



Synthesis, Characterization and Antibacterial Study of Some Transition Metal Complexes with Novel Schiff Base having 1,3,4-Thiadiazole Moiety

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Some transition metal ions [Zr(IV), Co(II), Cu(II), Cr(III), Ag(I), Pd(II)] complexes were synthesized by reacting anisaldehyde, thiosemicarbazide and 2-(4-hydroxybenzylideneamino)benzoic acid to form (4-[2{5-[(4-methoxy-benzylidene)amino][1,3,4]thiadiazole-2-yl}phenylimino)methyl]phenol ligand. Schiff base ligand and its metal complexes were characterized by elemental analysis, IR, UV-visible, NMR (¹H NMR, ¹³C NMR), thermal analysis, molar conductance, magnetic susceptibility and antimicrobial study. Zone of inhibition as well as MIC has been evaluated against *E. coli* (MTCC443), *S. aureus* (MTCC1688), *P. aeruginosa* (MTCC96), *C. albicans* (MTCC227), *A. niger* (MTCC82) organisms comparing with standard antimicrobial and antifungal drugs. TGA/DTA of the synthesized metal complexes shows the thermal stability and non-spontaneous nature of decomposition. It also shows multi-step degradation behaviour and final weight loss with respect to the formation of metal oxide and residue.

Keywords: Biological activity, Coordination, Schiff base, Thermal analysis, Transition complex.

INTRODUCTION

1,3,4-Thiadiazole structure showed much feeble because of inductive effect of S-atom which acquire strong aromaticity [1]. Azomethine bearing *sp*² hybridized N-atom considerably signify because of its structural flexibility. Heterocyclic nitrogen atom in ring structure can acts as e⁻ deficient, as a result electrophilic substitution reaction can takes place at 2nd and 5th position of ring [2]. To obtain 4-[(2-5-amino[1,3,4]thiadiazole-2-yl)-phenylimino)methyl]phenol intermediate, the pH of reaction mixture should be maintain at 7. As 1,3,4-thiadiazole derivative showed *meso*-ionic nature which are capable to transverse cell layer as a result they showed *in vitro* biological property [3].

Ligands which donate electron to *d*-orbital of metal ion and form a bond has to be a great attention due to its potential activity towards transition metal complexes [4]. Synthesized complexes having N,O donor atoms in coordination complexes show valuable use in stereospecific reaction as well as biological activity [5]. Metal complex exhibited thiadiazole ring synthesized from Schiff base ligand comprising significant function in various influence for lower down toxicity and increase strength in living organism [6]. Palladium(II) complexes

show biological activity such as anti HIV, antifungal, antitumor activities and show less side effect compared to cisplatin [7]. As a result transition metal complexes prepared from Schiff base ligands have wide applications in medicinal purposes [8].

1,3,4-Thiadiazoles derivatives show the remarkable use in CNS depressant, molluscicidal, antitubercular also anti *H. pylori* [9], antibacterial, antifungal and anticancer properties, pharmaceutical [10]. Now a days, there has been much interest in the metal complex study containing, N, S and N, O donor ligand because of structural properties and carcinostatic activity of ligands and its meal complexes derived from them [11]. In view of above facts, the present article embodies the spectral, thermal and biological studies on the newly synthesized (4-[2{5-[(4-methoxybenzylidene)amino][1,3,4]-thiadiazole-2-yl}phenylimino)methyl]phenol and its metal complexes [Zr(IV), Co(II), Cu(II), Cr(III), Ag(I), Pd(II)].

EXPERIMENTAL

All the chemicals and solvents were of A.R. grade and used without purification. Phosphorus oxychloride was purchased from Loba Chemie, 4-nitrobenzaldehyde, anisaldehyde

were procured from Thomas-Baker, potassium hydroxide pallets and silver nitrate from Loba chemie, PdCl₂ was purchased from Burgoyne. The UV-visible spectra was recorded on Agilent Cary 5000, infrared spectra were recorded on Perkin Elmer FTIR 400, ¹H NMR in Bruker Avance III, NMR by Jeol, Japan ECZR Series 600 MHz Spectrometer, ¹³C NMR from Avance Neo Bruker 125 MHz, magnetic susceptibility was done by Gouys balance electromagnet model no. SSA-1305B, (Acculab) melting point were determined in electrical melting point apparatus and are uncorrected. Digital conductivity meter (model no. EQ 660A) was used to evaluate conductivity of ligand and its metal complexes using DMSO-*d*₆ solvent. Elemental analysis (C,H,N,S) were determined on Elementary Vario EL III. Thermal analysis (TGA, DTA) was done on Perkin-Elmer STA 600.

Synthesis of Schiff base ligand

(4-[2{5-[(4-Methoxy-benzylidene)amino][1,3,4]thiadiazole-2-yl}phenylimino)methyl]phenol (L): A mixture of 2-(4-hydroxybenzylideneamino)benzoic acid (0.01 mol), thiosemicarbazide (0.01 mol) and POCl₃ (5 mL) was heated under reflux for about 3 h. Upon cooling 50 mL distilled water was added to the reaction mixture and refluxed was carried for 4 h. The obtained filtrate was neutralized with KOH solution to obtain 4-[(2,5-amino[1,3,4]thiadiazole-2-yl)phenylimino]methyl]phenol. In the next reaction, 4-[(2,5-amino[1,3,4]thiadiazole-2-yl)phenylimino]methyl]phenol (0.02 mol) was added dropwise in 20 mL ethanolic solution of anisaldehyde in (0.02 mol) solution. The mixture afterwards refluxed for about 3 h. Yellow coloured precipitate was obtained, which get filtered and recrystallized with ethanol and dried out in vacuum.

Synthesis of metal complex: Ethanolic solution of metal ion ZrOCl₂·8H₂O, CoCl₂·6H₂O, CuCl₂·2H₂O, Cr(NO₃)₃·9H₂O, AgNO₃, PdCl₂ was added in ethanolic solution of (4-[2{5-[(4-methoxybenzylidene)amino][1,3,4]thiadiazole-2-yl}phenylimino)methyl]phenol in 1:2 ratio. The reaction mixture was heated for 0.5 h. The coloured precipitate was obtained get filtered and recrystallized with ethanol.

RESULTS AND DISCUSSION

The elemental analysis and other physical data of ligand and its metal complexes are shown in Table-1. The molecular formula of compounds was suggested on the basis of elemental analysis (CHNS), spectral characterization, magnetic moment and conductivity measurement. The molar conductance of synthesized complexes were recorded at room temperature. All complexes were found to be low molar conductivity values in the range of 43-55 ohm⁻¹ cm² mol⁻¹. It signify that all the synthesized metal complexes are non-electrolytic and neutral in nature (Table-1). The magnetic susceptibility were measured at room temperature by using Gouy method. Mercuric tetrathio-cyanatocobaltate(II) was used as a standard for susceptibility measurement. The magnetic moment values are also given in Table-1.

IR analysis: The key spectral IR data of novel Schiff base and their metal complexes are given in Table-2. Ligand shows a broad band in the region 3063 cm⁻¹ revealed the presence of ν(O-H) stretching. Infrared spectrum of ligand showed the appearance of band at 1250 cm⁻¹ indicating ν(C-O) stretching. In addition, band observed at 3009 cm⁻¹ represent aromatic (C-H) stretching in ligand. The azomethine (C=N) band observed at 1635 cm⁻¹ region, the shifting of band from ligand to metal ion region by 10-15 cm⁻¹ indicates complex were formed. In ligand as well as its metal complexes methyl (C-H) stretch observed at ~2950 and 2838 cm⁻¹. Frequency corresponds to (C-O-C) asymmetric stretching at 1301 cm⁻¹, while 1001 cm⁻¹ for symmetric stretching is due to presence of methylated group attached to aromatic ring [12]. All the synthesized compounds show spectrum band at region 603 cm⁻¹ assigned to ring stretching of (C-S) stretching. New peaks appear in the region of 523-406 cm⁻¹ and 523-500 cm⁻¹. These bands were observed in metal complexes while absent in ligand may be attributed to vibration of ν(M-N) and ν(M-O), respectively [13].

NMR: The ¹H NMR spectra were recorded on DMSO-*d*₆. The ¹H NMR spectra of ligand showed δ 9.83 ppm for -OH, -N=CH and aromatic protons signals at δ 6.84 ppm and in the

TABLE-1
PHYSICO-CHEMICAL ANALYSIS DATA OF NOVEL SCHIFF BASE
CONTAINING 1,3,4-THIADIAZOLE MOIETY AND ITS METAL COMPLEXES

Compound	Colour	m.p. (°C)	Elemental analysis (%): Found (calcd.)						χ _m (A/m)	Λ _m (ohm ⁻¹ cm ² mol ⁻¹)
			C	H	N	S	O	M		
C ₂₃ H ₁₈ N ₄ O ₂ S	Red	130	66.81 (66.32)	4.14 (4.10)	13.55 (13.32)	7.75 (7.61)	7.74 (7.60)	-	-	42
C ₄₆ H ₃₆ N ₈ O ₆ SZr	Orange	128	61.30 (60.82)	2.27 (2.14)	13.03 (12.87)	7.02 (6.94)	6.98 (6.58)	9.84 (9.25)	Diamag.	47
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Co	Green	125	61.27 (60.07)	2.97 (2.82)	13.06 (12.84)	6.68 (6.40)	6.24 (6.03)	6.36 (6.14)	3.85	52
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Cu	Yellow	124	61.93 (61.41)	3.85 (3.72)	12.50 (12.23)	7.20 (6.85)	7.19 (7.03)	7.11 (6.98)	1.64	50
C ₄₆ H ₃₈ N ₈ O ₆ S ₂ Cr	Red	197	58.96 (58.76)	4.11 (3.96)	11.85 (11.42)	6.80 (6.51)	6.73 (6.48)	11.27 (11.12)	3.92	53
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Ag	Green	126	60.92 (60.74)	4.88 (4.03)	12.68 (12.45)	7.05 (6.82)	10.36 (9.85)	4.58 (4.21)	Diamag.	40
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Pd	Red	195	58.67 (58.32)	3.85 (3.14)	12.19 (12.10)	6.01 (5.87)	6.12 (5.85)	11.60 (11.13)	0.72	42

TABLE-2
KEY IR (cm⁻¹) SPECTRAL DATA OF NOVEL SCHIFF BASE CONTAINING 1,3,4-THIADIAZOLE AND ITS METAL COMPLEXES

Compound	v(O-H)	Ar(C-H)	(C=C)	v(C=N)	v(C-S)	v(M-O)	v(M-N)
C ₂₃ H ₁₈ N ₄ O ₂ S	3063	3009	1442	1635	603	–	–
C ₄₆ H ₃₆ N ₈ O ₆ S ₂ Zr	–	3107	1440	1632	605	513	416
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Co	–	3108	1448	1630	602	518	420
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Cu	–	3111	1450	1634	605	514	434
C ₄₆ H ₃₈ N ₈ O ₆ S ₂ Cr	–	3110	1452	1634	606	515	418
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Ag	–	3109	1449	1630	604	515	448
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Pd	–	3110	1448	1631	606	516	432

range of δ 7.53-8.77 ppm, respectively. The ¹H NMR spectra for C4 complex showed lower chemical shift for –OH at δ 8.98 ppm, –N=CH, aromatic protons and –OCH₃ signal centering at δ 6.82 ppm, in the range of δ 7.19-8.09 ppm and δ 3.92 ppm, respectively.

¹³C NMR of ligand was characterized by presence of –(N=CH) of azomethine group, which appeared as a signal at δ 3.75 ppm. The chemical shift of C-atom in ring appeared at δ 123.57-131.96 ppm. The spectra appeared low field at δ 175.32 ppm, which was assigned for CH=N of thiozole ring. The ¹³C NMR spectral data of complexes is shown in Table-3. The spectra of C5 complex was characterized by presence of (N=CH) of azomethine group which appeared a signal at δ 111.62 ppm. Chemical shift of C atoms in aromatic appeared at ring δ 122.85-135.58 ppm. The spectra appeared at low field at δ 174.28 ppm, which was assigned to CH=N of thiozole ring [14].

Electronic spectra: The electronic spectra of ligand exhibited a high intensity band appeared as a singlet due to intra ligand transition, the band which appeared at 318 nm (31447 cm⁻¹) was assigned to π - π^* transition of the conjugated system. A lower intensity band appeared at the region 425 nm

(23529 cm⁻¹) was assigned to n- π^* . The electronic spectrum of Zr(IV) complex exhibited absorption band at 240 nm (41600 cm⁻¹) and 248 nm (40322 cm⁻¹) assigned to CT transition, indicating octahedral geometry. The electronic spectrum of Co(II) complex exhibited absorption bands at 632 nm (15822 cm⁻¹) and 391 nm (25575 cm⁻¹) signify ⁴A₂(F) → ⁴T₁(P) and MLCT transition shows complex is tetrahedral. The Cu(II) complex shows band at range of 644 nm (15527 cm⁻¹), 571 nm (17573 cm⁻¹), 513 nm (19493 cm⁻¹) is due to ²B_{1g} → ²A_{1g}, ²B_{1g} → ²E_g, CT transition respectively. This indicate square planar geometry of complex (Table-4).

The spectrum of Cr(III) shows band at 644 nm (15527 cm⁻¹), 491 nm (20328 cm⁻¹), 354 nm (28221 cm⁻¹) assigned for ⁴A_{2g} → ⁴T_{2g}(F), ⁴A_{2g} → ⁴T_{1g}(F), ⁴A_{2g} → ⁴T_{2g}(P) indicate presence of octahedral geometry. Ag(I) complex shows band at 284 nm (40322 cm⁻¹), 305 nm (32786 cm⁻¹), 348 nm (28735 cm⁻¹) given for π - π^* transition, n- π^* transition and Ag → L (CT) transition. This shows that complex display square planar geometry. Palladium(II) complexes appears at 448 nm (22321 cm⁻¹), 402 nm (24875 cm⁻¹), 318 nm (31446 cm⁻¹), which are due to ¹A_{1g} → ¹B_{1g}, ¹A_{1g} → ¹E_g, L → Pd indicating square planar geometry (Table-4).

TABLE-3
NMR (¹H NMR, ¹³C NMR, δ ppm) SPECTRAL DATA OF NOVEL SCHIFF BASE CONTAINING 1,3,4-THIADIAZOLE MOIETY AND ITS METAL COMPLEXES

Compound	¹ H NMR				¹³ C NMR		
	N=CH	Aromatic	OH	O-CH ₃	N=CH	Thiozole ring (CH=N)	Aromatic
C ₂₃ H ₁₈ N ₄ O ₂ S	6.84(s)	7.53-8.77(m)	9.82(s)	3.75(s)	115.76	175.32	123.57-131.96
C ₄₆ H ₃₆ N ₈ O ₆ S ₂ Zr	6.89(s)	7.66-8.72(m)	–	2.51(s)	112.64	171.45	124.65-133.63
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Co	6.90(s)	7.19-8.09(m)	–	3.78(s)	114.46	170.63	122.23-135.81
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Cu	6.93(s)	7.21-8.68(m)	–	2.45(s)	112.12	176.42	125.38-133.62
C ₄₆ H ₃₈ N ₈ O ₆ S ₂ Cr	6.82(s)	7.19-8.09(m)	–	3.92(s)	116.87	174.74	123.52-134.74
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Ag	6.87(s)	7.74-8.77(m)	–	3.80(s)	111.62	174.28	122.85-135.58
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Pd	6.89(s)	7.65-8.73(m)	–	3.65(s)	112.83	173.47	121.46-134.86

TABLE-4
ELECTRONIC TRANSITION DATA OF NOVEL SCHIFF BASE CONTAINING 1,3,4-THIADIAZOLE AND ITS METAL COMPLEXES

Compound	Absorption	Bond assignment	Geometry
C ₂₃ H ₁₈ N ₄ O ₂ S	318 nm (31447 cm ⁻¹), 425 nm (23529 cm ⁻¹)	(π - π^*), (n- π^*) transition	–
C ₄₆ H ₃₆ N ₈ O ₆ S ₂ Zr	240 nm (41600 cm ⁻¹), 248 nm (40322 cm ⁻¹)	CT transition	Octahedral geometry
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Co	632 nm (15822 cm ⁻¹), 391 nm (25575 cm ⁻¹)	⁴ A ₂ (F) → ⁴ T ₁ (P), MLCT	Tetrahedral geometry
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Cu	644 nm (15527 cm ⁻¹), 571 nm (17573 cm ⁻¹), 513 nm (19493 cm ⁻¹)	² B _{1g} → ² A _{1g} , ² B _{1g} → ² E _g , CT transition	Square planar geometry
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Ag	284 nm (40322 cm ⁻¹), 305 nm (32786 cm ⁻¹), 348 nm (28735 cm ⁻¹)	(π - π^*) transition, (n- π^*) transition, Ag → L (CT) transition	Square planar geometry
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Pd	448 nm (22321 cm ⁻¹), 402 nm (24875 cm ⁻¹), 318 nm (31446 cm ⁻¹)	¹ A _{1g} → ¹ B _{1g} , ¹ A _{1g} → ¹ E _g , L → Pd	Square planar geometry

Thermal analysis: Thermal analysis of metal complexes were carried in thermal range of 40 to 830 °C at 20 °C/min under nitrogen flow. All the metal complexes undergoes decomposition in stepwise manner. The Zr(II) complex shows the weight loss of (3.76% calcd., 3.83% found) correspond to the removal of two water molecules at temperature range 80-180 °C. At temperature range 250-350 °C, weight loss was 25.15% calcd. (25.42% found) indicate the removal of two molecules of C₈H₈O. The 400-450 °C correspond to the removal of two molecules of C₈H₄N₃S with a weight loss of 36.47% calcd. (36.53% found). The next step occurred within the temperature range 500-600 °C, which shows the weight loss of 5.66% calcd. (5.72% found) which might be loss of two molecules of CHN moiety. Afterwards, the gradual decrease in TGA mass loss occurred at temperature < 700 °C resulting in the formation of metal oxide (ZrO₂).

The complexes **C2** and **C3** show the weight loss at 250-330 °C (24.19% calcd., 24.23% found) and at 330-520 °C was (27.37% calcd., 27.84% found) removed two molecules of C₇H₇O and C₈H₈O. In second step, at temperature 330-450 °C, the weight loss was 38.64% calcd. (38.66% found) and at 520-650 °C (39.10% calcd., 37.62% found) with the loss of two molecules of C₈H₄N₃S moiety. At 450-700 °C and 650-800 °C (23.25% calcd., 23.87% found) and (23.87% calcd., 22.67% found) with loss of CHN and C₁₄H₁₀N₂O, respectively. The last residue (MO) were found at temperature < 800 °C. The C4 complex at temperature range 300-450 °C results in

the loss of two water molecules (3.94% calcd., 3.99% found). The next step shows at temperature range 450-590 °C results with the loss of two molecules of C₉H₅N₃S (weight loss of (26.72% found; 26.69% calcd.). At 600-750 °C show loss of two molecules of CHN and the last step show residue part of complex at temperature < 800 °C. The metal complexes C5 and C6 complexes show the weight loss of 23.03% found (22.91% calcd.) at temperature of 250-330 °C with removal of two molecules of C₇H₇O. Afterwards the weight loss of 37.74% found (37.25 % calcd.) found at temperature 450-600 °C shows removal of two molecules of C₁₆H₈N₆S₂ and C₈H₄N₃S. In the last step, there is weight loss of 23.82% found (23.76% calcd.) and 23.85% found (23.79% calcd.) at temperature range 600-750 °C with loss of C₁₄H₁₀N₂O. The results are listed in Table-5.

Antibacterial activity: In this method, the given compound solution of DMSO which was put on a Muller-Hinton Agar (Hi-Media) agar plate containing tested bacteria. Plates get incubated for 24 h at 37 °C. After 24 h diameter of inhibition zone in (mm) was determined. The *in vitro* antibacterial screening activity and MIC of ligand and their metal complexes (**C1-C6**) are given in Tables 6 and 7. The synthesized Schiff base ligand and its metal complexes were studied as antibacterial and antifungal activity against *E. coli* (MTCC443), *S. aureus* (MTCC1688), *P. aeruginosa* (MTCC96), *C. albicans* (MTCC227), *A. niger* (MTCC82) strain using disc diffusion technique. Ampicillin was used as a standard drug, which show activity

TABLE-5
THERMAL ANALYSIS DATA OF NOVEL SCHIFF BASE CONTAINING 1,3,4-THIADIAZOLE MOIETY AND ITS METAL COMPLEXES

Compd. No.	m.f.	m.w.	Temperature range of decomposition (TG) (°C)	Moiety loss	Mass loss (%)	
					Calculated	Found
C1	C ₄₆ H ₃₆ N ₈ O ₆ S ₂ Zr	954.13	80-180	2H ₂ O	3.76	3.83
			250-350	2C ₈ H ₈ O	25.15	25.42
			400-450	2C ₈ H ₄ N ₃ S	36.47	36.53
			500-600	2CHN	5.66	5.72
			650-700	2C ₆ H ₅	16.14	16.28
< 750	ZrO ₂	12.89	12.93			
C2	C ₄₆ H ₃₄ N ₈ O ₂ S ₂ Co	885.81	300-350	2C ₇ H ₇ O	24.19	24.27
			350-400	2C ₉ H ₅ N ₃ S	38.64	38.73
			450-500	2CHN	54.05	54.13
			500-650	2C ₁₂ H ₁₀ O	19.20	19.25
			< 700	CoO	8.47	8.52
C3	C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Cu	890.42	350-400	2C ₈ H ₈ O	27.10	27.12
			450-550	2C ₈ H ₄ N ₃ S	39.10	39.11
			550-600	2C ₁₄ H ₁₀ N ₂ O	24.94	24.97
			< 700	CuO	8.87	8.95
			80-180	2H ₂ O	3.96	3.97
C4	C ₄₆ H ₃₈ N ₈ O ₆ S ₂ Cr	914.90	250-350	2C ₆ H ₅ NO ₂	26.15	26.73
			400-450	2C ₉ H ₅ N ₃ S	40.91	40.95
			500-600	2CHN	5.66	5.70
			650-700	2C ₆ H ₅	9.14	9.20
			< 750	1/2CrO ₂	22.89	22.91
C5	C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Ag	934.74	350-400	2C ₇ H ₇ O	22.91	22.93
			450-550	2C ₁₆ H ₈ N ₆ S ₂	37.25	37.30
			550-600	2C ₁₄ H ₁₀ N ₂ O	23.76	23.78
			< 700	1/2Ag ₂ O	24.73	24.80
C6	C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Pd	933.29	350-400	2C ₇ H ₇ O	22.94	22.96
			450-500	2C ₈ H ₄ N ₃ S	37.29	37.32
			500-650	2C ₁₄ H ₁₀ N ₂ O	23.77	23.79
			< 700	PdO	13.07	13.09

TABLE-6
ANTIMICROBIAL ACTIVITY OF DATA OF NOVEL SCHIFF BASE
CONTAINING 1,3,4-THIADIAZOLE MOIETY AND ITS METAL COMPLEXES

Compound	Zone of inhibition (mm)				
	<i>E. coli</i> (MTCC443)	<i>P. aeruginosa</i> (MTCC96)	<i>S. aureus</i> (MTCC1688)	<i>C. albicans</i> (MTCC227)	<i>A. niger</i> (MTCC282)
C ₂₃ H ₁₈ N ₄ O ₂ S	13	14	14	25	13
C ₄₆ H ₃₆ N ₈ O ₆ S ₂ Zr	12	12	15	10	14
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Co	16	11	18	12	23
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Cu	18	13	14	16	21
C ₄₆ H ₃₈ N ₈ O ₆ S ₂ Cr	11	10	13	22	18
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Ag	14	13	12	20	12
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Pd	12	09	14	14	22
Ampicillin	16	15	16	–	–
Nystatin	–	–	–	28	24

TABLE-7
in vitro ANTIBACTERIAL/ANTIFUNGAL ACTIVITIES AND MINIMUM INHIBITORY CONCENTRATION VALUES (MIC)
OF NOVEL SCHIFF BASE CONTAINING 1,3,4-THIADIAZOLE MOIETY AND ITS METAL COMPLEXES

Compound	<i>E. coli</i> (MTCC443)			<i>S. aureus</i> (MTCC1688)			<i>C. albicans</i> (MTCC227)			<i>A. niger</i> (MTCC282)			
	µg/mL	25	50	100	25	50	100	25	50	100	25	50	100
C ₄₆ H ₃₆ N ₈ O ₆ S ₂ Zr	++	+	++	++	+	+	++	++	+++	++	++	++	++
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Co	+	++	+++	+	++	++	++	++	+	+++	+	++	++
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Cu	++	+	++	++	++	+++	+	++	+	++	++	+++	+++
C ₄₆ H ₃₈ N ₈ O ₆ S ₂ Cr	+++	+	++	++	+	++	+++	++	+	+	++	++	++
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Ag	++	++	+	+++	++	+	++	+	+	++	++	+++	+++
C ₄₆ H ₃₄ N ₈ O ₄ S ₂ Pd	+	++	+	++	++	+	+	++	++	++	+	+	++
Ampicillin	++	+++	+++	++	++	+++	–	–	–	–	–	–	–
Nystatin	–	–	–	–	–	–	+	++	+++	+	+	+++	+++

against bacteria while Nystatin was used as a standard drug antibiotic against fungus. Complex **2** show most effective against *S. aureus* with maximum zone of inhibition of 18 mm and MIC of 62.5 µg/mL.

Conclusion

All the synthesized metal complexes containing novel Schiff base [4-[2{5-[(4-methoxybenzylidene)amino][1,3,4]-thiadiazole-2-yl}phenylimino)methyl]phenol] were successfully synthesized and characterized. All the compounds are stable at room temperature. The IR spectroscopy assisted that Schiff base is O,N donor, bidentate ligand and coordinated via phenolic oxygen and azomethine nitrogen. From biological studies, some synthesized complexes were found to be as that effective as that of effective as standard drug.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this article.

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