Water Soluble Cationic Porphyrin Sensor for Detection of Hg^{2+}, Pb^{2+}, Cd^{2+}, and Cu^{2+}

STEPHEN F. AUSTIN STATE UNIVERSITY
Department of Chemistry and Biochemistry

Christopher Orr, Miranda Uherek, Matibur Zamadar*

ABSTRACT

Here we report the sensing properties of the aqueous solution of *meso*-tetra(N-methyl-4-pyridyl)porphine tetrachloride (**1**) for simultaneous detection of toxic metal ions by using UV-vis spectroscopy. Cationic porphyrin **1** displayed different electronic absorptions in UV-vis region upon interacting with Hg^{2+}, Pb^{2+}, Cd^{2+}, and Cu^{2+} ions in neutral water solution at room temperature. Quite interestingly, the porphyrin **1** showed that it can function as a single optical chemical sensor and/ or metal ion receptor capable of detecting two or more toxic metal ions, particularly, Hg^{2+}, Pb^{2+}, and Cd^{2+} ions coexisting in a water sample. Porphyrin **1** in an aqueous solution provides a unique UV-vis sensing system for the determination of Cd^{2+} in the presence of larger metal ions such as Hg^{2+}, or Pb^{2+}. Finally, the examination of the sensing properties of **1** demonstrated that it can operate as a Cu^{2+} ion selective sensor via metal displacement from the **1-Hg^{2+}**, **1-Pb^{2+},** and **1-Cd^{2+}**.

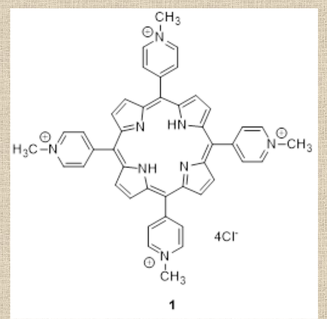
INTRODUCTION

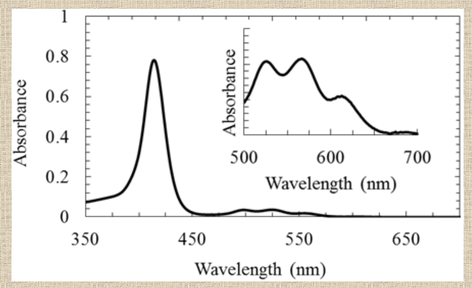
- Toxic metal ions are dangerous to human health and environment.
- Determination of metal ions, particularly, Hg^{2+}, Pb^{2+}, Cd^{2+}, and Cu^{2+} simultaneously by using an inexpensive, water soluble porphyrin based optical sensor has always been a great challenge.
- In addition, the preparation of porphyrin-based optical sensors often requires complex organic syntheses, which are very costly, and time consuming.
- Furthermore, the porphyrin-based sensors are water insoluble, which limits the detection of metal ions in aquatic environment.

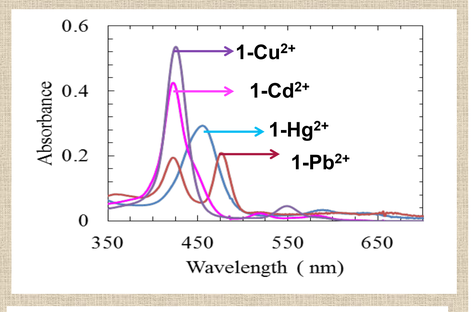
PURPOSE

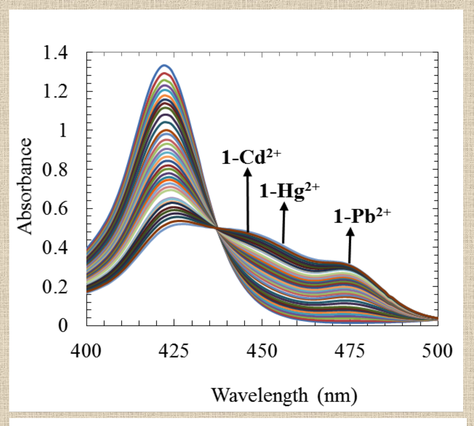
- To find a simple, inexpensive, water soluble, and commercially available porphyrin
- a single optical chemical sensor capable of detecting any or all Hg^{2+}, Pb^{2+}, Cu^{2+}, and Cd^{2+} ions simultaneously

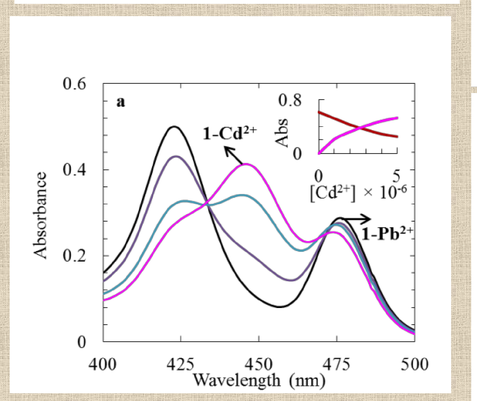
RESULTS



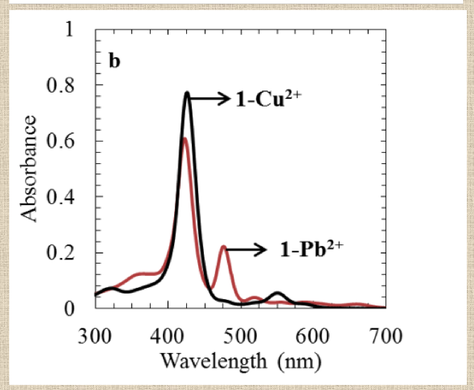








Cd^{2+} ions are detected in the presence of larger metal ions such as Pb^{2+}



Cu^{2+} ions are detected via metal displacement from the 1-Pb^{2+}.

FUTURE PLAN

- Preparation of solid sensor **1**
- Determination of toxic metal ions in aqueous solution using solid sensor **1**

CONCLUSIONS

- We found water soluble, inexpensive, and commercially available cationic porphyrin **1** produced different electronic absorptions in UV-vis region upon interacting with Hg^{2+}, Pb^{2+}, Cd^{2+}, and Cu^{2+} ions.
- The porphyrin **1** showed the ability to detect multiple metal ions, particularly Hg^{2+}, Pb^{2+}, and Cd^{2+} in aqueous solution.
- The porphyrin **1** displayed the ability to determine Cd^{2+} ions more easily when other metal ions with larger ionic radii are present.
- The porphyrin **1** detected Cu^{2+} via metal displacement from the **1-Hg^{2+}**, **1-Pb^{2+},** and **1-Cd^{2+}**.

ACKNOWLEDGEMENTS

- Michael A. Janusa, Chair and Professor of Chemistry and Biochemistry at SFASU
- The Welch Foundation Departmental Grant (AN-0008)
- RCA grant at the Stephen F. Austin State University Research Enhancement Program