IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 8, Issue 12 Ver. I (Dec. 2015), PP 67-74
www.iosrjournals.org

Synthesis, Characterization and antimicrobial activity of some novel sulfacetamide metal complexes

Ahmad S. Abu-Khadra[*1], Rabie S. Farag[2], Alaa-Eldin Mokhtar Abdel-Hady[3],
[1] *(Department of Basic Science, Faculty of Engineering Science, Sinai University, North Sinai, Egypt)*
[2] *(Department of Chemistry Faculty of Science, , All-Azhar University, Cairo, Egypt)*
(Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Sinai University, North Sinai,Egypt)

Abstract:*New series of Ca(II), Cd(II), Ce(III), Cr(III),Cs, Fe(II) ,Fe(III) , Pb(II) and Hg(II) complexes with sulfacetamide (N-[4-(amino-phenyl)sulfonil]acetamide) have been synthesized. The measured molar conductance values indicated that the complexes are non-electrolytes. These compounds have been characterized by different physico-chemical techniques like, melting point, elemental analysis, inductively coupled plasma (ICP), FT-IR,[1]HNMR,UV spectroscopy, conductance measurements, magnetic susceptibility and Mass spectral analysis. Spectroscopic studies suggested that most of complexes were coordinated in a regular octahedral arrangement by, two N amino(secondary amine adjacent to carbonyl group) and two O acetamido atoms(carbonyl group) in 2:1,(ligand, metal molar ratio respectively). Complexes have been screened for their antibacterial {Gram negative bacteria (Escherichia coli and pseudomonas aeruginosa)}, {Gram positive baccteria (Bacillus subtilis and Sterptococcuspneumoniae) and antifungal (Aspergillusfumigates and Candida albicans) and the results showed promising antimicrobial activity.*
Keywords: *Biological activity, Inductively coupled plasma, Synthesis, Sulfacetamide, Transition Metal complexes,*

Author of correspondence: Ahmad Sabry Abu-Khadra[*1]
[1] (Department of Basic Science, Faculty of Engineering Science, Sinai University, North Sinai, Egypt)
*Abstracted from Ph.D Thesis of Ahmad Sabry Abu-Khadra.

I. Introduction

Sulfonamide is one of a group of chemotherapeutic agents commonly referred to as Sulfa drugs which were discovered in the 1930's.,Sulfonamides remain the most widely used as antibacterial agents in the world because of their low cost, low toxicity and excellent activity against common bacterial diseases. The clinically useful sulfonamides are derived from sulfanilamide, which is similar to Para amino benzoic acid, NH_2 group in sulfa drug is responsible for the activity and R group acts as modified for the activity [1,2]. Most of heavy metals play a vital role as co-factors for many important enzymatic reactions in human body. However, coordination metal complexes were gained an increasing importance in the design of respiratory, slow release and long acting drugs. Metal ions are therefore known to accelerate drug actions. The efficacies of some therapeutic agents are known to increase upon coordination, so several authors have reported the synthesis of sulfa drugs and their metal complexes which were prepared and characterized by elemental analyses, magnetic measurement, and electronic absorption data. Antimicrobial activity studies on their metal chelates could have much physiological and pharmacological relevance, because the metal chelates of sulfa drugs have been found to be more bacteriostatic than the drugs themselves [3-6].A part from the antibacterial activity, sulfonamides were developed for antitumor, anti-viral, anti-fungal, anti-carbonic anhydrase, diuretic, hypoglycemic, anti thyroid or protease inhibitor activity. Among others also sulfacetamide sodium is an antibiotic which is being used for eye infections[7-10]. Besides the above, reports of Zn(II), Cu(II), Ni(II), Ce(III), Bi(III), Cd(II), Hg(II) and Sm(III), sulfonamide complexes can be found in the literature showing the versatility of sulfonamides as ligands and the importance of their complexes in coordination chemistry and medicinal chemistry [11-15].In addition, complexes like $M(sulfisoxazole)_2(H_2O)_4]2H_2O$ (with M = Cu(II)or Ni(II)) characterized by different physic-chemical techniques presented different microbiological behavior showing the role of the metal ion[16]. The presented work was devoted to elucidate the geometrical structures of new sulfactamide metal complexes and to check their biological activity.

II. Experimental

2.1 Materials and Methods

All of the chemicals and solvents employed in synthesis were of extra-pure grade and used as received without further purification. Sulfacetamide were obtained as gift sample from Epico-Pharm (Cairo Egypt),melting points were taken on(BI Bamtead Electothermal) and are uncorrected, TLC checked by VL-6-

LC. UV lampelemental analysis(C,H,N,S)was carried out at Fisons EA 1108 CHNS Micro analyzer. Metal ions concentrations were measured using ICP Perkin Elmer/Optima 7000.The UV spectra of compounds were recorded on UV- Vis. Spectrophotometer(UV-1700,Shimadzu).Molar conductance measurements were made in DMF at 25˚C ± 5˚C using a Systronics conductivity bridge model 305. Magnetic susceptibility was measured on powdered samples using the Sherward scientific magnetic susceptibility balance. The diamagnetic corrections were made by Pascal's constant and $Hg[Co(SCN)_4]$ was used as the calibrant. Mass spectral analysis were measured using Shimadazu Qp-2010 plus. Infrared spectra were recorded on a Perkin-Elmer FT-IR 1650 spectrophotometer in wave number region 4000-200 cm^{-1}asKBrpellet. TheH^1 NMR spectra were recorded using Mercury-300bb "NMR 300", using DMSO-as solvent and tetramethylsilane(TMS) as an internal standard. Antibacterial andantifungal activities measured at (The regional center for Mycology and Bitechnology, Al-Azhar University, Cairo, Egypt).

2.2Synthesis

Cesium complexwas prepared by adding a hot ethanolic solution of CsCl to sulfacetamide in the same solvent in equimolar ratio. The other metal complexes were prepared in 2:1 (ligand, metal molar ratio respectively) with vigorous stirring. The reaction refluxed for many hours until a colored(or sometimes white) precipitate was formed, washed several times, recrystallized and dried in a vacuum over anhydrous calcium chloride. The purity was checked by TLC and by melting point.

III. Results and discussion

Most of the 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. (Cr(III) and Pb (II)complexes were readily soluble in water).The analytical data showed that most of complexes had stoichiometry of the type $[ML_2 (H_2O)_2]$, (Table 1).

Table 1. Analytical and physical data(S:Sulfacetamide)

Compds. Symbol	Reactants		Products			
	Ligand	Metal salts	Color	M.P °C	Yield (%)	M. F. (M.wt)
S-Ca 2:1	Sulfacetamide	$CaCo_3$	White yellowish	186-188	85.5	$C_{16}H_{22}CaN_4O_8S_2$ (502.58)
S-Cd 2:1	Sulfacetamide	$CdSO_4.8H_2O$	White	>300	68.4	$C_{16}H_{22}CdN_4O_8S_2$ (574.91)
S-Ce 2:1	Sulfacetamide	$Ce(NO_3)_3{\cdot}6H_2O$	Yellow	>300	67.3	$C_{16}H_{20}CeN_5O_{10}S_2$ (646.60)
S-Cr 2:1	Sulfacetamide	$CrCl_3.6H_2O$	Green	197-199	86.8	$C_{16}H_{20}ClCrN_4O_7S_2$ (531. 93)
S-Cs 1-1	Sulfacetamide	CsCl	Brown	212-214	84.2	$C_8H_{13}CsN_2O_5S$ (382.17)
S- Fe(III) 2-1	Sulfacetamide	$Fe(NO_3)_3.9H_2O$	Deep orange	>300	83.7	$C_{16}H_{20}FeN_5O_{10}S_2$ (562.33)
S- Fe(II) 2-1	Sulfacetamide	$FeSO_4$	Deep orange	>300	81.7	$C_{16}H_{22}FeN_4O_8S_2$ (518.34)
S-Hg 2:1	Sulfacetamide	$Hg(NO_3)_2$	Pale brown	239-241	86.3	$C_{16}H_{22}HgN_4O_8S_2$ (663. 09)
S-Pb 2:1	Sulfacetamide	$Pb(NO_3)_2$	White	244-246	89.9	$C_{16}H_{22}N_4O_8PbS_2$ (669.70)

3.1 Elemental analyses of the complexes

The results of elemental analyses as shown in (Table 2) are in good agreement with those required by the proposed formula (calculated). Inductively coupled plasma (ICP) technique play an important role in elucidating the structure of the complexes, by determining metal ion concentration which also in good agreement with calculated metal ion concentration confirming presence of metal ion in coordination as proposed.

Table 2. Elemental analysis of the complexesCalcd./Found.

Compd. Symbol	C%	H%	N%	S%	M % (ICP)
S-Ca 2:1	38.24 38.34	4.41 4.85	11.15 11.18	12.76 12.62	7.97 8.11
S-Cd 2:1	33. 43 33.55	3.86 3.75	9.75 10.10	11.15 11.31	19.55 19.31
S-Ce 2:1	29.72 30.10	3.12 3.19	10. 83 10.65	9. 92 10.11	21.67 21.76
S-Cr 2:1	36.13 36.20	3.79 3.86	10.53 10.40	12. 06 12. 04	9.77 9.80
S-Cs 1-1	25.14 25.34	3.34 3.19	7.33 7.44	8.39 8. 29	34.78 34.82
S- Fe(III) 2-1	34.17 34.16	3.58 3.64	12.45 12.49	11.40 11.41	9.93 9.99
S- Fe(II) 2-1	37.07 37.22	4.28 4.17	10.81 10.80	12.37 12.41	10.77 10.80
S-Hg 2:1	28. 98 28.91	3.34 3.39	8.45 8.48	9. 76 9.70	30.25 30.29
S-Pb 2:1	28.70 28.96	3.31 3.24	8.37 8.46	9.58 9.63	30.94 31.08

3.2Infrared spectra

The IR spectra of the complexes were compared with those of the sulfacetamide and the previously reported complexes[3,4,17,18].The spectra of sulfacetamide compounds have numerous bands, as shown in (Table3) which summarizes the main bands and their proposed. The hydrated complexes exhibited an IR bands approximately around these bands at 3445, 834 cm^{-1} and 650–700cm^{-1} range due to ν(H_2O), suggestive of water molecules coordinated to the metal in the complexes, some of these bands corresponding to water molecule modes could not be assigned, due to the fact that they overlapped with some other signals. [19, 20]. The band of the carbonyl group (C = O) appears at1652- 1633 cm^{-1}, this shift respect to the free ligand, and pervious results of F.Blasco et.al indicating the involvement of this band in the coordination with metal[3,17]. The asymmetric and symmetric (SO_2) group stretching vibrations in the sulfonamides were observed at 1322-1311 and 1155-1144 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 small changes in the –SO_2group stretching vibrations can be due to the variations of the S–N bond to hydrogen bonding or condensation effects in the solid[18]. The coordination of N amino of secondary amine and O acetamido (carbonyl group) atoms is further supported by appearance of two non ligand bands at 552-537 cm $^{-1}$ and 424-418 cm $^{-1}$ due to υ metal-N and metal- O bonds respectively.Studies on the stretching vibrations of these bonds are important in elucidating the structure of the complexes [21,22]. Other bands like υC-H Ar appears around 2950 cm^{-1} and υC-H Al appears around 2800 cm^{-1},another bands such as C=C appears around 1500 cm $^{-1}$ [23]. The band υ(S-N) appears at 896-1024 cm^{-1} vibration [24].

Table 3. IR spectra of sulfacetamide metal complexes

Compounds/Bands	υN-H	υC=O	υSO_2as	υSO_2sym	υM-N	υM-O
S-Ca 2:1	3380 3256	1642	1322	1152	539	423
S-Cd 2:1	3392 3279	1652	1311	1147	550	423
S-Ce 2:1	3373 3246	1639	1314	1144	538	421
S-Cr 2:1	3401 3349	1646	1316	1155	547	421
S-Cs 1-1	3381 3302	1633	1314	1148	549	426
S- Fe(III) 2-1	3381 3257	1633	1322	1148	537	418
S- Fe(II) 2-1	3355 3287	1637	1319	1147	548	423
S-Hg 2:1	3366 3228	1633	1313	1144	550	418
S-Pb 2:1	3347 3238	1642	1319	1147	550	424

3.3 Molar conductivity measurements

By using the relation Λm= K/C, the molar conductance of the complexes (Λm) can be calculated. Where C is the molar concentration of the metal complex solutions, and K is specific conductivity of the complex. The chelates were dissolved in DMF and the molar conductivities of 10^{-4} M of their solutions at 25 ± 2 °C were measured. (Table 4) shows that low molar conductivity values of the complexes (Λm = 4.37–37.05 $\Omega^{-1}mol^{-1}$ cm^2) which indicate that these complexes are non-electrolytes [25].

3.4 Magnetic susceptibility measurements

The observed magnetic moments (Table 4) of Fe (III), Fe (II) complexes are 5.88,5.79 B.M. respectively. Thus, the complexes formed have octahedral geometry involving d^2sp^3 hybridization in the Fe ions [26].The magnetic moments values, μ_{eff} of the Ce(III)complex is 2.65 B.M., being consistent with mononuclear complex and free from antiferromagnetism [27]. The Cr (III) complex shows a magnetic moment corresponding to 3 unpaired electrons 3.89 B.M., which is approximately equal to a spin-only value [28]. The magnetic moments of remaining complexes, Cd, and Hg, show no d-d bands as expected for a d^{10} system and were found to be diamagnetic in nature. In case of the Ca and Cs complexes that contain only paired electron was found to be diamagnetic in nature. Also Pb complex is diamagnetic, these results agree with measured magnetic moments (μ_{eff}). On the basis of analytical, conductance, spectral data, and the magnetic moments values μ_{eff} , the prepared complexes were assigned an octahedral geometry except Cs complex which exhibited a tetrahedral geometry.

3.5 Electronic Spectra

Electronic spectra of complexes can provide valuable information related to bond and structure, since the colors are intimately related to the magnitude of the spacing between d-orbitals (e_g and t_{2g} or e and $t_2$orbitals in octahedral and tetrahedral complexes, respectively), which depends on factors such as the geometry of the complex, the nature of the ligands present and the oxidation state of the central metal atom[29]. The electronic spectra for all compounds were obtained (Table 4) in DMSO solution and showed absorption bands in three distinct regions. The first region ranging from 200 to approximately 249 nm, is characteristic for the electronic inter-ligand π→π* transitions correspond to (1La← 1A) transition C=C of the phenyl group [30], while the second characteristic wavelength in the region of 280 nm to approximately 350 nm is the second inter ligand n→π transition C=O [31]. The third distinct region ranging from 400 nm to approximately 500 nm is the characteristic for the ligand to metal charge transfer (LMCT) from the nitrogen atom to the transition metal centre [32]. The UV bands of SO_2 group merge to form a single strong absorption band around 260 nm. The sulfa drugs in general show two bands, one due to sulfanilamide part in the range 260-275 nm and the other due to R part in the range 300-310 nm. When the NH- proton is lost, the first band is affected while the coordination of R part affects the other band as well. If the drug acts simultaneously as an anion and coordinating ligand, both the bands are affected. The bands positions are considerably shifted from-their original positions (Table 4) indicating coordination of the neutral drug molecule or the drug anion to the metal [33].Spectrum of Fe (II) and Fe (III) complexes exhibited three bands in the region339–636 nm that are assignable for$^6A_{1g} \rightarrow {}^4T_{1g}$ $^6A_{1g} \rightarrow {}^4E_g$, $^4A_{1g}$ (G) and $^6A_{1g} \rightarrow {}^4E_g$(D) transitions [34] which can be assigned to transition characteristic of octahedral structure. Also this relatively stronger band around 340 nm due to L→M charge transfer,the low intensity band around λ_{max}=450 nm may be assigned to d-d transition[35]. In case of a d^{10} system, the present diamagnetic

complexes show no d-d transition in the visible region [36]. Cerium(III) complex shows a new absorption band at 453 nm which may be related to metal-ligand charge transfer excitations. The complexes have a coordination number 6 and may exist in octahedral geometries [37]. Chromium (III) complex shows three bands 588- 536, , 469- 410 and 260-290, similar to those observed for six coordinate chromium complexes. Assuming the octahedral stereo- chemistry, these bands can be assignedtoC_{2v} symmetry of six transitions respectively arising from the lifting of the degeneracy of the orbital triplet in octahedral symmetry I: $^4B_{1g} \rightarrow {}^4E_g$ ($^4T_{2g}$), 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)), [38].

Table 4. The UV-Vis. absorption spectra, molar conductance and magnetic moment of metal complexes

Compds. Symbol	λ_{max} ***nm***	**Λm** $\Omega^{-1}mol^{-1}cm^2$	**μeff. (B.M.)**	**Geometry**
S-Ca 2:1	638, 538, 468, 452 342, 300. 266, 229, 210.	5.41	Diamagnetic	Octahedral
S-Cd 2:1	748, 452, 417, 364, 341, 293. 262, 232, 221.	15.60	Diamagnetic	Octahedral
S-Ce 2:1	729, 638, 538, 453. 375, 350, 328. 261, 232, 218.	12.12	2.65	Octahedral
S-Cr 2:1	633, 588, 536, 469, 410. 375, 335, 274. 250, 212.	14.45	3.89	Octahedral
S-Cs 1-1	638, 538, 469. 304, 278. 251, 227.	5.66	Diamagnetic	Square planner
S- Fe(III) 2-1	730, 670, 636, 504, 461, 401. 341, 291, 276, 253, 245, 225.	22.91	5.88	Octahedral
S- Fe(II) 2-1	722, 633, 538, 467, 409, 339, 301, 275. 255, 238.	33.24	5.79	Octahedral
S-Hg 2:1	638, 600, 538, 467, 429. 363, 292. 255, 229.	4.18	Diamagnetic	Octahedral
S-Pb 2:1	712, 631, 535, 466. 340, 277. 262, 225.	6.84	Diamagnetic	Octahedral

3.6 Mass spectra analysis

The mass spectra of complexes are given in (Table 5), the molecular ion peaks are in good agreement with their empirical formula as indicated from elemental analyses. The other peaks represent fragments of the molecular ions.

Table 5.Mass spectral data of the compounds.

Compound symbol	**molecular ion (M^+) peak at m/z**	Relative intensity (%)
S-Ca 2:1	$[C_{16}H_{20}CaN_4O_8S_2]^+$ 502	71
S-Cd 2:1	$[C_{16}H_{22}CdN_4O_8S_2]^+$ 574	43
S-Ce 2:1	$[C_{16}H_{20}CeN_5O_{10}S_2]^+$ 646	55
S-Cr 2:1	$[C_{16}H_{21}ClCrN_4O_7S_2]^+$ 531	79
S-Cs 1-1	$[C_8H_{10}CsN_2O_4S]^+$ 382	86
S- Fe(III) 2-1	$[C_{16}H_{20}FeN_5O_{10}S]^+{}_2$ 562	85
S- Fe(II) 2-1	$[C_{16}H_{22}FeN_4O_8S_2]^+$ 518	75
S-Hg 2:1	$[C_{16}H_{22}HgN_4O_8S_2]^+$ 663	97
S-Pb 2:1	$[C_{16}H_{22}PbN_4O_8S_2]^+$ 669	99

3.7^{1}HNMR spectra

^{1} HNMR for diamagnetic complexes (Ca, Cd, Cs, Hg and Pb sulfacetamid) are shown in (Table 6).All the protons were found as expected in the spectra of complexes, the spectra of the complexes were examined in comparison with sulfacetamid ligand. The complexes give a duplet signals inthe region 6.43 - 7.62 ppm (d) for the aromatic protons. Singlet peaks appeared in the region of 1.82–1.89 ppm were attributed to the methyl group. The NH_2 protons give a singlet signals in the region 5.96 - 6.09 ppm (s) nearly not changed which reveals that this group is not involved in coordination. Cs complex has integration corresponding to 2 protons because it reacts in a molar ratio 1:1. N-H proton of secondary amine in ligand appears at 11.65 this group disappeared in complexes which confirm participating of this group in the coordination, by losing H proton in all complexes. These numbers of protons results give a good agreement with CHNS calculated and found results.

Table 6.Proton NMR spectral data of the diamagnetic complexes.

Compound	Chemical shift, (δ) ppm & Assignment
S-Ca 2:1	NH absent 6.43-7. 41 (d,8H, Aromaic rings) 6.01 (s,4H, NH_2) 1.82 (s,6H, CH_3)
S-Cd 2:1	NH absent 6.58-7.54 (d,8H, Aromaic ring) 6.09 (s,4H, NH_2) 1.87 (s,6H, CH_3)
S-Cs 1-1	NH absent 6.52-7.50 (d,4H, Aromaic ring) 5.98 (s,2H, NH_2) 1.88(s,3H, CH_3)
S-Hg 2:1	NH absent 6.58-7.48 (d,8H, Aromaic ring) 5.96 (s,4H, NH_2) 1.85 (s,6H, CH_3)
S-Pb 2:1	NH absent 6.43-7.62 (d,8H, Aromaic ring) 6.07 (s,4H, NH_2) 1.87(s,6H, CH_3)

3.8Biological Activity

This test was performed using the diffusion agar technique [39]. The sensitivity of a microorganism to antibiotics and other antimicrobial agents was determined by the assay plates, which were incubated at 28 °C for 2 days (for fungi) and at 37 °C for 1 day (for bacteria). Most of the tested compounds showed a promising biological activity against different types of Gram-positive and Gram-negative bacteria, and fungi. According to F.Blasc .et.al. The bacteriostatic agent of the Co, Ni, and Cu Sulfacetamide complexes be more efficient than sulfacetamide itself, which already similar to our results [3,17]. The data are listed in (Tables 7a,7b) 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, also this promising activity might have a possible antitumor effect since Gram-negative bacteria are considered a quantitative microbiological method for testing beneficial and important drugs, in both clinical and experimental tumor chemotherapy[40]. The mechanism of action of this complexes seems to be connected with the inhibition of phosphor mannose isomerase, a key enzyme in the bio- synthesis of yeast cell walls [41].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 (Tables 7a,7b).

Table 7a.Biological activity of metal complexes.

Sample / Tested Microorganisms	**S-Ca 2:1**	**S-Cd 2:1**	**S-Ce 2:1**	**S-Cr 2:1**	**S-Cs 1:1**	**St.**
Fungi						**Amphotericin B**
Aspergillus fumigates (RCMB 02568)	12.8 ± 0.34	14.3 ± 0.21	13.2 ± 0.63	20.4 ± 0.66	11.1 ± 0.12	23.7 ± 0.1
Candida albicans (RCMB 05036)	15.4 ± 0.53	16.1 ± 0.11	13.7 ± 0.55	19.7 ± 0.45	13.6 ± 0.22	25.4 ± 0.1
Gram positive bacteria						Ampicillin
SterptococcusPneumonie (RCMB 010010)	14.1 ± 0.52	18.2 ± 0.33	12.2 ± 0.15	21.5 ± 0.41	16.1 ± 0.85	23.8 ± 0.2
Bacillus subtilis (RCMB 010067)	12.7 ± 0.37	19.6 ± 0.43	15.8 ± 0.33	19.7 ± 0.38	17.7 ± 0.54	32.4 ± 0.3
Gram negative bacteria						Gentamicin
Pseudomonas aeruginosa (RCMB 010043)	11.6 ± 0.35	10.1 ± 0.12	11.2 ± 0. 22	12.3 ± 0.25	14.3 ± 0.77	17.3 ± 0.1
Escherichia coli (RCMB 01052)	9.1 ± 0.37	13.7 ± 0.65	11.3 ± 0.32	17.6 ± 0. 73	10.3 ± 0.18	19.9 ± 0.3

Table 7b.Biological activity of metal complexes.

Sample / Tested Microorganisms	**S-FeII 2-1**	**S-FeIII 2-1**	**S-Hg 2-1**	**S-Pb 2-1**	**St.**
Fungi					Amphotericin B
Aspergillus fumigates (RCMB 02568)	15.8 ± 0.32	16.9 ± 0.12	14.6 ± 0.52	19.8 ± 0.68	23.7 ± 0.1
Candida albicans (RCMB 05036)	19.1 ± 0.22	18.3 ± 0. 53	15.1 ± 0.48	17.9 ± 0.71	25.4 ± 0.1
Gram positive bacteria					Ampicillin
SterptococcusPneumonie (RCMB 010010)	14.1 ± 0.34	13.7 ± 0.77	14.7 ± 0.52	18.4 ± 0.62	23.8 ± 0.2
Bacillus subtilis (RCMB 010067)	13.7 ± 0.89	10.5 ± 0.74	14.3 ± 0.58	14.9 ± 0.36	32.4 ± 0.3
Gram negative bacteria					Gentamicin
Pseudomonas aeruginosa (RCMB 010043)	11.6 ± 0.94	9.9 ± 0.78	13.2 ± 0.47	13.6 ± 0.42	17.3 ± 0.1
Escherichia coli (RCMB 01052)	9.4 ± 0.66	10.6 ± 0.45	9.6 ± 0.48	11.8 ± 0.31	19.9 ± 0.3

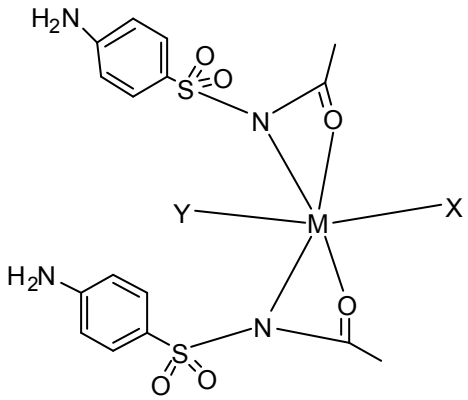
I. Conclusion

Based on the above discussions, the prepared complexes showing promising antimicrobial activity and we propose this structure for these complexes.

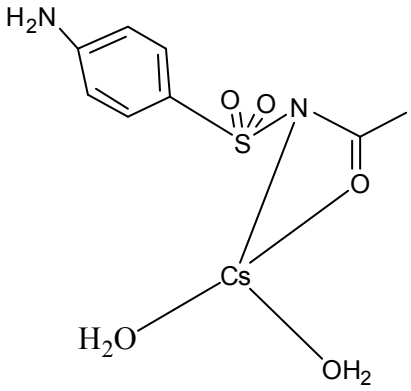
M= Ca, Cd, Fe(II), Hg or Pb (X= Y= H_2O)

M=Cr, (X= H_2O, Y= Cl)

M= Ce or Fe(III) (X= H_2O, Y= NO_3)



In case of Cs complex the structure proposed is.



References

[1] Connor EE, Prim Care Update Ob/Gyns5,32 1998.
[2] Bult A,Met Ions Biol Sys,16(261),1982.
[3] Blasco F, Perello L, Latorre, J, Borra, J, Garcia Granda SJ,Inorg. Biochem, 61(143), 1996.
[4] FerrerS, Borras J, Garcia-Esparia, E J InorgBiochem, 39(297)1990.
[5] Supuran CT, Minicione F, Scozzafav A, Briganti F, Minicinone G, Ilises M.A, Eur J Med Chem, 33 (247),1998.
[6] Kiasen H, Burns J, 26 (117),2000.
[7] Chohan ZH, Mahmood-Ul-Hassan K, Khan M, Supuran CT, J. Enzyme Inhib.MedChem, 20(2), 2005,183
[8] Bellú S, Hure E, Trapé M, TrosseroC,Molina G, Drogo C, Williams PAM, Atria AM, Muñoz Acevedo JC, Zacchino S, Sortino M, Campagnoli D, Rizzotto M, Polyhedron, 24 (501),2005.
[9] Huang Z, Lin Z, Huang J, Eur J Med Chem, 36 (863),2001.
[10] Ilies M.A, Supuran CT, Scozzafava, A Metal based Drugs,7(2)2000.
[11] Chohan ZH, Pervez H, Rauf A, Khalid KM, Supuran CT, J Enzyme Inhib Med Chem, 21 (2),2006, 193.
[12] Joseph J, Nagashri K, BoomadeviJanaki G,Eur J Med Chem, 49 (151), 2012.
[13] Yang L, Yang X, Liu J, Li Y, Lou Q, Liu Q, Coord J Chem 56 (13), 2003,1131.
[14] Torre MH, Calvo S, Pardo H, Mombrú A, Coord J Chem, 58(6),2005,513.
[15] Macías B, Villa MV, García I, Castiñeiras A, Borrás J, Cejudo Marin R, InorgChimActa, 342 (241), 2003.
[16] Mondelli M, Bruné V, Borthagaray G, Ellena J, Nacimiento OR, Leite CQ, Batista AA, Torre MH, Inorg J Biochem,102 (285),2008.
[17] Blasco F, Ortiz R, Perello L, Borra´s J, Amigo J, Debaerdemaeker T J InorgBiochem, 53 ,1994,117-126.
[18] Borra´s E, Alzuet G, Borra ´s J, Server carrio J,.Castineiras A, Liu Gonzalez M, Sanz Ruiz F Polyhedron, 19, 2000,1859-1866.
[19] Nakamoto K Infrared and Raman Spectra of Inorganic and Coordination Compounds Part B, fifth ed, Wiley, New York, p 1–16 ,1997.
[20] Bhowmik P, Chattopadhyyay S, Drew MGB, Diaz C, Ghosh A Polyhedron, 29, 2010, 2637-2642.
[21] Nejo A A, Kolawole G A, Opoku AR, Muller C, and Wolowska J, Journal of Coordination Chemistry, 62 (21), 2009, 3411-3424.
[22] Emara AA, Saleh A A and Adly OM I,SpectrochimicaActa Part A, 68, 2007, 592–604.
[23] Khazaei A K, Zolfigol MA and Abedian N Iranian Polymer Journal, 10 (1), 2001,59-65.
[24] Garcıa Raso A, Fiol JJ, Martorell G, Lopez Zafra A, Quiros M Polyhedron, 16,1997, 613.
[25] Feng D and Wang B Transition Met Chem 18, 1993 ,101-103.
[26] Zhu DR, Song Y, Xu Y, Zhang Y, Raj SSS, Fun HK and You XZ Polyhedron, 19,2000, 2019- 2025.
[27] AbdElwahab Z H, Mashaly M M and Faheim AA Chem Pap, 59: 25(1),2005, 25—36.
[28] Dobrzanska, L, Wrzeszcz G, Grodzicki A and Rozpoch Polish F J Chem, 74,2000, 1017
[29] Huheey J, Keiter E, Keiter R, Inorganic Chemistry Principles of Structure and Reactivity Harper Collins, New York,1993.
[30] Chen W, Li Y, Cui Y, Zhang X, Zhu HL, Zeng Q ,Eur J Med Chem, 45,2010, 4473–4478.
[31] Creaven BS, Duff B, Egan DA, Kavanagh K, Rosair G, Thangella VR, Walsh M InorgChimActa 363 , 2010, 4048–4058.
[32] Raman N, Jeyamurugan R, Senthilkumar R, Rajkapoor B, Franzblau SG,Eur J Med Chem,45, 2010,5438–5451.
[33] K.K. Narang and J.K, Gupta, 45(21) , 1976.
[34] FiggisBN Introduction to Ligand Fields, Wiely New York, p98,1976.
[35] Erdem E, Sari EY, Arslan RK and KabayN ,Transition Met Chem,34, 2009, 167–174.
[36] Mohammad NasirUddin, Abdus Salam Md, Jannat Sultana , Modern Chemistry,3(1), 2015,7-14.
[37] Abd El-Wahab Z H, Mashaly MM, Salman AA, El Shetary BA, Faheim AA SpectrochimActa Part A 60,2004, 2861.
[38] Alaghaz AMA, AmmarRA,Eur J Med Chem, 45, 2010,1314–1322.
[39] Singh HL, Singh JB and Sharma KP () 38,2012,53-65
[40] Gehad G M, Mohamed MO, Ahmed M HTurk J Chem30,2006,361 – 382.
[41] Louie AY, Meade TJ ,Chem Rev, 99,1999,2711 -2734.