SYNTHESIS AND DESIGN OF FLUORESCENCE LIGANDS TO ACT AS SENSOR FOR ZINC

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ABSTRACT

Design and synthesis of ligands to detect low concentrations of Zn^{2+} in various systems are being explored worldwide. The purpose of this research is to synthesize and study fluorescent sensors for Zn^{2+} in nervous system by utilizing CHEF (Chelation Enhanced Fluorescence) effect. TQA, a known compound, was synthesized and characterized. It is small and hydrophobic, which may allow it to cross the blood-brain barrier. The quinolyl groups provide good fluorescent properties. Ni^{2+}, Cu^{2+}, Cd^{2+}, Pb^{2+} were selected to compare the selectivity of the designed ligand for Zn^{2+}. It was shown that TQA does have CHEF effect with Zn^{2+} and Cd^{2+} (of which Zn^{2+}-ligand complex is 10 times stronger in terms of fluorescence intensity) and has no CHEF effect with Ni^{2+}, Cu^{2+}, Pb^{2+}. The drawback of TQA is that its solubility in water is too low (only 10^{-5} *M* in 50% methanol/water) to test its pK_a and formation constants with metals ions above. DQPMA, also a known compound, and DQPEA were synthesized and characterized to improve the selectivity and solubility of sensors.

Three aspects characterizing the ligands were explored in this work. Crystals of Zn^{2+}-DQPEA and Cd^{2+}-DQPEA were grown and their crystal structures were determined. The pK_a's of DQPMA and DQPEA were then determined by potentiometry and NMR. Finally, the formation constants of DQPMA and DQPEA with the metal ions above were determined by polarography and fluorescence techniques. It was proved in this study that the selectivities of the sensors, DQPMA and DQPEA, for small metal ions such as Zn^{2+} over big metal ions such as Cd^{2+}do increase when one of chelate ring increases from the five membered (Zn^{2+}-DQPMA) to the six membered (Zn^{2+}-DQPEA).

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I would like to thank my family----the big family ---both blood-based and marriage-based relatives. I can not make it without their love, prayer, and support.

DEDICATION

I would like to dedicate this work to my wife. For her sacrifice to our family, for her encouragement and braveness of leaving a familiar environment and going to a totally new country, for her hard work she payed on the way for a better life. Whatever I do, better or worse, she always cares about it more than I do.

LIST OF ABBREVIATION

Name	IUPAC	CAS Registry #	Abbre.
Triquinaldineamine	2-Quinolinemethananamine, N,N-bis(2-quinolinylmethyl) -(9Cl)	154823-46-8	TQA
Diquinaldinepyridine methylamine	2-Quinolinemethanamine, N-(2-pyridinylmethyl)-N-(2-quinolinylmethyl)-(9Cl)	154823-45-7	DQPMA
Diquinaldinepyridine ethylamine	2-Quinolinemethanamine, N-(2-pyridinylethyl)-N-(2-quinolinylmethyl)-(9Cl)		DQPEA
Corelation spectroscopy			COSY
Chelate enhanced fluorescence			CHEF
Molecular mechanics			MM
Flash column chromatography			FCC
Thin layer chromatography			TLC
The ratio of the concentration of protons bound to the ligand (H^{+}_{B}), to total ligand concentration (L_{total}):			$\bar{n}$
Tri-2-pycolylamine			TPA

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