



ISSN Print: 2394-7500  
 ISSN Online: 2394-5869  
 Impact Factor: 5.2  
 IJAR 2019; 5(1): 491-495  
[www.allresearchjournal.com](http://www.allresearchjournal.com)  
 Received: 09-11-2018  
 Accepted: 11-12-2018

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## Formation and description of the coordination compounds of N-(2-hydroxymethylphenyl)-C-(3'-carboxy-2'-hydroxyphenyl) thiazolidin-4-one

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### Abstract

A dry benzene solution of the Schiff base N-(2-hydroxymethylphenyl)-3'-carboxy-2'-hydroxybenzylideneimine upon reacting with mercaptoacetic acid undergoes cyclization and forms N-(2-hydroxymethylphenyl)-C-(3'-carboxy-2'-hydroxyphenyl) thiazolidin-4-one, LH<sub>3</sub> (I). A MeOH solution of I reacts with Co(II), Ni(II), Cd(II), Zr(OH)<sub>2</sub>(IV), and UO<sub>2</sub>(VI) ions and forms the monomeric coordination compounds, [M(LH)(MeOH)<sub>3</sub>] [where M = Co(II), Ni(II)], [M'(LH)(MeOH)] [here M' = Cd(II), UO<sub>2</sub>(VI)] and [Zr(OH)<sub>2</sub>(LH)(MeOH)]. The coordination compounds have been characterized on the bases of elemental analyses, molar conductance, molecular weight, spectral (IR, NMR, and reflectance) studies, and magnetic susceptibility measurements. I behaves as a dibasic tridentate OOS donor ligand in these compounds. The compounds are nonelectrolytes ( $A_M = 3.8-8.9$  mho cm<sup>2</sup> mol<sup>-1</sup>) in DMF.

**Keywords:** Parental attitude, participation, sports, girls

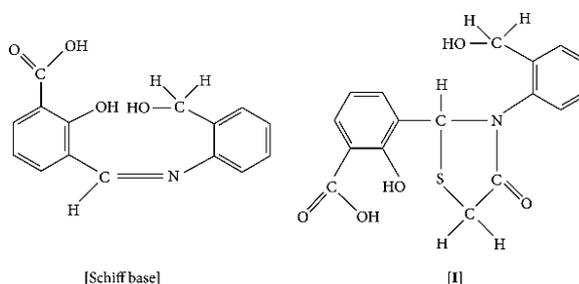
### 1. Introduction

The chemistry of thiazolidin-4-ones has been studied extensively due to their versatile biological properties<sup>[1]</sup>. Thiazolidin-4-ones, a saturated form of thiazole with carbonyl group on fourth carbon<sup>[2]</sup>, have biological activities like those that are antipsychotic<sup>[3]</sup>, antitubercular<sup>[4]</sup>, antibacterial<sup>[5]</sup>, anticonvulsant<sup>[6]</sup>, antifungal<sup>[7]</sup>, amoebicidal<sup>[8]</sup>, antioxidant<sup>[9]</sup>, antibiotic<sup>[10]</sup>, and so forth.

Literature survey shows that much of them has been reported on the syntheses and<sup>[11]</sup> of a variety of thiazolidin-4-ones, but very less is known about their coordination compounds<sup>[12-14]</sup>. Metal complexes play an important role in plant and animal life due to their physicochemical and biological properties. Metal ions are involved in specific interactions with antibiotics, proteins, nucleic acids, and other biomolecules<sup>[15]</sup>. Most of the drugs have improved pharmacological properties in the form of their metal complexes. Transition metal ions play a very important role in the pharmacological action of metal-based drugs and these drugs are more effective against infectious microbes than the uncomplexed drugs<sup>[16]</sup>.

These facts motivate us to explore the coordination behavior of a newly synthesized thiazolidin-4-one with some transition metal ions.

In this paper, we describe the of N-(2-hydroxymethylphenyl)-C-(3'-carboxy-2'-hydroxyphenyl)thiazolidin-4-one, LH<sub>3</sub> (I) and its coordination compounds with Co(II), Ni(II), Cd(II), Zr(OH)<sub>2</sub>(IV), and UO<sub>2</sub>(VI) ions. The structure of Schiff base and thiazolidin-4-one, LH<sub>3</sub> (I) is shown in Figure 1.



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## 2. Experimental

2.1. Materials. *o*-Aminobenzylalcohol [Aldrich]; nickel(II) acetate tetrahydrate, cadmium(II) acetate dihydrate, dioxouranium (VI) acetate tetrahydrate (Sarabhai); cobalt(II) acetate tetrahydrate, hexadecaquaoctahydroxotetrazirconium (IV) chloride (BDH); methanol, ethanol, mercaptoacetic acid, dry benzene, and sodium bicarbonate (Ranbaxy) were used as supplied for the syntheses. 3-Formylsalicylic acid [17] and hexadecaquaoctahydroxotetrazirconium (IV) acetate [18] were synthesized by the following reported procedures.

2.3. Synthesis of the *N*-(2-hydroxymethylphenyl)-3'-carboxy-2'-hydroxybenzylidene-neimine (Schiff Base). A MeOH solution (30 mL) of *o*-aminobenzylalcohol (1.23 g, 10 mmol) was added to a MeOH solution (30 mL) of 3-formylsalicylic acid (1.66 g, 10 mmol) and the mixture was then refluxed for 1 h. The precipitates formed were suction filtered, washed with MeOH, and dried in *vacuo* at room temperature over silica gel for 24 h. Yield = 58%. The elemental analyses of the compound gave the satisfactory results.

2.4. Synthesis of *N*-(2-hydroxymethylphenyl)-C-(3'-carboxy-2'-hydroxyphenyl)thiazolidin-4-one (I). A dry benzene solution of the Schiff base (2.71 g, 10 mmol) and

mercaptoacetic acid (0.92 g, 10 mmol) were refluxed for 12h in a water bath. The mixture was cooled to room temperature and then was washed with 10% NaHCO<sub>3</sub> solution. The benzene layer was separated by using a separating funnel. The partial evaporation of the benzene layer gave a solid product, which was filtered, washed with petroleum ether and recrystallized from petroleum ether. The compounds were dried as mentioned above. Yield = 14%. Anal: (I, C<sub>17</sub>H<sub>15</sub>NO<sub>5</sub>S) (obsd: C, 58.91%; H, 4.37%; N, 4.12%; S, 9.11%. calc.: C, 59.13%; H, 4.35%; N, 4.06%; S, 9.28%); IR bands (KBr): 2860 cm<sup>-1</sup> [ν(O-H)(intramolecular H-bonding)], 1710 cm<sup>-1</sup> [ν(C=O)(thiazolidinone ring)], 1675 cm<sup>-1</sup> [ν(C=O)(carboxylic)], 1570 cm<sup>-1</sup> [ν(C-N)(thiazolidinone ring)], 1520 cm<sup>-1</sup> [ν(C-O)(phenolic)], 1225 cm<sup>-1</sup> [ν(C-O)(alcoholic)], and 830 cm<sup>-1</sup> [ν(C-S)(thiazolidinone ring)].

2.5. Syntheses of Coordination Compounds of I. A MeOH solution (30-50 mL) of the appropriate metal salt (10 mmol) was added to a MeOH solution (50 mL) of I (3.45 g, 10 mmol) and the mixture was then refluxed for 3-4 h. The solid products formed were suction filtered, washed with MeOH and recrystallized from MeOH and were then dried as mentioned above. Yield = 50-75%.

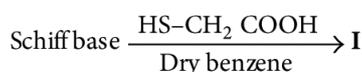
**Table 1:0** Analytical, molar conductans (Δ<sub>M</sub>), and molecular weight data of I and its coordination compounds

Compound	Mol. formula	Δ (mho cm <sup>2</sup> Mol <sup>-1</sup> )	Mol. wt obsd (calcd)	Obsd (calcd)9%				
				M	C	H	N	S
LH <sub>3</sub> (I)	C <sub>17</sub> H <sub>15</sub> NO <sub>5</sub> S	-	345 <sup>a</sup> (345.0)	-	58.91 (59.13)	4.37 (4.35)	4.12 (4.06)	9.11 (9.28)
[Co(LH)(MeOH) <sub>3</sub> ]	CoC <sub>20</sub> H <sub>23</sub> NO <sub>8</sub> S	4.8	511.6 <sup>b</sup> (497.9)	11.64 (11.83)	48.37 (48.20)	5.10 (5.02)	2.74 (2.81)	6.32 (6.43)
[Ni(LH)(MeOH) <sub>3</sub> ]	NiC <sub>20</sub> H <sub>23</sub> NO <sub>8</sub> S	3.8	481.3 <sup>b</sup> (497.7)	11.56 (11.79)	48.17 (48.22)	5.17 (5.02)	2.72 (2.81)	6.28 (6.43)
[Cd(LH)(MeOH)]	CdC <sub>18</sub> H <sub>17</sub> NO <sub>6</sub> S	7.7	511.2 <sup>b</sup> (487.4)	23.17 (23.06)	44.50 (44.32)	3.53 (3.49)	2.72 (2.87)	6.49 (6.56)
[Zr(OH) <sub>2</sub> (LH)(MeOH)]	ZrC <sub>18</sub> H <sub>19</sub> NO <sub>8</sub> S	8.9	517.2 <sup>b</sup> (500.2)	18.06 (18.23)	43.34 (43.18)	3.74 (3.80)	2.85 (2.80)	6.32 (6.40)
[UO <sub>2</sub> (LH)(MeOH)]	UC <sub>18</sub> H <sub>17</sub> NO <sub>8</sub> S	6.8	659.5 <sup>b</sup> (645.0)	36.67 (36.90)	33.24 (33.49)	2.45 (2.64)	2.05 (2.17)	4.85 (4.96)

<sup>a</sup>Mass spectral data. <sup>b</sup>Rast method data.

**Table 2:** IR, reflectance spectral data (cm<sup>-1</sup>), and magnetic moments of the coordination compounds of I.

Compound	ν <sub>as</sub> (COO)	ν <sub>s</sub> (COO)	ν(C-O) (phenolic)	ν(C-S)	ν(C-O) (MeOH)	ν <sub>max</sub>	Mag. moment (B.M)
LH <sub>3</sub> (I)	-	-	1520	830	-	-	Diamagnetic
[Co(LH)(MeOH) <sub>3</sub> ]	1572	1358	1530	795	986	8700,13000,18550	4.75
[Ni(LH)(MeOH) <sub>3</sub> ]	1572	1352	1526	805	989	8980,15980,24900	3.14
[Cd(LH)(MeOH)]	1560	1347	1530	810	984	-	Diamagnetic
[Zr(OH) <sub>2</sub> (LH)(MeOH)]	1562	1337	1530	815	974	-	Diamagnetic
[UO <sub>2</sub> (LH)(MeOH)]	1567	1349	1529	810	980	-	Diamagnetic



**Scheme 1:** Preparative scheme of LH<sub>3</sub>(I).

## 3. Results and Discussion

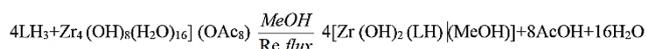
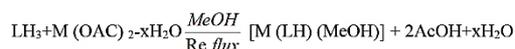
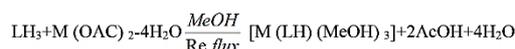
A dry benzene solution of the Schiff base reacts with mercaptoacetic acid and forms *N*-(2-hydroxymethylphenyl)-C-(3'-carboxy-2'-hydroxyphenyl)thiazolidin-4-one, LH<sub>3</sub> (I). The reaction of I with appropriate metal salt in 1 : 1 molar ratio in MeOH produces the coordination compounds, [M(LH)(MeOH)<sub>3</sub>] [where M = Co(II)], [M'(LH)(MeOH)] [where M' = Cd(II)], and [Zr(OH)<sub>2</sub>(LH)(MeOH)]. The formations of I from the Schiff base and the coordination compounds of I take place according to Schemes 1 and 2.

The coordination compounds are air-stable at room temperature. They are insoluble Highly polar in H<sub>2</sub>O, partially soluble in slightly polar molecules MeOH, EtOH, and completely soluble in DMSO and DMF. Their molar

conductance measurements (Λ<sub>M</sub> = 3.8-8.9 mho cm<sup>2</sup> mol<sup>-1</sup>) in DMF indicate their nonelectrolytic nature. The analytical data of I and its coordination compounds are presented in Table 1.

3.1. Infrared Spectral Studies. The infrared spectra of I and its coordination compounds were recorded in KBr and the prominent peaks (in cm<sup>-1</sup>) are shown in Table 2. The Schiff base exhibits the ν(C=N) (azomethine) stretch at 1640 cm<sup>-1</sup>. This band disappears in I and a new band appears at 1570 cm<sup>-1</sup> due to the ν(C-N)(thiazolidinone ring) stretch [19] indicating the conversion of the Schiff base into I. The formation of I is further supported by the appearance of a new band at 830 cm<sup>-1</sup> due to the ν(C-S) (thiazolidinone ring) stretch [20]. A negative shift of 15-35 cm<sup>-1</sup> of the ν(C-S) (thiazolidinone ring) stretch in the coordination compounds indicates the involvement of the S atom of the thiazolidinone moiety in coordination [14]. I shows the ν(C=O) (thiazolidinone ring) stretch [20] at 1710 cm<sup>-1</sup>. This band remains unchanged in the coordination compounds

indicating the noninvolvement of O atom in the coordination. The  $\nu(\text{C-O})$  (alcoholic) stretch <sup>[21]</sup> of I occurs at  $1225\text{ cm}^{-1}$  which remains unchanged in the complexes. I exhibits a strong band at  $2860\text{ cm}^{-1}$  due to the intramolecular H-bonded OH group of phenolic and/or carboxylic acid moieties <sup>[22]</sup>. This band disappears in the coordination compounds indicating the breakdown of H-bonding and subsequent deprotonation of the OH group followed by the involvement of phenolic and carboxylic acid O atoms in coordination. The presence of a broadband at  $\sim 3400\text{ cm}^{-1}$  due to  $\nu(\text{O-H})$  (MeOH) and the decrease of  $\nu(\text{C-O})$  (MeOH) stretch from  $1034\text{ cm}^{-1}$  to lower energy by  $45\text{--}60\text{ cm}^{-1}$  in the coordination compounds of I indicate the



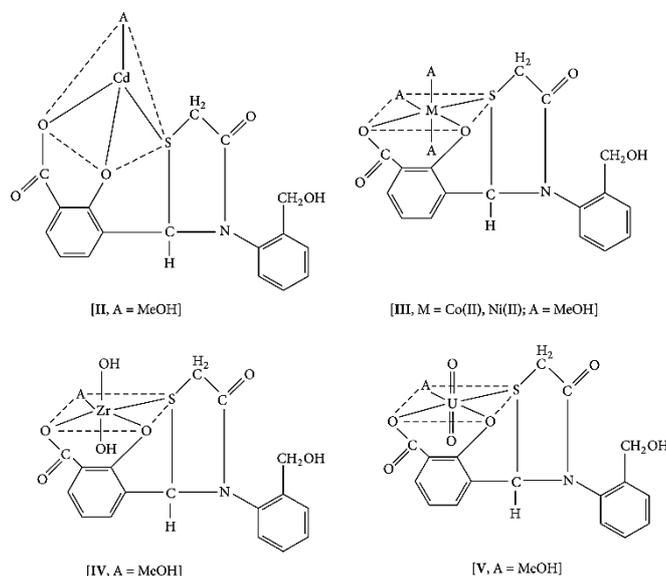
**Scheme 2:** Preparative scheme of coordination compounds of  $\text{LH}_3$  (I).

involvement of the O atom of MeOH in coordination <sup>[23]</sup>. The appearance of two new bands between  $1560\text{--}1572\text{ cm}^{-1}$ ,  $\nu_{\text{as}}(\text{COO})$  and  $1337\text{--}1358\text{ cm}^{-1}$ ,  $\nu_{\text{s}}(\text{COO})$  stretches indicates the presence of the coordinated carboxylate group in the coordination compounds. The energy difference ( $\Delta\nu = 213\text{--}225\text{ cm}^{-1}$ ) between these stretches is  $>210\text{ cm}^{-1}$  which indicates the monodentate nature of the carboxylate moiety [24]. The  $\nu(\text{C-O})$  stretch of I occurs at  $1520\text{ cm}^{-1}$ . This band shifts to higher energy by  $6\text{--}10\text{ cm}^{-1}$  in the coordination compounds indicating the involvement of phenolic O atom of 3-formylsalicylic acid moiety in coordination <sup>[23]</sup>. The absence of a band between  $835\text{--}955\text{ cm}^{-1}$  due to the  $\nu(\text{Zr=O})$  stretch [25] in the present  $\text{Zr}(\text{OH})_2(\text{IV})$  compound suggests its formulation as  $[\text{Zr}(\text{OH})_2(\text{LH})(\text{MeOH})]$  and not as  $[\text{Zr}(\text{O}(\text{H}_2\text{O})(\text{LH})(\text{MeOH}))]$  [25]. The presence of a broadband at  $3440\text{ cm}^{-1}$  due to  $\nu(\text{OH})$  stretch and the appearance of a new medium intense band at  $1135\text{ cm}^{-1}$  due to the  $\delta(\text{Zr-OH})$  bending mode [26] also support the proposed structure of the present  $\text{Zr}(\text{OH})_2(\text{IV})$  compound.  $[\text{UO}_2(\text{LH})(\text{MeOH})]$  exhibits the  $\nu_{\text{as}}(\text{O=U=O})$  stretch at  $898\text{ cm}^{-1}$  and this band occurs in the usual range ( $870\text{--}950\text{ cm}^{-1}$ ) observed for the majority of *trans*- $\text{UO}_2(\text{VI})$  compounds [27]. The force constant ( $f_{\text{U-O}}$ ) and U-O bond length in the present dioxouranium(VI) compound are  $6.70\text{ mdyne/\AA}$  and  $1.74\text{ \AA}$ , respectively. These values are in the expected range ( $6.58\text{--}7.03\text{ mdyne/\AA}$  and  $1.60\text{--}1.92\text{ \AA}$ ) reported for the majority of  $\text{UO}_2(\text{VI})$  compounds [26]. The new nonligand bands in the present coordination compounds in the low-frequency region are assigned to the  $\nu(\text{M-O})$  ( $550\text{--}570\text{ cm}^{-1}$ ) and the  $\nu(\text{M-S})$  ( $345\text{--}375\text{ cm}^{-1}$ ) and these bands [28] are in the expected order of increasing energy:  $\nu(\text{M-S}) < \nu(\text{M-O})$ .

**3.2. NMR Spectral Studies.** The NMR spectra of I and its coordination compounds were recorded in  $\text{DMSO-d}_6$ . The chemical shifts ( $\delta$ ) are expressed in ppm downfield from TMS. The prominent resonance signals of these compounds were compared with the reported peaks [30]. I exhibits a singlet at  $\delta 17.5\text{ ppm}$  due to the carboxylic proton, a sharp singlet at  $\delta 13.60\text{ ppm}$  due to phenolic proton, a singlet at  $\delta 2.35\text{ ppm}$  due to alcoholic proton, multiplets due to methylene protons at  $\delta 4.70\text{--}4.79\text{ ppm}$ , and multiplets between  $\delta 7.34$  and  $7.50\text{ ppm}$  due to the aromatic protons.

The occurrence of the resonance signal at the same frequency ( $\delta 2.35\text{ ppm}$ ) due to alcoholic proton ( $\text{CH}_2\text{OH}$ ) indicates the noninvolvement of the alcoholic group in coordination. The absence of the signal at  $\delta 17.5\text{ ppm}$  due to the  $\text{COOH}$  proton in the coordination compounds indicates the deprotonation of the  $\text{COOH}$  group, followed by the involvement of its O atom in coordination. The absence of the resonance signal at  $\delta 13.60\text{ ppm}$  due to the phenolic proton in the coordination compounds indicates the deprotonation of the phenolic OH group followed by its involvement in coordination [23]. The appearance of resonance signals at  $2.81\text{--}2.85\text{ ppm}$  due to alcoholic proton and at  $3.0\text{--}3.1\text{ ppm}$  due to methyl protons in the coordination compounds supports the presence of MeOH in these compounds.

**3.3. Reactance Spectral Studies.** The presence of three bands at  $8700$ ,  $13000$ , and  $18550\text{ cm}^{-1}$  due to  ${}^4\text{T}_{1g}(\text{F})$ ,  ${}^4\text{T}_{2g}(\text{v}_1)$ ,  ${}^4\text{T}_{1g}(\text{F})$ ,  ${}^4\text{A}_{2g}(\text{v}_2)$ , and  ${}^4\text{T}_{1g}(\text{F})$ ,  ${}^4\text{T}_{1g}(\text{v}_3)$  transitions, respectively, suggests an octahedral arrangement of I around Co(II) ions in  $[\text{Co}(\text{LH})(\text{MeOH})_3]$  [31]. The value of  $\nu_3/\nu_1$  (2.13) lies in the range  $2.00\text{--}2.80$ , reported for most of the octahedral Co(II) compounds [30]. The spectral parameters [30–32] for  $[\text{Co}(\text{LH})(\text{MeOH})_3]$  are  $Dq=979\text{ cm}^{-1}$ ,  $B' = 729\text{ cm}^{-1}$ ,  $\beta=B'/B=0.75$ ,  $\beta^0 = 25\%$ , and  $\text{CFSE} = -93.57\text{ kJ mol}^{-1}$ . Reduction of Racah parameter from  $971\text{ cm}^{-1}$  (free ion value) to  $729\text{ cm}^{-1}$  and the  $\beta^0$  value (25%) indicate the covalent nature of the compound and strong field nature of I [20].  $[\text{Ni}(\text{LH})(\text{MeOH})_3]$  shows three bands at  $8980$ ,  $15980$ , and  $24900\text{ cm}^{-1}$  due to  ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{2g}(\text{F})(\text{V}_1)$ ,  ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{1g}(\text{F})(\text{V}_2)$ , and  ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{1g}(\text{P})(\text{V}_3)$  transitions, respectively, in an octahedral symmetry [31]. The value of  $\nu_2/\nu_1$  is 1.78 which lies in the usual range ( $1.60\text{--}1.82$ ), reported for the majority of octahedral Ni(II) compounds. The spectral parameters [31, 32] for  $[\text{Ni}(\text{LH})(\text{MeOH})_3]$  are  $Dq=898\text{ cm}^{-1}$ ,  $B'=843\text{ cm}^{-1}$ ,  $\beta=B'/B=0.82$ ,  $\beta^0=18\%$ , and  $\text{CFSE}=-128.75\text{ kJ mole}^{-1}$ . The reduction of the Racah parameter from the free ion value ( $1030\text{ cm}^{-1}$ ) to  $843\text{ cm}^{-1}$  and the  $\beta^0$  value (18%) are indicative of the presence of covalent nature of the compound and the strong field nature of the tridentate ligand (I) [19]. For a given ligand and given stereochemistry, the covalent character of the corresponding Co(II) and Ni(II) coordination compounds is comparable since Co(II) and Ni(II)



occupy the adjacent positions in the nephelauxetic metal ion series (i.e., Co(II) ~ Ni(II))<sup>[19]</sup>. In the present Co(II) and Ni(II) coordination compounds, the  $\beta^0$  values are quite comparable: [Co(LH)(MeOH)<sub>3</sub>]: 25%; [Ni(LH)(MeOH)<sub>3</sub>]: 18%. For a given ligand and given stereochemistry, the spectrochemical series of metal ions on the basis of increasing 10 Dq values is Ni(II) < Co(II). Our calculated 10 Dq values indicate that the 10 Dq values are in the expected order: Ni(II) < Co(II). The greater negative CFSE value (−128.75 kJ mol<sup>−1</sup>) for [Ni(LH)(MeOH)<sub>3</sub>] in comparison to that of [Co(LH)(MeOH)<sub>3</sub>] (CFSE = −93.57 kJ mol<sup>−1</sup>) is as expected [34].

**3.4. Magnetic Measurements:** The room temperature magnetic moments of the coordination compounds of I are presented in Table 2. The magnetic moments of [Co(LH)(MeOH)<sub>3</sub>] and [Ni(LH)(MeOH)<sub>3</sub>] are 4.75 and 3.14 B.M., respectively. These values are indicative of the magnetically dilute high-spin octahedral coordination compounds of Co(II) and Ni(II) ions<sup>[35]</sup>. The coordination compounds of other ions are diamagnetic.

### Conclusion

Thus, on the basis of analytical data, valence requirements, molecular weight, spectral and the magnetic studies, it is proposed that I behaves as a dibasic tridentate OOS donor ligand in the tetrahedral compound, [Cd(LH)(MeOH)] (II) and in the octahedral compounds, [M(LH)(MeOH)<sub>3</sub>] [where M=Co(II), Ni(II)], (III), [Zr(OH)<sub>2</sub>(LH)(MeOH)] (IV) and for [UO<sub>2</sub>(LH)(MeOH)] (V), as shown in Figure 2.

### References

1. Abhinit M, Ghodke M, Pratima NA. Exploring potential of 4-thiazolidinone: a brief review, *International Journal of Pharmacy and Pharmaceutical Sciences* 2009;1:47-64.
2. Horton DA, Bourne GT, Smyth ML. The combinatorial synthesis of bicyclic privileged structures or privileged substructures, *Chemical Reviews* 2003;103(3):893-930.
3. Hrib NJ, Jurcak JG, Bregna JG. 3[4-[1-(6-Fluorobenzo[b]thiophen-3-yl)-4-piperazinyl]butyl]-2, 5, 5-trimethyl-4-thiazolidinone: a new atypical antipsychotic agent for the treatment of schizophrenia, *Journal of Medicinal Chemistry* 1992;35(14):2712-2715.
4. Solanki A, Kishore K. Synthesis and antitubercular activity of some 4-thiazolidinones, *Asian Journal of Chemistry* 1994;6(3):177.
5. Choudhari BP, Mulwad VV. Synthesis of 1-(6-methylbenzofuran-2-yl)-3-aryl[4-( $\beta\beta$  substitutedethoxy) phenyl] propenones as marked antimicrobial agents, *Indian Journal of Chemistry* 2005;44:1074.
6. Gaikwad NJ, Agrawal SB. Substituted 4-thiazolidinones as anticonvulsants VII, *Indian Drugs* 1997;34(9):542-543.
7. Patel PV, Desai KR. Synthesis and anti-bacterial activity of new isoxazolines derivatives of 3,5-diaryl isoxazolines, *Oriental Journal of Chemistry* 2002;18(3):311.
8. Desai NC, Parekh BR, Thaker KA. Preparation of some important medicinal compounds. Thiosemicarbazones, thiadiazolines, 4-thiazolidinones and 5-arylidine derivatives as antibacterial and tuberculostatic agents, *Journal of the Indian Chemical Society* 1987;64(8):491-493.
9. Kato T, Ozaki T, Tamura Y, Suzuki M, Akima N. Ohi Novel calcium antagonists with both calcium overload inhibition and antioxidant activity. 2. Structure-activity relationships of thiazolidinone derivatives, *Journal of Medicinal Chemistry* 1999;42(16):3134-3146.
10. Ingle VS, Sawale AR, Ingle RD, Mane RA. Synthesis of new 4-thiazolidinones bearing potentially active heteryl moieties, *Indian Journal of Chemistry B*, 2001;40(2):124-128.
11. Junne SB, Wadje SS, Baig MMV, Vibhute YB. Novel heterocyclic schiff bases, 4-thiazolidinones and 2-azetidinones possessing antibacterial and antifungal activity, *International Journal of Chemical Sciences* 2007;5:2093.
12. Kumar D, Kumar A. Syntheses, magnetic and spectral studies on the coordination compounds of the polystyrene anchored thiazolidin-4-one, *E-Journal of Chemistry* 2012;9(4):2532-2539.
13. Rehab Al-Hasani AM, Sinan Al-byatti MM, Sarab Al Azawi MS. Synthesis, structural and biological studies of /3-(1, 3- benzothiazol-2-yl) - /4H- spiro[indole2,3-[1,3]thiazolidine]-2,/4(1H) dion with Cr (III), Mn(II), Co(II), Ni(II), Cu(II), and Zn(II) ions, *Engineering & Technology Journal* 2011;29(15):3067-3078.
14. Kumar D, Kumar A, Sharma J. Physico-chemical studies on the coordination compounds of thiazolidin-4-one, *Journal of Chemistry Article ID 870325* 2013, 7.
15. Anacona JR, Rodriguez I. Synthesis and antibacterial activity of cephalixin metal complexes, *Journal of Coordination Chemistry* 2004;57(15):1263-1269.
16. Anacona JR, Estacio J. Synthesis and antibacterial activity of cefixime metal complexes, *Transition Metal Chemistry* 2006;31(2):227-231.
17. Duff JC, Bills EJ. The solubility of picric acid in mixed solvents. Part II. Benzene-alcohol mixtures, *Journal of the Chemical Society* 1932, 881-884.
18. Syamal A, Kumar D. Syntheses of new zirconium (IV) complexes with the tridentate Schiff bases derived from oaminophenol and salicylaldehydes or 2-hydroxy-1-naphthaldehyde, *Indian Journal of Chemistry A* 1985;24:62.
19. Dutta RL, Syamal A. *Elements of Magnetochemistry*, Affiliated East-West Press, New Delhi, India, 2nd edition 1993.
20. Patel PV, Desai KR. Synthesis and anti-bacterial activity of new isoxazolines derivatives of 3,5-diaryl isoxazolines, *Oriental Journal of Chemistry* 2002;18(3):311.
21. Dash DC, Mahapatra A, Mahapatra RK, Ghosh S, Naik P. Synthesis and characterization of dioxouranium (VI), thorium (IV), oxozirconium (IV) and oxovanadium (IV) complexes with 1,11-dihydroxy-1,4,5,7,8,11-hexaaza-2,3,9,10-tetramethyl-1,3,8,10-decatetraene-6-thione and their derivatives with chloroacetic acid, *Indian Journal of Chemistry* 2008;47A:1009-1013.
22. Roy RU, Desai KR. Anticancer evaluation of azetidinone and thiazolidinone derivatives of quinolone, *International Journal of Chemical Sciences* 2005;3(3):529.
23. Syamal A, Singhal OP. New dioxouranium (VI) complexes with tridentate dibasic schiff bases

- containing ONO donor sets, Transition Metal Chemistry 1979;4(3):179-182,.
24. Syamal A, Kumar D. New zirconium (IV) complexes with the ons donor tridentate schiff bases derived from salicylaldehyde or substituted salicylaldehydes and 2-aminobenzothiol, Synthesis and Reactivity in Inorganic and Metal-Organic Chemistry 1984;14(3):325.
  25. Kumar D, Syamal A, Gupta A, Rani M, Gupta PK. Role of pH on the formation of the coordination compounds with the schiff base derived from 3-formylsalicylic acid and 4-amino-2,3-dimethyl-1-phenyl-3-pyrazolin-5-one, Journal of the Indian Chemical Society 2010;87(10):1185-1197.
  26. Anaconda JR, Toledo C. Synthesis and antibacterial activity of metal complexes of ciprofloxacin, Transition Metal Chemistry 2001;26(1-2):228-231.
  27. Kumar D, Syamal A, Kumar A, Gupta PK, Dass D. Syntheses and characterization of coordination compounds of N-(2-mercaptoethyl)-4-(3'-carboxy-2'-hydroxyphenyl)-2-azetidinone, Journal of the Indian Chemical Society 2010;87(4):417-423.
  28. Kumar D, Syamal A, Sharma LK. Synthesis and characterization of polystyrene-anchored monobasic bidentate schiff base and its complexes with bi-, tri-, tetra- and hexavalent metal ions, Journal of Coordination Chemistry 2008;61(11):1788-1796.
  29. Kumar D, Gupta PK, Kumar A, Dass D, Syamal A. Syntheses, spectroscopic, and magnetic properties of polystyrene-anchored coordination compounds of tridentate ONO donor schiff base, Journal of Coordination Chemistry 2011;64(4):590-599.
  30. Charasia MR. Cu(II), Ni(II) and Co(II) complexes of N-phenyl- benzothiazolyl thiocarbamide, Journal of Inorganic and Nuclear Chemistry 1975;37(6):1547-1548.
  31. Nag JK, Pal S, Sinha C. Synthesis and characterization of cobalt (II), nickel (II), copper (II), palladium (II) and dioxouranium (VI) complexes of the antipyrine schiff base of 3-formylsalicylic acid, Transition Metal Chemistry 2005;30(5):523-526.
  32. Lever ABP. Inorganic Electronic Spectroscopy, Elsevier, Amsterdam, The Netherlands, 2nd edition 1984.
  33. Syamal A, Kumar D, Singh AK, *et al.*, Syntheses and characterization of a chelating resin containing ONO donor tridentate Schiff Base and its coordination compounds with copper (II), nickel (II), cobalt (II), iron (III), zinc (II), cadmium (II), manganese (II), molybdenum (VI), zirconium (IV) and uranium (VI), Indian Journal of Chemistry 2002;41(7):1385-139.
  34. Huheey JE, Inorganic Chemistry, Principles of Structure and Reactivity, Harper and Row Publishers, New York, NY, USA, 3rd edition 1983.
  35. Cotton FA, Wilkinson G, Murillo CA, Bochmann M. Advanced Inorganic Chemistry, John Wiley, New York, NY, USA, 6th edition 1999.