H NMR (Nuclear Magnetic Resonance) and visible spectra (see Figure 3.)

To determine the presence and impact of the metal binding to the porphyrin and ligand groups, changes in the locations and intensities of these peaks can be used to characterize the molecule, including metal binding to the porphyrin and ligand binding to the metal. Synthesis of Tetraphenylporphyrin (TPP)

Reflex Apparatus

Figures 1 and 2: Synthesized porphyrin crystals showing the intense purple color associated with porphyrins.

Experimental Methods

Ultraviolet-Visible Spectroscopy

To determine the presence and impact of the metal binding to the porphyrin ring, all samples were dissolved in tetrahydrofuran (THF) and analyzed via Ultra-Violet Spectroscopy (Figure 5). A visible spectrum measures the amount of light the sample absorbs at different wavelengths. The spectra of porphyrins have certain distinctive absorbance bands referred to as Soret bands (very intense absorbance at about 420 nm) and Q bands. Changes in the locations and intensities of these peaks can be used to characterize the molecule, including metal binding to the porphyrin and ligand binding to the metal.

Future Work

- Synthesize additional metalloporphyrins with metals such as vanadium and tin.
- Ligand binding with various amines
- Strapped porphyrin synthesis

Acknowledgements

- Dr. Kevin Jantzi
- Valparaiso University Chemistry Department