The Open Bioactive Compounds Journal, 2018, 6, 1-10 1

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The Open Bioactive Compounds Journal

Content list available at: www.benthamopen.com/TOBCJ/

DOI: 10.2174/1874847301806010001

RESEARCH ARTICLE

Preparation, Characterization and Antimicrobial Activity of Schiff Base of (*E*) - *N* - (4-(Thiophen-2-ylmethyleneamino) Phenylsulfonyl) Acetamide Metal Complexes

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Received: December 07, 2017 Revised: January 27, 2018 Accepted: January 29, 2018

Abstract:

Aim:

Metal complexes of (*E*)-*N*-(4-(thiophen-2-ylmethyleneamino) phenylsulfonyl) acetamide (S.TH) Schiff bases derived from sulfacetamide (*N*-[4-(amino-phenyl) sulfonil] acetamide) and 2-thiophenecarboxaldehyde were synthesized and characterized.

Methods and Results:

The synthesized compositions have been characterized using different physico-chemical techniques. The investigation included elemental analysis, melting point measurements, proton NMR, UV spectroscopy, FT-IR, magnetic susceptibility, conductance measurements, mass spectral analysis, and inductively coupled plasma mass spectrometry (ICP-MS) for determining the concentrations of metal ions. The measured values for molar conductance indicated that the majority of the prepared complexes were nonelectrolytes. The biological activity of the prepared compositions has been investigated.

Conclusion:

Spectroscopic studies suggested that most of the complexes were coordinated in a regular octahedral arrangement where S.TH ligand and the central metal atom were coordinated through two N amino azomethine groups (−HC=N−) and two sulfur atoms of S thiophene rings in 2L:1M molar ratio. Complexes have shown a promising activity upon screening for the antibacterial characteristics, and antifungal (*Aspergillus fumigates* and *Candida albicans*)

Keywords: Thiohene carboxaldehyde, Transition metal complexes, Sulfacetamide, inductively coupled plasma (ICP-MS), Thiophene rings, Anticonvulsant activity.

1. INTRODUCTION

Schiff bases (imines) are the products of condensation of primary amines with carbonyl compounds in acidic

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1874-8473/18 2018 Bentham Open

medium. Imines were first reported in 1864 by Schiff H [1]. The formation of carbon-nitrogen double bonds is a very important step in organic synthesis due to their significant biological activities such as anticancer [2], anti-inflammatory and antitumor agents [3], antibacterial, insecticidal, antimicrobial [4], anticonvulsant activity [5], antituberculosis [6]. Additionally, Schiff bases are useful as versatile constituents in nucleophilic addition reactions including organometallic reagents [7] as well as in the reactions including cycloadditions [8]. They have been widely used in dye and food industries, catalytic processes, analytical chemistry, in addition to several agrochemical applications [9].

The Schiff base produced from the reaction of 2,5-thiophenedicarboxaldehyde with o-amino benzenethiol is 2,5-bis(benzothiazolidin-2-yl)thiophene(I) which is able to react with Pb(II), Cd(II), Ag(I), Zn(II) and Cu(II) forming different complexes [10]. The condensation of 2-thiophenecarboxaldehyde with o-amino thiophenol gives 2-thiazolin-2-ylthiophene, which reacts with Pd(II), Cd(II), Pb(II), Cu(II), Ni(II), Ag(I) Zn(II) forming new complexes [11]. Several methods can be utilized for determining the transition metal ions. These methods include: Ion Chromatography (IC), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Atomic Absorption Spectroscopy (AAS), and Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). The concurrent multi-element determination with AAS is not possible, while ICP-MS and ICP-AES techniques are more suitable. The ICP-MS technique is chosen due to its capability of mainly detecting metals and several nonmetals. ICP-MS has several advantages when compared to the other analytical techniques. This includes a higher throughput and better detection limits for most elements than Graphite Furnace Atomic Absorption Spectroscopy (GFAAS). It can also handle both complex and simple matrices with minimum matrix interference due to the high temperature of ICP source, in addition to its ability to obtain isotropic information [12].

The aim of this study is to prepare, characterize and elucidate the geometrical structures of new sulfactamide Schiff bases metal complexes and to investigate some of their biological activity.

2. EXPERIMENTAL

2.1. Materials and Methods

All solvents and chemicals used were of extra-pure grade. Sulfacetamide samples were obtained from EPICO Pharm (Cairo, Egypt). Melting points were denoted using (BI Bamtead Electothermal). TLC was visualized using VL-6-LC UV lamp (VILBER, Germany). The elemental analysis for (C, H, N, S) was carried out using Fisons EA 1108 CHNS Micro Analyzer (Thermo Scientific, USA). Metal ions concentrations were measured using ICP Perkin Elmer/Optima 7000. The UV spectra have been recorded using UV-Vis spectrophotometer (UV-1700, Shimadzu). Measurements of molar conductance were carried out in DMF at 25°C ±5°C using a conductivity bridge (model 305, Systronics Ltd., India). Magnetic susceptibility for powdered samples was measured using a magnetic susceptibility balance (Sherwood, UK). The diamagnetic corrections were done by Pascal's constant and $Hg[Co(SCN)_4]$ was used as a calibrant. Mass spectral analysis was carried out using Shimadazu Qp-2010 Plus. Infrared spectra were recorded using a Perkin-Elmer FT-IR 1650 spectrophotometer in wave number region 4000-200 cm^{-1} as KBr pellet. The proton NMR spectra were recorded using Mercury-300 bb "NMR 300 MHz", using DMSO as a solvent and tetramethylsilane (TMS) as an internal standard. Antibacterial and antifungal activities were performed sing the diffusion agar technique [13] and then, the sensitivity of clinically pathogenic microorganisms to antibiotics and other sulfacetamide complexes was determined by the assay plates using 100 µl (5 mg/ml concentration) of the tested samples. The plates were incubated at 28°C for 3 days (for fungi) and at 37°C for 1 day (for bacteria).

2.2. Synthesis of Schiff Base (S.TH) Ligand

The ligand was prepared by adding a hot ethanolic solution of 2-Thiophene carboxyaldehyde (0.03 mole) to a hot ethanolic solution of (0.03 mole) sulfacetamide in 1:1 molar ratio, with vigorous stirring. The reaction mixture was refluxed for 4 hours till a yellow precipitate was formed, which was then washed several times, recrystallized from ethanol, and dried in a vacuum over anhydrous calcium chloride. The purity was checked by TLC and by melting point measurement.

S.TH Ligand had a pale yellow color (melting point 206-208°C) yield 84.6%, molecular weight 308.38 g/mol with molecular formula $C_{13}H_{12}N_2O_3S_2$. The elemental analysis was as follows: C 50.63 (51.03), H 3.92 (3.98), N 9.08 (9.21), S 20.80 (20.77).

The reaction can be expressed as shown in Fig. (**1**):

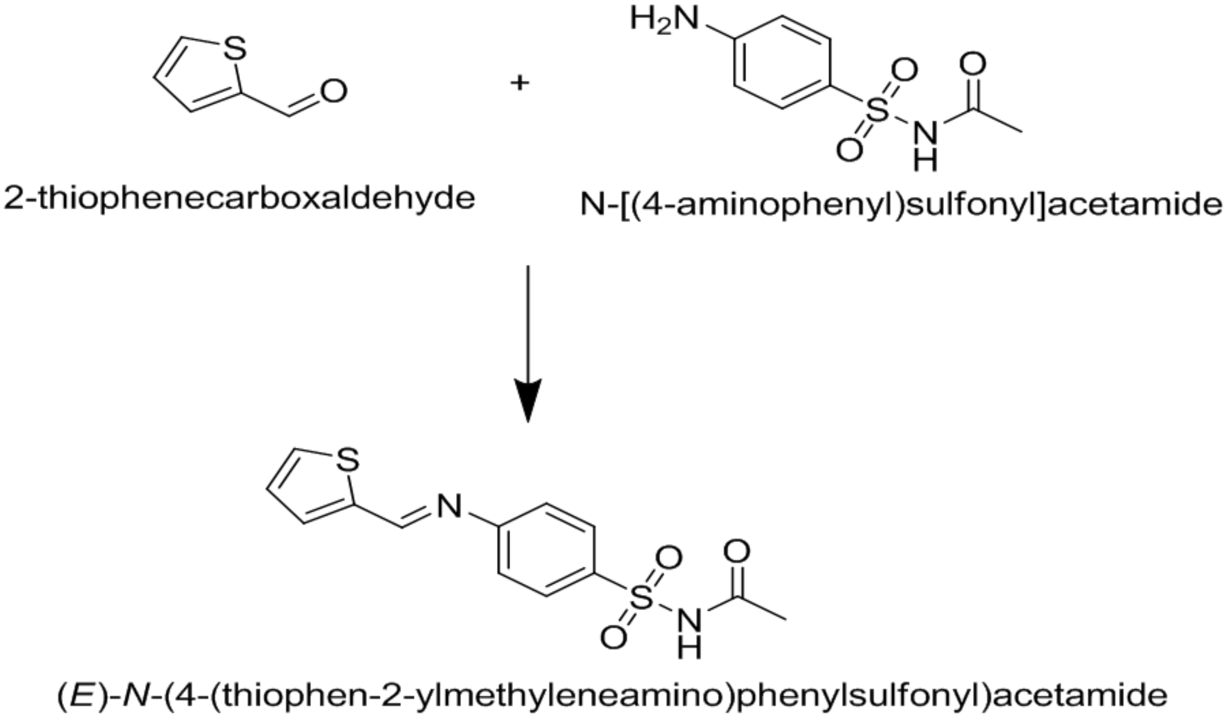

Fig. (1). Condensation reaction between 2-thiophenecarboxyaldehyde and sulfacetamide give (*E*)-*N*-(4-(thiophen-2-ylmethyleneamino) phenylsulfonyl)acetamide S.TH.

2.3. Synthesis of the Schiff Base Metal Complexes:

The Schiff base metal complexes were prepared by adding a hot ethanolic (or distilled water) solution of metal salts (0.03 mole) with vigorous stirring to a hot ethanolic solution of (*E*)- *N*- (4- (thiophen-2-ylmethyleneamino) phenylsulfonyl) acetamide S.TH (0.06 mole) in 1M:2L molar ratio (where M is noted for the metal and L is for the ligand). Silver complex was prepared in equimolar ratio to the Schiff base. The reaction was refluxed for several hours until a colored (or sometimes white) precipitate is formed, which was then washed several times and recrystallized from ethanol (or distilled water) then dried in a vacuum over anhydrous calcium chloride. The purity was checked by TLC and by melting point.

2.4. Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

5 ml of the internal standard were transferred to a test tube (the internal standard consists mainly of deionized water, with hydrochloric of nitric acid, and indium and/or gallium, depending on the type of sample), along with 10–500 µL of the metal complex sample. The mixture was then shaken by vortex, and after that the mixture was loaded into the instrument's auto-sampler tray. The instrument's operating conditions are listed in Table **1**.

Table 1. Operation parameters for determination of elements by ICP- MS.

Parameters	Parameters' Value
Flush pump rate	$1.85\ mL.min^{-1}$
Analysis pump rate	
Pump relaxation time	0 s
RF power	1350 w
Nebulizer flow	26.0 psi
Auxiliary gas	1.0 ppm
Gate 1	5 s
Gate 2	15 s
Light source	ICAP
ICAP view	Axial
Replicate numbers	3

(Table 1) contd.....

Parameters	Parameters' Value
Detection wavelength (nm)	Ag 338.289, Co 238.892, Cr 205.560, Cu 327.393, Ni 221.648 and Zn 220.353.

3. RESULTS AND DISCUSSION

Most of the prepared complexes were colored, stable at room temperature for extended periods, decomposed on heating and insoluble in water but readily soluble in strong coordinating solvents like DMF and DMSO (S.TH Co 2-1 complex was readily soluble in water) (Table **2**).

Table 2. Analytical and physical data of the complexes.

Compound Symbol	Reactants		Products			
	Ligand	Metal salts	Color	M.P°C	Yield (%)	M. F. (M.wt)
S.TH-Ag 1:1	S.TH	$AgNO_3$	Black	>300	89.3	$C_{13}H_{14}AgN_3O_7S_2$ (496.26)
S.TH-Co 2:1	S.TH	$CoCl_2.6H_2O$	Deep yellow	219-221	86.6	$[C_{26}H_{26}ClCoN_4O_7S_4]^+ Cl^-$ (764. 61)
S.TH-Cr 2-1	S.TH	$CrCl_3.6H_2O$	Black	>300	70.9	$[C_{26}H_{26}ClCrN_4O_7S_4]^+ Cl_2^-$ (793.12)
S.TH-Cu 2:1	S.TH	$CuSO_4$. $5H_2O$	Blue	259-261	85.9	$C_{26}H_{26}CuN_4O_{11}S_5$ (794.38)
S.TH-Ni 2:1	S.TH	$NiSO_4.6H_2O$	Pale green	>300	68.4	$C_{26}H_{26}N_4NiO_{11}S_5$ (789.52)
S.TH-Zn 2:1	S.TH	$ZnSO_4.7H_2O$	White	249-251	82.2	$C_{26}H_{26}N_4O_{11}S_5Zn$ (796.24)

S.TH (*E*)-*N*-(4-(thiophen-2-ylmethyleneamino) phenylsulfonyl)acetamide)

3.1. Elemental Analyses of the Complexes

The results of elemental analyses are shown in Table **3**, which are in good agreement with those required by the proposed formula (calculated). Inductively coupled plasma (ICP-MS) technique plays an important role in confirming the structure of the complexes by determining metal ion concentration. The metal percentages of newly synthesized Schiff base metal complexes shown in Table **3** give a good agreement with the proposed formula (calculated), and confirm binding of the metal ion to ligand sites.

Table 3. Elemental analysis of the complexes calculated/found.

Complex Symbol	C%	H%	N%	S%	M % (ICP)
S.TH-Ag 1:1	31. 46 31.76	2. 84 3.02	8.47 8.32	12.92 12.83	21. 74 21.91
S.TH-Co 2:1	40. 84 41.99	3. 43 3.20	7.33 7.63	16.77 16.43	7. 71 7.96
S.TH-Cr 2-1	39. 37 39.55	3.30 3.21	7.06 7.28	16. 17 16.39	6. 56 6.81
S.TH- Cu 2-1	39. 31 39.66	3.30 3.11	7. 05 7.14	20.18 20.03	8. 00 7.92
S.TH-Ni 2:1	39. 55 39.69	3.32 3.28	7. 10 7.02	20. 31 20.47	7. 43 7.58
S.TH-Zn 2:1	39. 22 39.28	3.29 3.25	7. 04 7.23	20.14 20.19	8. 21 8.34

3.2. Infrared Spectra

The nature and functional groups attached to metal atoms can be provided by FTIR spectra. The IR spectra of the complexes were compared with those of their ligand (S.TH) and the previously reported complexes [14]. The spectra of compounds have numerous bands, as shown in Table (**4**), which summarizes the main bands and their proposed groups. The absence of IR characteristic bands for amino group of aryl amine and the carbonyl group of aldehyde is an indication of forming Schiff base compounds. This is further confirmed as shown in the equation of Fig. (**1**) by the appearance of a new characteristic band of νC=N at 1578 cm^{-1}, which has already shifted to higher frequencies in all complexes suggesting that this group is involved in the coordination with metal [15]. The IR spectrum of S.TH exhibits many potential donor sites like nitrogen of the azomethine group (C=N), sulfonamide oxygen (SO_2), nitrogen of secondary amine (NH), O acetamido C=O, and sulfur atom of S thiophene ring. The asymmetric and symmetric (SO_2) group stretching vibrations in the sulfonamides were observed at 1331-1325 and 1157-1152 cm^{-1}, respectively, which indicate no significant shifts. This behavior has been observed in similar sulfonamide complexes that do not coordinate through this group. The band of the carbonyl group (C = O) appears around 1717-1709 cm^{-1}, has nearly not changed, indicating that they are also not involved in coordination. The hydrated complexes exhibited an IR bands approximately around 3447 cm^{-1} range due to ν(H_2O) bands, which refer to water molecules coordinated to the metal in the complexes. The coordination of metals to ligand potential sites is further supported by appearance of non-ligand bands around 519-502 cm^{-1} and around 490-450 cm^{-1} due to υM_N and υM_S, respectively. Studies on the stretching vibrations of these bonds are important in elucidating the structure of the complex [16]. Other bands like υC-H Ar appears around 3050 cm^{-1} and υC-H Al appears around 2800 cm^{-1}, other bands such as C=C appears around 1490 cm^{-1}.

Table 4. Characteristic FT-IR bands.

Compounds/Bands	υH_2O br	υN-H	υC=O	υC=N	υSO_2as	υSO_2sym	υM-N	υM-S
S.TH	-	3290	1716	1578	1328	1153	-	-
S.TH-Ag 1:1	3447	3284	1714	1611	1331	1157	502	450
S. TH-Co 2:1	3448	3289	1710	1599	1328	1154	507	478
S. TH-Cr 2:1	3418	3283	1709	1595	1330	1152	519	490
S. TH-Cu 2:1	3446	3285	1712	1595	1325	1154	505	461
S. TH-Ni 2:1	3421	3289	1711	1593	1329	1154	507	477
S. TH-Zn 2-1	3417	3288	1717	1597	1327	1156	510	467

3.3. Molar Conductivity Measurements

The molar conductance of the complexes (Λm) can be calculated using the relation: Λm= K/C, where K is specific conductivity of the complex, and C is the molar concentration of the metal complex solutions. The chelates were dissolved in DMF and the molar conductivities of 10^{-4} M of their solutions at 25 ± 2°C were measured. Table (**5**) shows that low molar conductivity values of the complexes (Λm = 11.67-33.27 Ω^{-1}mol^{-1} cm^2) which indicate that these complexes are non-electrolytes [17]. Except Co(II) and Cr(III) complexes, they have high molar conductance of 120.21 and 114.61 Ω^{-1}mol^{-1}cm^2, respectively, which indicating the electrolytic nature of the complex [18].

Table 5. The UV-Vis. absorption spectra, molar conductance and magnetic moment of metal complexes.

Compund Symbol	λ_{max} *nm*	Λm Ω^{-1}mol^{-1}cm^2	μeff. (B.M.)	Transitions	Geometry
S.TH Ligand	638, 538, 468, 427 358, 338. 266, 222, 210.				
S.TH-Ag 1:1	633, 534, 443, 349, 260, 224.	33.27	Diamagnetic	no d-d transition	Square planar
S.TH-Co 2:1	632, 538, 467, 429, 379, 354, 293. 261, 229.	120.21	5.24	s ${}^4T_{1g} \rightarrow {}^4T_{2g}(F)(\nu_1)$, ${}^4T_{1g} \rightarrow {}^4A_{2g}(F)(\nu_2)$ ${}^4T_{1g} \rightarrow {}^4T_{1g}(P)(\nu_3)$	Octahedral
S.TH-Cr 2-1	637, 538, 455, 375, 350, 275. 260, 227, 215.	114.16	3.71	${}^4B_{1g} \rightarrow {}^4E_g$ (${}^4T_{2g}$), II: ${}^4B_{1g} \rightarrow 4B_{2g}({}^4T_{2g})$, III: ${}^4B1_g \rightarrow {}^4E_g({}^4T_{1g})$, IV: ${}^4B1g \rightarrow {}^4A_{2g}({}^4T_{1g})$ V: ${}^4B1g \rightarrow {}^4A_{2g}({}^4T_{1g}$ (P)), VI: ${}^4B1g \rightarrow 4E_{2g}$ (${}^4T_{1g}$ (P)	Octahedral
S.TH- Cu 2-1	633, 588, 536, 469, 410,375, 335, 274. 250, 227.	14.96	2.11	${}^2B_{1g} \rightarrow {}^2B_{2g}$, ${}^2B_{1g} \rightarrow {}^2E_g$, ${}^2B_{1g} \rightarrow {}^2A_{1g}$	Octahedral
S.TH-Ni 2:1	638, 537, 467,403, 366, 323, 278. 250, 227.	11.67	3.04	${}^3A_{2g} \rightarrow {}^3T_{1g}(P)(\nu_1)$, ${}^3A_{1g} \rightarrow {}^3T_{2g}(F)(\nu_2)$ and ${}^3A_{2g} \rightarrow {}^1E_g$	Octahedral
S.TH-Zn 2:1	636, 538, 461, 401. 362,253, 221.	16.07	Diamagnetic	no d-d transition	Octahedral

3.4. Magnetic Susceptibility Measurements

The magnetic moment values in Table (**5**) show that the S.TH-Co (II) complex has magnetic moment value 5.24 B.M. which agrees well with the range normally observed for octahedral cobalt(II) complexes [14]. The S.TH Cr (III) complex shows a magnetic moment corresponding to 3 unpaired electrons 3,71 B.M., similar to those observed in octahedral geometry [19]. The value of magnetic moment of S.TH Cu(II) complex was 2.11 B.M. which is in a good agreement with the characteristics of mononuclear, (d^9, 1 unpaired electron) distorted octahedral geometry due to Jahn–Teller effect. This phenomenon is very common in six-coordinate copper (II) complexes. The d^9 electronic configuration of this ion gives three electrons in the two degenerate eg orbitals, leading to a doubly degenerate electronic ground state. Such complexes distort along one of the molecular four fold axes (always labeled the z axis), which has the effect of removing the orbital and electronic degeneracies and lowering the overall energy. When such an elongation occurs, the effect is to lower the electrostatic repulsion between the electron-pair on the Lewis basic ligand and any electrons in orbitals with a z-component, thus lowering the energy of the complex where inversion center is preserved after the distortion [20].

In case of S.TH Ni complex, the magnetic moment value is 3.04 B.M. (d^8, 2 unpaired electrons, octahedral geometry) [21]. The magnetic moments values of diamagnetic Ag and Zn complexes show no d-d bands as expected for a d^{10} system.

3.5. Electronic Spectra

Electronic spectra of complexes can provide valuable information related to stereo chemistry of metal ions in the complexes based on the positions and number of d–d transition peaks. The electronic spectra for all compounds were obtained in DMSO solution and show absorption bands in three distinct regions as can be seen in Table (**5**). The first region ranging from 200 to approximately 249 nm, is characteristic for the electronic inter-ligand $\pi \rightarrow \pi^*$ transitions correspond to transition C=C of the phenyl group, while the second characteristic wavelength in the region of 280 nm to approximately 350 nm is the second inter ligand $n \rightarrow \pi$ transition C=O, the third distinct region ranging from 410 nm to approximately 540 nm is an indicator for the Ligand to Metal Charge Transfer (LMCT) from the nitrogen atom to the transition metal center [22 - 24]. The UV bands of SO_2 group merge to form a single strong absorption band around 260 nm. Many bands positions are considerably shifted from their original positions in their ligands to blue or red regions in all complexes indicating coordination to the metal, while new bands were observed in the visible region for the complexes due to d→d transitions (Table **5**). In case of a d^{10} system (Ag & Zn complexes) the present diamagnetic complexes show no d-d transition in the visible region.

3.6. Mass Spectra Analysis

The mass spectra of complexes are shown in Table (**6**). The molecular ion peaks are in a good agreement with their empirical formula as indicated from the elemental analyses. The other peaks represent fragments of the molecular ions.

Table 6. Mass spectral data.

Compound Symbol	Molecular ion (M^+) peak at m/z	Relative Intensity (%)
S.TH Ligand	$[C_{13}H_{12}N_2O_2S_2]^+$ (308.38)	91
S.TH-Ag 1:1	$[C_{13}H_{14}Ag\ N_3O_7S_2]^+$ (496.26)	93
S.TH-Co 2:1	$[C_{26}H_{26}Cl_2CoN_4O_7S_4]^+$ (746.59)	94
S.TH-Cr 2-1	$[C_{26}H_{26}Cl_2CrN_4O_7S_4]^+$ (776.05)	81
S.TH- Cu 2-1	$[C_{26}H_{26}CuN_4O_{11}S_5]^+$ (794.38)	86
S.TH-Ni 2:1	$[C_{26}H_{26}N_4NiO_{11}S_5]^+$ (789.52)	72
S.TH-Zn 2:1	$[C_{26}H_{26}N_4O_{11}S_5Zn]^+$ (796.24)	77

3.7. Proton NMR Spectra

The proton NMR for S.TH and the diamagnetic complexes (S.TH-Ag and S.TH-Zn) are shown in Table **7**. All the protons were found as expected. The spectra of the complexes were examined in comparison with their ligand. The ligand and the diamagnetic complexes give a duplet signals in the region 7.12-7.91 ppm (d, m) for the aromatic protons. Singlet peaks appeared in the region of 1.82-1.85 ppm was attributed to the methyl group. The N-H proton give a singlet signals in the region 11.85-11.91 ppm which nearly not changed compared to ligand, this indicate NH group is not involved in the coordination of metal complexes. Signals for the methine protons of the azomethine group, were observed between 8.91 and 8.80 ppm, the coordination of azomethine nitrogen is confirmed by down field shift. These numbers of protons results give a good agreement with CHNS calculated and found results.

Table 7. Proton NMR spectral data for ligands and the diamagnetic complexes.

Compound	Chemical shift, (δ) ppm & Assignment
S.TH ligand	11.89(s,1H, NH) 8. 80(s,1H, CH=N) 7.24-7.89 (d, m 7H, Aromatic ring) 1.85(s,3H, CH_3)
S.TH-Ag 1-1	11. 91(s,1H, NH) 8. 90 (s,1H, CH=N) 7. 12-7.66 (d, m 7H, Aromatic ring) 1.82(s,3H, CH_3)
S.TH-Zn 2-1	11.85(s,2H, NH) 8. 97 (s,1H, CH=N) 7.22-7. 91 (d, m 14H, Aromatic ring) 1.84 (s,6H, CH_3)

3.8. The Suggested Structure of Complexes

Based on the previous results, we can propose these two structures for the synthesized complexes Fig. (**2**).

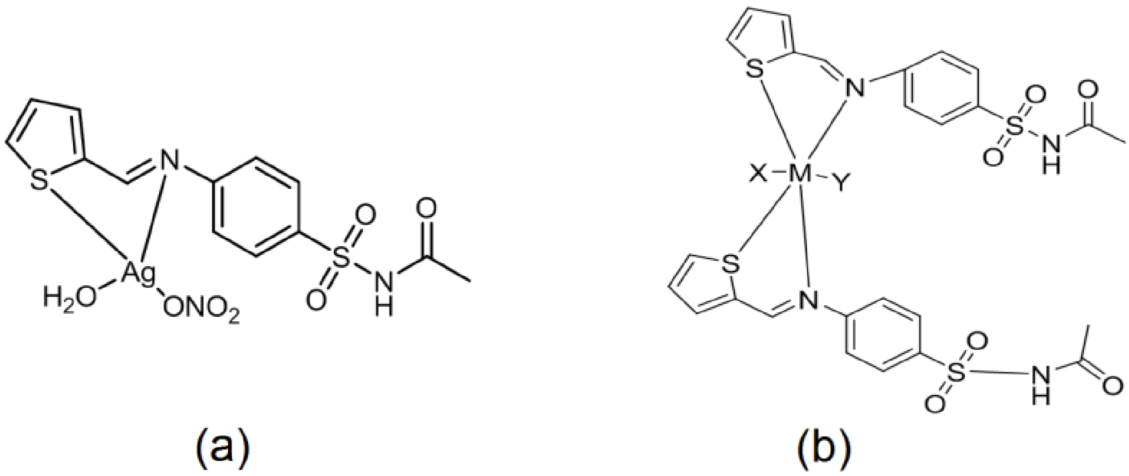

Fig. (2). (a) Proposed structure for S.TH - Ag complex, and (b) Proposed structure for the remaining metal complexes

where, M= Co or Cr (X= H_2O, Y= Cl)

$[Co(L)_2 (H_2O)(Cl)]^+Cl^-$

$[Cr(L)_2 (H_2O)(Cl)]^{2+}2Cl^-$

M= Cu, Ni or Zn (X= H_2O, Y= SO_4) $[ML_2 (SO_4) (H_2O)]$.

3.9. Biological Activity

Most of the tested compounds have shown a promising biological activity against different types of Gram-positive and Gram-negative bacteria, and fungi. The bacteriostatic property of the metal complexes is higher than the ligand itself. The data are listed in Table **8** that show that *E. coli* was inhibited by all complexes. The importance of this lies in the fact that these complexes could reasonably be used for the treatment of some common diseases caused by *E. coli, e.g.*, septicemia, gastroenteritis, urinary tract infections, and hospital-acquired infections. The mechanism of action of this complexes seems to be connected with the inhibition of phosphomannose isomerase, which is a key enzyme in the bio-synthesis of yeast cell walls [25].

Table 8. Biological activity of S.TH and its metal complexes.

Tested Microorganisms	**S.TH ligand**	**S.TH-Ag1:1**	**S TH -Co 2:1**	**S TH -Cr 2:1**	**S TH -Cu 2:1**	**S TH -Ni 2:1**	**S. TH -Zn2:1**	**St.**
Fungi								**Amphotericin B**
Aspergillus fumigates (RCMB 02568)	11.7 ± 0. 43	13.5 ± 0. 13	23.8 ± 0.2	28.7 ± 0.2	19.5 ± 0.7	13.1 ± 0. 31	16.4 ± 0. 52	23.7 ± 0.1
Candida albicans (RCMB 05036)	12.2 ± 0.44	11.4 ± 0.27	32.4 ± 0.3	25.4 ± 0.1	17.8 ± 0. 54	10.5 ± 0.32	13.9 ± 0.39	25.4 ± 0.1
Gram-positive bacteria								Ampicillin
Sterptococcus Pneumonie (RCMB 010010)	10.2 ± 0.3	12.0 ± 0. 54	13.2 ± 0.38	23.7 ± 0.1	22.6 ± 0.33	15.1 ± 0. 48	11.9 ± 0. 32	23.8 ± 0.2
Bacillus subtilis (RCMB 010067)	12.2 ± 0.45	18.7 ± 0.78	13.1 ± 0.31	19.7 ± 0.2	20.1 ± 0.27	18.2 ± 0.44	19.8 ± 0.63	32.4 ± 0.3
Gram-negative bacteria								Gentamicin
Pseudomonas aeruginosa (RCMB 010043)	11.5 ± 0. 51	13.8 ± 0. 89	NA	17.3 ± 0. 1	14.4 ± 0.78	12.5 ± 0.48	12.8 ± 0. 38	17.3 ± 0.1
Escherichia coli (RCMB 01052)	10.3 ± 0.21	12.9 ± 0.11	10.2 ± 0. 41	19.9 ± 0.3	18.8 ± 0. 57	11.1 ± 0.42	10.9 ± 0.35	19.9 ± 0.3

Mean zone of inhibition in mm ± Standard beyond well diameter (6mm) (100 ml was tested) produced on a range of clinically pathogenic microorganisms using (5mg per ml) concentration of tested samples. Results are depicted in Table **8**.

CONCLUSION

In the present study new Schiff Base of (E)-N-(4-(thiophen-2-ylmethyleneamino) phenylsulfonyl) acetamide metal complexes were synthesized and then characterized by various physicochemical and spectral analytical techniques. The obtained complexes showed promising antimicrobial activity when compared to those of parent ligand.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

ACKNOWLEDGEMENTS

We are grateful to Eburon Organics (B-2310 Rijkevorsel, Belgium) for providing the authentic samples of CA and CAF, and to the Service Central d'Analyse (SCA), CNRS, F69360 Solaize, for recording the LC-MS spectra. We also thank the European SUDOE program for financial support. We would like to thank Saurabh Bansal, Eduardo Portillo Hahnefeld, and everyone who kindly volunteered on the spot to help us harvest our sea grass samples in various locations.

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