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Exploration of solvent responsive Cr^{3+}- Schiff base conjugates for monitoring Cr^{3+} ions and organophosphates: Fabrication of spot-testing devices

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Abstract

Herein, we report 2-((2-hydroxybenzylidene)hydrazono)(phenyl)methyl)-5-methoxyphenol (**SB**) synthesized by Schiff base condensation and characterized by spectroscopic techniques, elemental analysis and X-ray crystallography. In solution phase, it interacts with Cr^{3+} ions and exhibits a prominent fluorimetric switch due to the formation of **SB·Cr**$^{3+}$ conjugate. The dual behavior of **SB·Cr**$^{3+}$ conjugates i.e. self-aggregation in high water fraction (f_w>50%) and dissolution in low water fraction (f_w<50%) proves this conjugation excellent tool for monitoring Cr^{3+} ions. The **SB·Cr**$^{3+}$ conjugate in methanol-water (70:30 v/v) allows quantification of Cr^{3+} ions with limit of detection 0.44 µM and its self-aggregation in high water fraction facilitates extraction of Cr^{3+} ions with 95% extraction efficiency. Although **SB** interacts with Zn^{2+} ions which causes inference in the determination of Cr^{3+} ions however the interferent can be easily masked with SCN^- ions. Besides, the **SB·Cr**$^{3+}$ conjugates are also able to quantify organophosphate neurotoxins; i.e. diethyl chlorophosphate (with LOD 4.1 nM) and diethyl cyanophosphonate (with LOD 3.3 nM) from aqueous solutions. Moreover, **SB** and **SB·Cr**$^{3+}$ conjugates can be coated on solid surfaces to fabricate portable devices for the on-spot detection of targets from real samples. Hence, the conjugation of Schiff base and Cr^{3+} ions can be explored for the recognition, quantification and extraction of Cr^{3+} ions and detection of organophosphates.

Key words: Schiff base, fluorescence, Cr^{3+}, diethyl chlorophosphate, diethyl cyanophosphonate, self-aggregation

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1. Introduction

Nowadays, molecules exhibiting self-aggregation are of immense interest due to their crucial role in hole-transport materials, fluorescence sensing and cell imaging [1-7]. Self-aggregation is regulated by the chemical constitution and orientation of the substituents [2,8-10]. Especially, phenyl substituents in non-planar molecules restrict the intramolecular rotation and stimulate aggregation accompanied with enhanced emission when solvent composition is varied [9-10]. This type of molecules exhibiting solvent responsive physico-chemical properties may act as probes with unique applicability in the routine analysis of various toxicants [11-13].

Analytical strategies for monitoring a toxicant (i.e. recognition, quantification and extraction) require effective interaction between the probe and the target. For example; multi-donor Schiff base ligands interact