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Construction of 3-amino-9-ethylcarbazole scaffold for multifunctional applications: Chemosensor for copper(II) ions along with antibacterial, antioxidant and anti-inflammatory activity

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A R T I C L E I N F O

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A B S T R A C T

This work describes the fabrication of a carbazole derivative **1** namely (E)-5-(diethylamino)-2-((9-ethyl-9H-carbazol-3-yl)imino)methyl)phenol(1) based colorimetric probe for the selective detection of copper (II) ions. The as-prepared carbazole derivative was characterized using various spectral techniques including UV–visible absorption, Emission, FT-IR, ^{1}H NMR, ^{13}C NMR and mass spectra. The colorimetric chemosensing potential of the synthesized carbazole derivative **1** to detect Cu^{2+} ions in a solution of different cations at different emission wavelengths based on photo-induced electron transfer (PET) mechanism was undertaken. In addition, the probe **1** showed significant DPPH scavenging activity. Antimicrobial and anti-inflammatory activities of the carbazole derivative **1** were also assessed. The selectivity of probe **1** towards Cu^{2+} ions could be exploited to reduce copper induced toxicity.

Introduction

Copper is an essential trace element, the third most abundant metal in human (after Fe^{2+} and Zn^{2+}) and present in higher concentrations in the liver [1] and brain [2]. It is an inevitable, nutrient redox active ion for normal brain function [3] due to the high oxygen demand and oxidative metabolism of brain tissues, neurons and glia alike cells. Copper is a necessary cofactor for many brain-specific enzymes that control the homeostasis of neurotransmitters, neuropeptides and dietary amines. In addition, copper also functions as an active site in antioxidant enzymes such as cytochrome *c* oxidase (CcO) and Cu/Zn superoxide dismutase (SOD1) [3]. It is also needed for the production of ceruloplasmin, a protein that helps transport of iron in the blood and in the production of white blood cells and in the activation of enzymes which are the part of immune system. The excess concentration or deficiency of Cu^{2+} has led to several diseases such as Alzheimer's disease [4], Menkes syndrom, haematological manifestations [5]. Further, higher consumption of copper leads to accumulation in liver and kidney that may cause gastrointestinal diseases and neurological disorders such as Wilson's disease [6], amyotrophic lateral sclerosis [7], Parkinson's diseases, hypoglycomia [8], dyslexia and infant liver damage [9]. Therefore, monitoring of Cu^{2+} level in living cells with higher sensitivity and selectivity is vital [10]. Various techniques have been developed for the detection and determination of Cu^{2+} ions such as organic fluorophores [11] or chromogenic sensors [12], a DNA enzyme based method [13], colorimetric detection [14], absorbance spectrophotometry, atomic absorption spectroscopy (AAS) [15] and inductively coupled plasma mass spectroscopy (ICP-MS) [16]. However, a suitable probe for naked eye detection of Cu^{2+} ions is still desirable and chemosensors are the excellent choice, in this regard.

Developing a suitable chemosensor for heavy metal ions turn into substantial because of the direct benefits applied to major sectors such as environment, industry, biology and human health. Chemosensors are particularly attractive due to their metal ion specific fluorescence nature, high sensitivity, selectivity and ease of preparation. Compounds that are capable of detecting the heavy metals by fluorescence is the

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