Journal of Molecular Structure 1228 (2021) 129460

Contents lists available at ScienceDirect

Journal of Molecular Structure

journal homepage: www.elsevier.com/locate/molstr

Exploration of synthesis, structural aspects, DFT studies and bio-efficacy of some new DHA-benzohydrazide based copper(II) complexes

Richa[a], Sunil Kumar[b], Jayant Sindhu[c], Poonam Choudhary[d], Sundeep Jaglan[d], Ennio Zangrando[e], Rakesh Kumar[a], Subash C. Sahoo[a], Vinod Kumar[f], Surinder K. Mehta[a], Ramesh Kataria[a,*]

[a] Department of Chemistry and Centre for Advance Studies in Chemistry, Panjab University, Chandigarh 160014, India
[b] Department of Chemistry, School of Basic and Applied Sciences, Maharaja Agrasen University, Baddi, Solan 174103, India
[c] Department of Chemistry, COBS & H, CCS Haryana Agricultural University, Hisar 125004, India
[d] Microbial Biotechnology Division, CSIR-Indian Institute of Integrative Medicine, Canal Road, Jammu 180001, India
[e] Department of Chemical and Pharmaceutical Sciences, University of Trieste, Trieste 34127, Italy
[f] Department of Chemistry, C. U. Haryana, Mahendergarh 123031, India

ARTICLE INFO

Article history:
Received 18 August 2020
Revised 13 October 2020
Accepted 14 October 2020
Available online 15 October 2020

Keywords:
Antibacterial
Copper complex
Carbohydrazide, DFT
X-ray crystal structure

ABSTRACT

A copper (II) complex with ligand obtained by the dehydrative condensation of 3-acetyl-6-methyl-2*H*-pyran-2,4(3*H*)–dione (DHA) and benzohydrazide has been synthesized (4). This species was additionally coordinated by various solvent molecules, namely ethanolamine, methanol, DMF, dimethyl amine, isopropyl amine, diisobutylamine, and ethylenediamine to synthesize complexes **5a-5g**. All the complexes were characterized by single crystal X-ray diffraction analysis and other analytical techniques. In each case, the copper atom is tetra-coordinated by chelating carbohydrazide ligand through *O, N, O* donor atoms and the *N/O* heteroatom from the coordinated solvent (except for ethylenediamine, where Cu is pentacoordinated). The intermolecular interactions present in each complex have been quantified using Hirshfeld surface analysis, and the electrostatic properties associated with these complexes were calculated using DFT studies. Considering the expected bioactivity of carbohydrazide derivatives, the antibacterial activity of ligand and copper complexes was tested against pathogenic Gram-positive and Gram-negative bacteria using ciprofloxacin as positive control. Compounds **4** and **5f** show potent antibacterial activity against *B. subtilis* with MIC and MBC value of 32 μM.

1. Introduction

Design and synthesis of bioinorganic compounds of biological interest has attracted considerable interest in past few years. The pharmacokinetic and pharmacodynamic properties of an agent are dependent upon solubility and bio-availability, which can be significantly enhanced by complexation [1,2]. It is well evident from the literature that the bioactivity of metal complexes surpasses that of organic ligands. The choice of proper ligands and its chelation with suitable metals are some of the key factors for controlling the biological efficacy of compounds. Copper complexes have also been explored as catalyst in asymmetric photoredox reactions [3], hydroalkylation of alkynes [4], alcohol oxidation [5] and C-H activation in the Henry reaction [6]. Many copper complexes have been utilised in sensing applications for the detection of hydrogen peroxide and nitrite [7], adrafinil [8] and dissolved oxygen in water [9]. In addition to this, a wide range of biological activity has been associated with copper complexes [10–12] which have attracted scientific community to develop novel, selective and less toxic copper compounds with promising biological properties.

Similarly, pyrones consist of a diverse group of bioactive metabolites, *viz.* cytotoxic, antialgal, antibacterial, and antifungal activity [13–16]. Recently, Marc Stadler and his coworkers isolated new α-pyrone derivatives **(Ia-Ib)**, udagawanones A and B, isolated from cultures of the endophyte *Neurosporaudagawae*, which were moderately active against fungi and mammalian cells [17]. Li *et al.* isolated two new Pleospyrones analogues (chlamydosporol derivatives) from the culture of the endophytic fungus *Pleosporales sp Sigrf05*. [18]. These analogues (**IIa** and **IIb**) exhibited good cytotoxi-

* Corresponding author.
E-mail address: rkataria@pu.ac.in (R. Kataria).

https://doi.org/10.1016/j.molstruc.2020.129460
0022-2860/