Spectrochimica Acta Part A 83 (2011) 271–278

Contents lists available at SciVerse ScienceDirect

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy

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

First row transition metal complexes of (E)-2-(2-(2-hydroxybenzylidene) hydrazinyl)-2-oxo-N-phenylacetamide complexes

T.A. Yousef[a,*], G.M. Abu El-Reash[b], T.H. Rakha[b], Usama El-Ayaan[b]

[a] Department of Toxic and Narcotic Drug, Forensic Medicine, Mansoura Laboratory, Medicolegal Organization, Ministry of Justice, Egypt
[b] Department of Chemistry, Faculty of Science, Mansoura University, Mansoura 35516, Egypt

ARTICLE INFO

Article history:
Received 28 April 2011
Received in revised form 15 August 2011
Accepted 19 August 2011

Keywords:
Hydrazones
PM3
Molecular modeling
ESR
Antimicrobial activity
MIC

ABSTRACT

Manganese(II), iron(II), cobalt(II), nickel(II), copper(II), and chromium(III) complexes of (E)-2-(2-(2-hydroxybenzylidene)hydrazinyl)-2-oxo-N-phenylacetamide were synthesized and characterized by elemental and thermal (TG and DTA) analyses, IR, UV–vis and ^{1}H NMR spectra as well as magnetic moment. Mononuclear complexes are obtained with 1:1 molar ratio except $[Mn(HOS)_2(H_2O)_2]$ and $[Co(OS)_2](H_2O)_2$ complexes which are obtained with 1:2 molar ratios. The IR spectra of ligand and metal complexes reveal various modes of chelation. The ligand behaves as a monobasic bidentate one and coordination occurs via the enolic oxygen atom and azomethine nitrogen atom. The ligand behaves also as a monobasic tridentate one and coordination occurs through the carbonyl oxygen atom, azomethine nitrogen atom and the hydroxyl oxygen. Moreover, the ligand behaves as a dibasic tridentate and coordination occurs via the enolic oxygen, azomethine nitrogen and the hydroxyl oxygen atoms. The electronic spectra and magnetic moment measurements reveal that all complexes possess octahedral geometry except the copper complexes possesses a square planar geometry. From the modeling studies, the bond length, bond angle, HOMO, LUMO and dipole moment had been calculated to confirm the geometry of the ligands and their investigated complexes. The thermal studies showed the type of water molecules involved in metal complexes as well as the thermal decomposition of some metal complexes. The protonation constant of the ligand and the stability constant of metal complexes were determined pH-metrically in 50% (v/v) dioxane–water mixture at 298 K and found to be consistent with Irving–Williams order. Moreover, the minimal inhibitory concentration (MIC) of these compounds against *Staphylococcus aureus*, *Escherechia coli* and *Candida albicans* were determined.

1. Introduction

Hydrazones and their metal complexes possessing pronounced biological and pharmaceutical activities as antitumor [1–3], antimicrobial [4], antituberculosis [5] and antimalarial agents [6]. Hydrazones play an important role in improving the antitumor selectivity and toxicity profile of antitumor agents by forming drug carrier systems employing suitable carrier proteins [7]. They also employ as extracting agents in spectrophotometric determination of some ions [8–10] and spectrophotometric determination of some species in pharmaceutical formulations [11], as well as uses in catalytic processes [12,13] and wastewater treatment [14].

In the present article, our attention is focused on the synthesis, characterization and thermal behavior of a series of transition metal complexes of new hydrazone (H_2OS) derived from condensation of 2-hydrazine-2-oxo-n-phenyacetamide and salicyaldehyde. The formation constants of the metal (Co, Ni and Cu) complexes were determined pH-metrically in solution. In addition, the biological activity of the ligand and its metal complexes as antimicrobial especially against Gram-positive and Gram-negative bacteria was investigated.

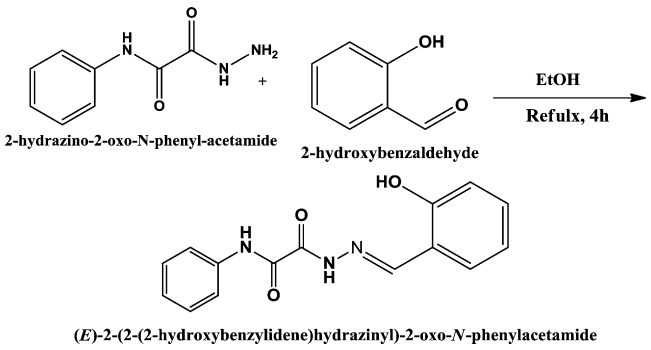
2. Experimental

2.1. Instrumentation and materials

All the chemicals for synthesis were purchased from Aldrich, Fluka and used without further purification. Microanalysis was performed with CHN Perkin-Elmer 2400 series II analyzer. Electronic spectra were recorded on a UV-UNICAM 2001 spectrophotometer. Magnetic susceptibilities were measured with a Sherwood Scientific magnetic susceptibility balance at 298 K. Infrared spectral (4000–200 cm^{-1}) for KBr discs were recorded on Mattson 500 FTIR spectrometer. The pH measurements were carried out using pH meter HANNA instrument 8519, Italy. Thermogravimetric measurements (TGA, DTA) were recorded on a DTG-50

* Corresponding author. Tel.: +20 122247712.
E-mail address: drroka78@yahoo.com (T.A. Yousef).

1386-1425/$ – see front matter.
doi:10.1016/j.saa.2011.08.030



Scheme 1.

Shimadzu thermogravimetric analyzer. Finally, the minimal inhibitory concentration (MIC) was carried out using the microdilution susceptibility method in Muller–Hinton Brothers and Sabouraud liquid medium.

2.2. Synthesis of (E)-2-(2-(2-hydroxybenzylidene)hydrazinyl)-2-oxo-N-phenylacetamide (H_2OS) hydrazone

2.2.1. Synthesis of 2-hydrazino-2-oxo-N-phenylacetamide

The 2-hydrazino-2-oxo-N-phenylacetamide was synthesized according to the general literature [15] by boiling 8 ml of aniline with 8.5 ml of diethyl oxalate, the product was crystallized in water then 1.65 g of the yield was refluxed with 0.5 ml of hydrazine hydrate. The white precipitate was filtered off, washed several times with hot ethanol and finally dried in vacuum desiccator over anhydrous calcium chloride.

2.2.2. Synthesis of H_2OS hydrazone

The ligand was synthesized by boiling an ethanolic solution of 2-hydrazino-2-oxo-N-phenylacetamide with salicyaldehyde under reflux for 4 h (Scheme 1). The yellowish white precipitate (m.p. 252 °C) was filtered off, washed with ethanol and recrystallized from hot ethanol and finally dried in vacuum desiccator over anhydrous calcium chloride. Yield 90%, found: C, 62.36; H, 3.76. Calc.: C, 63.89; H, 4.62.

2.3. Synthesis of metal complexes

All complexes were prepared by refluxing H_2OS (0.252 g, 1.0 mmol) and the hydrated metal salts (1.0 mmol) (chloride and acetate) in 30 ml ethanol for 2–3 h. The solid complexes were filtered off, washed with ethanol followed by diethyl ether and dried in vacuum over $CaCl_2$.

2.4. Antimicrobial activity

The compounds, ampicillin and nystatin were dissolved in dimethylsulfoxide at concentration of 1 mg/ml. The twofold dilutions of the solution were prepared. The microorganism suspensions [16] at 10 CFU/ml (colony forming unit/ml) concentration were inoculated to the corresponding wells. The plates were incubated at 36 °C for 24 and 48 h for the bacteria and *Candida albicans*, respectively. The MIC values were determined as the lowest concentration that completely inhibited visible growth of the microorganism as detected by unaided eye.

2.5. Molecular modeling

An attempt to gain a better insight on the molecular structure of the ligand and its complexes, geometric optimization and

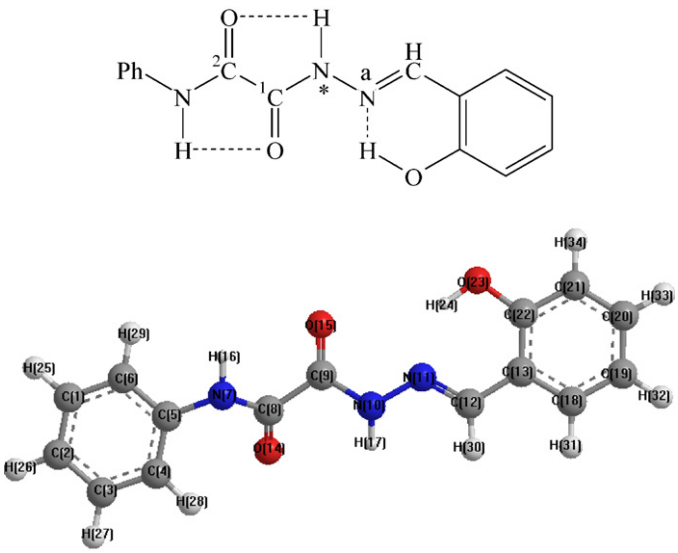


Fig. 1. Molecular modeling of ligand H_2OS.

conformational analysis has been performed using MM+ [17] force field as implemented in hyperchem 8 [18]. The low lying obtained from MM+ was then optimized at PM3 using the Polak-Ribiere algorithm in RHF-SCF, set to terminate at an RMS gradient of 0.01 kcal/mol.

2.6. pH-metric studies

The titrations were performed at 25 °C. pH measurements were carried out using pH-meter HANNA instrument 8519, Italy. For thoroughly mixing the solution contents during the titration process, a magnetic device is employed. The pH-meter is calibrated from time to time by means of buffer solution of pH=4 and pH=9. The experimental procedure involves the potentiometic titrations of the following solutions against 0.01 M NaOH in 50% (v/v) dioxane–water. The following solution mixtures (i–iii) were prepared and titrated potentiometrically with standardized sodium hydroxide (9×10^{-3} M) at constant ionic strength (1 M) KCl.

(i) 1.25 ml (1.26×10^{-3} M) HCl + 1.25 ml (1 M) KCl + 12.5 ml dioxane + 10 ml H_2O.
(ii) 1.25 ml (1.26×10^{-3} M) HCl + 1.25 ml (1 M) KCl + 2.5 ml (5×10^{-3} M) H_2OS + 10 ml dioxane + 10 ml H_2O.
(iii) 1.25 ml (1.26×10^{-3} M) HCl + 1.25 ml (1 M) KCl + 2.5 ml (5×10^{-3} M) H_2OS + 10 ml dioxane + 0.5 ml (5×10^{-3} M) metal ion in distilled water + 9.5 ml H_2O. (M = Co^{2+}, Ni^{2+} and Cu^{2+}). The total volume was adjusted to 25 ml by adding dioxane in each case. After adding of each increment of the titrant, the solution was stirred for about 2 min and the pH-reading is then recorded.

3. Results and discussion

The physical and analytical data of the (H_2OS) ligand and its metal complexes are listed in Table 1.

3.1. IR and NMR spectra

The IR data for H_2OS (Fig. 1) and its metal complexes are shown in Table 2. The ligand has multi-coordination sites which gave variable coordination modes. A comparison of the spectrum of H_2OS and its complexes revealed that the ligand coordinates in the ketone and enol forms. IR spectra of the free ligand shows bands at 3300,