Available online at www.sciencedirect.com

ScienceDirect

Journal of Taibah University for Science 8 (2014) 26–30

Journal of Taibah University for Science

www.elsevier.com/locate/jtusci

Synthesis, characterization and preliminary *in vitro* antibacterial screening activity of metal complex derivatives of 2-[(5-styryl-[1,3,4]thiadiazol-2-ylimino)-methyl]-phenol

Emad A. Yousif [a,*], Ahmed S. Majeed [a], Nadia A. Salih [b]

[a] *Department of Chemistry, College of Science, Al-Nahrain University, Baghdad, Iraq*

[b] *School of Chemical Sciences & Food Technology, Faculty of Science and Technology, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia*

Available online 2 October 2013

Abstract

Five new metal complex derivatives of 2-[(5-styryl-[1,3,4]thiadiazol-2-ylimino)-methyl]-phenol with the metal ions [Ni(II), Cu(II), Zn(II), Cd(II) and Sn(II)] were prepared in alcoholic medium. The complexes were characterized quantitatively and qualitatively by micro elemental analysis, Fourier transform infrared spectroscopy, ultraviolet–visible spectroscopy, mass spectroscopy, ^{1}H and ^{13}C nuclear magnetic resonance, magnetic susceptibility and conductivity measurements. The spectral study showed that all the complexes obtained as monomeric structures and the central metal moieties are four-coordinated, with tetrahedral geometry, except for the Cu(II) complex, which had square planar geometry. In preliminary *in vitro* antibacterial screening, all the complexes showed moderate activity against the bacterial strains tested, which was slightly higher than with the ligand.

Keywords: 1,3,4-Thiadiazole derivatives; Metal complexes; Antibacterial activity

1. Introduction

Heterocyclic moieties are found in many compounds that have biological activity that depends mainly on their molecular structure [1]. 1,3,4-Thiadiazoles are interesting compounds because of their important use in many pharmaceutical, biological and analytical applications [2,3]. Schiff bases, which are bimolecular condensation products of primary amines with aldehydes, are valuable intermediates in organic synthesis and in other applications [4]. They are aromatic aldehydes *ortho*-substituted with a hydroxyl group, which initially raised the interest of researchers because of their ability to act as bidentate ligands for transition metal ions [5]. Schiff bases are also important because of their flexibility, their structural similarity with natural biological substances and because of the presence of imine (N=CH–), all of which help in elucidating the mechanism of transformation and racemization in biological systems [6]. These compounds can also act as ligands, increasing biological activity by complexation [7]. Derivatives of 1,3,4-thiadiazoles have been reported to have antimicrobial activity [8].

Thiadiazole derivatives have occupied a unique position in medicinal chemistry. Molecules like

* Corresponding author. Tel.: +964 7901782816.
E-mail addresses: emad_yousif@hotmail.com, emadayousif@gmail.com (E.A. Yousif).
Peer review under responsibility of Taibah University

Production and hosting by Elsevier

1658-3655 © 2013 Taibah University. Production and hosting by Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.jtusci.2013.09.003

thiadiazole-containing Schiff bases have been investigated for their pharmaceutical activity [9], and the naturally occurring B6 vitamins pyridoxine, pyrodoxal, pyridoxamine and codecarbaxylase contain a thiadiazole nucleus [10]. As some drugs with a thiadiazole nucleus were once used in the chemotherapy of bacterial diseases [11], we decided to synthesize more potent molecules.

2. Material and methods

2.1. General and instrumental

All the reagents, starting materials and solvents were purchased commercially and used without further purification. The melting-points were measured on a hot-stage Gallen Kamp melting-point apparatus. Elemental C, H, N and S analysis was carried out on a Fison EA 1108 analyser. The Fourier transform infrared spectra were recorded on an FTIR.8300 Shimadzu spectrophotometer with a CsI disc in the frequency range 4000–200 cm^{-1}. The ultraviolet–visible spectra were recorded on a Shimadzu UV–vis 160 A-Ultra-violet spectrophotometer in the range 200–1100 nm. Magnetic susceptibility was measured at room temperature on a Magnetic Susceptibility Balance Bruke Magnet B.M.6. Conductivity was measured on a WTW conductivity metre, and atomic absorption was measured on a Shimadzu 680cc-flame spectrometer. The spectra of ^{1}H and ^{13}C NMR were recorded on a Jeol 400 MHz spectrometer with d_6-DMSO as the solvent and tetramethylsilane, as the internal standard. Mass spectra were recorded on a Micromass UK Platform II LC–MS spectrometer.

2.2. Preparation of 2-[(5-styryl-[1,3,4]thiadiazol-2-ylimino)-methyl]-phenol

A mixture of 3-phenylacrylic acid (0.01 mol), thiosemicarbazide (0.01 mol) and phosphorus oxychloride (5 ml) was heated under reflux for 3 h. Upon cooling, distilled water (50 ml) was added to the mixture, and heating under reflux was continued for another 4 h. The reaction mixture was filtered and neutralized with potassium hydroxide. Then, the precipitate was filtered and washed with cold distilled water and finally recrystallized in a 2:1 ethanol:water mixture to obtain 2-[(5-styryl-[1,3,4]thiadiazol-2-ylimino)-methyl]. In the next reaction, this compound (0.01 mol) and salicyladehyde (0.01 mol) were heated under reflux for 3 h to obtain a yellow precipitate, which was filtered and crystallized from ethanol to give the 2-[(5-styryl-[1,3,4]thiadiazol-2-ylimino)-methyl]-phenol ligand for further complexation with metal ions. The stepwise preparation of the ligand is shown in Fig. 1.

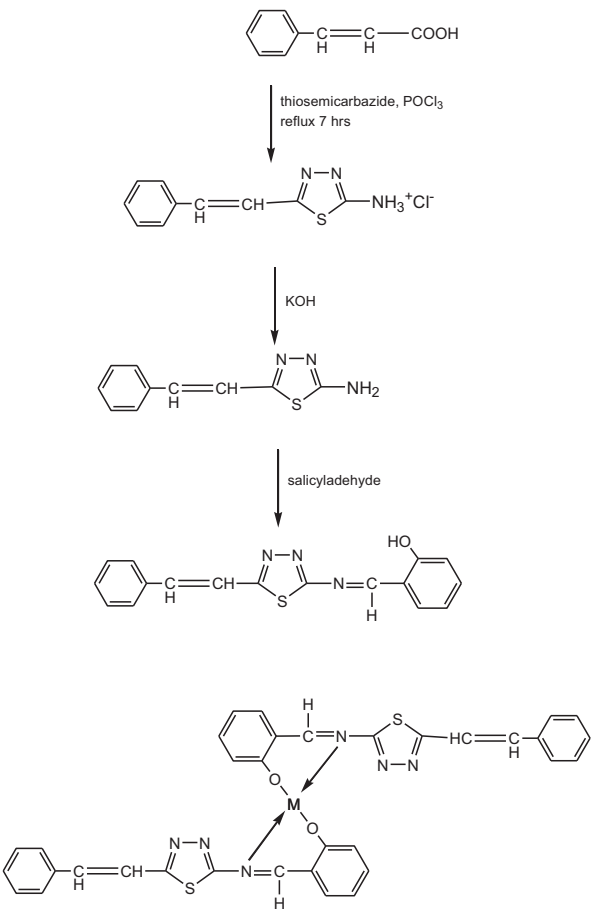

Fig. 1. Structure of ligand (L) and the proposed structure of complexes 1–5 (M = metal).

2.3. Preparation of complexes

An ethanol solution of the metal(II) salts nickel(II) chloride hexahydrate, tin(II) chloride, copper(II) chloride dihydrate, cadmium(II) chloride dihydrate and zinc(II) chloride was added to the ethanol solution of the ligand in a 1:2 metal:ligand molar ratio. Then, the mixture was heated under reflux for 30 min, and coloured precipitates were obtained, which were filtered out, washed with distilled water and finally recrystallized.

3. Results and discussion

The purity of the ligand and the five complexes obtained were checked by thin-layer chromatography with silica gel-G as the adsorbent. The complexes had sharp melting-points, indicating the isolation of