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A new colorimetric sensor for Cu^{2+} detection based on s-triazine cored amino carbazole

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Abstract

Triazine cored 3-amino-9ethly-carbazole (TAC) was designed, synthesized and characterized to constitute a new chemosensor for detecting Cu^{2+} with high selectivity over different metal ions. Besides, the optimized geometry of TAC was determined. Through TAC-Cu^{2+} interaction, TAC depicted a detectable absorbance and fluorescence signal shifting. This interaction was related to binding between –NH group of TAC and Cu^{2+} ion. Furthermore, stoichiometric ratio of TAC-Cu^{2+} determined using Job's plot as 3:2 (Cu^{2+}: TAC). Consequently, TAC fluorescent chemosensor for Cu^{2+} ions is important study for environmental and biological studies.

1. Introduction

The detection of toxic chemicals has attracted considerable attention depend on their quantitative and reliable determination for biology and environmental science [1–5]. In this regard, chemosensors have been shown to be promising depend on easily detection, highly sensitivity [6–9]. Especially, fluorescent chemosensors demonstrate changing of fluorescence emission presence of selected substrate with high detection limit and rapid detection [5, 10, 11]. These chemosensors act as alternative method to expensive methods such as inductively coupled plasma atomic emission, atomic emission spectroscopy [12]. In addition to all these, despite the excellent scientific developing in designing chemosensors, operating it in a natural environment may possess substantial challenges. Unfortunately, chemosensors have some disadvantages such as requirement of specific synthesis to analytes and affected by environmental factors. Besides, these chemosensors are mainly derived from chemical materials. So, they may react or degrade with different factor in the environment. In this case, the stability of these chemosensors is limited in long term usage [13, 14].

The generating and improve of fluorescent chemosensor for heavy metal ions such as Hg^{2+}, Cu^{2+}, Pb^{2+} is very important in studies to determine environmental pollution [15–17]. Copper, one of the heavy metal ions is raising concerns over its potential effects on human health. It has catalysis properties which can damage proteins and nucleic acids. Moreover, cellular toxicity of copper can lead to diseases including Wilson's disease [18, 19], Alzheimer's disease [20], Menke's disease [21, 22]. In this respect, to design fluorescence chemosensor for Cu^{2+} ions via Schiff-base based ligands have been used in previous studies [23]. However, to our knowledge, triazine-based fluorescence chemosensors showing fluorescence signal change in the presence of Cu^{2+} ions is very limited in literature.

s-triazine based star-shape molecules that derived from the structural symmetry of 1, 3, 5-triazine units have superior properties related to their compact structure. It is affordable commercial material which has the spatial coplanarity and high electron deficiency [24–28].

This study focuses on the synthesis and characterization of fluorescent molecule which consisting s-triazine cored 3-amino-9ethly-carbazole (TAC). In TAC, fluorescent dye carbazole acts as a signal transduction moiety while –NH group act as an interacting group for the Cu^{2+} ion. The fluorescent sensor TAC depicts absorbance and fluorescence change presence of Cu^{2+} ions binding. Consequently, this study is considerable interest to evaluate principle sensitivity of TAC towards Cu^{2+} and effect of Cu^{2+} ions to the spectrochemical properties of TAC for environmental and biological studies.