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## Trigonal Pyramidal Pb (II) Complexes of Schiff bases of Orthoaminophenol: Synthesis, Characterization, and Antibacterial Evaluation

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**Abstract:** Some Pb(II) complexes of dibasic tridentate Schiff base ligands derived from aldehydes and orthoaminophenol have been synthesized and characterized by some physico-chemical studies; elemental, spectral (IR, UV, NMR, Mass), magnetic, and conductance analyses. The CHN elemental analysis data showed the formation of 1:1 [M:L] complexes. The obtained molar conductance values revealed non-electrolytic nature. The results of magnetic moment measurements supported diamagnetic phenomenon for the complexes. The infrared spectral data displayed the main coordination sites of ligands towards Pb<sup>2+</sup> ions. The electronic spectral results of the complexes showed  $\pi \rightarrow \pi^*$  (phenyl ring),  $n \rightarrow \pi^*$  (HC=N), CT transition. Based on analytical data Trigonal pyramidal geometry for the prepared complexes has been proposed. The antibacterial activity of the prepared complexes was also studied against some gram positive and gram negative bacteria. It was found that complexes are quite effective against some tested bacteria.

**Keywords:** Tridentate Schiff base, Orthoaminophenol, Pb(II) complexes, Antibacterial activity, Trigonal pyramidal geometry.

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### 1. INTRODUCTION

Schiff base is a compound that contains azomethine group ( $>C=N-$ ) connected to an aryl or alkyl group but not hydrogen. Schiff bases can be synthesized from an amine and a carbonyl compound by nucleophilic addition forming a hemi-aminal group followed by dehydration to generate an imine compound. A number of metal complexes with dibasic tridentate Schiff bases derived from various thiosemicarbazide hydrazides, *o*-hydroxybenzylamine or ethanolamine and *o*-hydroxy-aromatic aldehydes/ketones have been synthesized and characterized by Syamal *et al.* [1-3]. A number of authors [4-6] studied different aspects, physical characterization, spectroscopic and potentiometric investigations and antibacterial activity of several M (II) complexes including Mn, Ni, Fe, Zn, Cu and Co with the Schiff bases derived from 2-amino benzoic acid and salicylaldehyde. Metal Complexes with Ligands derived from aroylhydrazines and aromatic or aliphatic carbonyls gained a great interest of studies. Synthesis, characterisation and structural aspects of diorganotin(IV) complex with *N*-(5-bromo-2-hydroxybenzylidene) benzoylhydrazone [7] or *N*-(2-Salicylidene)-*N'*-benzoylhydrazone ligand [8]. Mn(II), Co(II), Ni(II), Cu(II), and Zn(II) metal complexes with NNO functionalized ligands, 2-acetyl pyridine benzoylhydrazone, etc. were synthesized and structures were elucidated by Jang *et al.* [9]. Mixed-ligand oxovanadium(IV) and oxovanadium(V) complexes incorporating the tridentate ONO donor Schiff base derived from acetylacetone and benzoylhydrazine were studied [10]. Chowdhury *et al.* [11] synthesized and characterized dioxo-uranium(VI) complexes of some aroylhydrazines and their Schiff bases with acetone.

Transition metal Schiff base complexes are used in various fields, such as medicine, agriculture, industries etc. Transition metal complexes derived from Schiff bases have been reported to have biological activity [4]. Pb(II) complex with the Schiff base derived from salicylaldehyde and *o*-phenylenediamine has been prepared and its geometry was investigated [12]. El-ajaily *et al.* [13] prepared Pb(II) complex with Schiff base derived from the reaction of salicylaldehyde and urea. Condensation and subsequent reaction with Pb(II) halides yielded complex of composition Pb[dbqdi], where dbqdi is 3,5-di-tertbutyl-1,2-quinone-1-(2-hydroxy-3,5-di-tert-butylphenyl)

imine anion [14]. Liu *et al.* [15] prepared [Pb (Saloph)] complex by electrochemical oxidation of anodic Pb from an acetonitrile solution of N,N-bis(salicylidene)-o-phenylenediamine. Shaker [16] presented a mixed-ligand Pb (II) complex with the general formula, [Pb(BT)(BI)<sub>2</sub>X<sub>2</sub>], where BT= Benzotriazole, BI= benzimidazole and X=SCN. Subudhi *et al.* [17] prepared Pb (II) complex of 4-(2-hydroxyphenylimino) phenyl sulphonamide and studied its antimicrobial activities. Synthesis, characterization, antimicrobial activity and electrochemical behaviours of lead(II) complexes of thiosemicarbazone ligands have been carried out [18]. Bhattacharyya *et al.* [19] synthesized a unique Pb(II) Schiff base complex where the ligand was tripodal Schiff base N[CH<sub>2</sub>CH<sub>2</sub>N=C(H)C<sub>6</sub>H<sub>3</sub>(OMe)-3-(OH)-2]<sub>3</sub>, having a distorted monocapped octahedron geometry. Lead (II) ion in the nicotinato lead(II) complex [Pb(C<sub>5</sub>H<sub>4</sub>NCOO)<sub>2</sub>] adopts 2-coordinate geometry, which is different from the 4-coordinate geometry of isonicotinato lead(II) complex [20].

The present work has been an attempt to study some of the Pb(II) complexes using some Schiff base ligands derived from aldehydes/ketones and orthoaminophenol. The chemical structure of the prepared complexes has been characterized by some physico-chemical studies and the antibacterial activity was studied against some gram positive and gram negative bacteria.

## 2. MATERIALS AND METHODS

### 2.1. Chemicals

2-hydroxy-1-naphthaldehyde, 2-hydroxyacetophenone and hydrazine hydrate were obtained from M/S. E. Merk (Germany). Salicylaldehyde, 2-aminophenol, benzoylacetone, methanol, chloroform, N, N-dimethylformamide (DMF), dimethylsulphoxide (DMSO) and carbon-tetrachloride were obtained from Aldrich Chemical Company Ltd. Perchloric acid, nitric acid, sulphuric acid and disodium salt of ethylenediaminetetraacetic acid were obtained from BDH Chemicals Ltd. All chemicals except solvent were used as received. Solvents were dried by standard methods and distilled under an inert atmosphere.

### 2.2. Analytical Methods

The analysis of the metal content, Pb(II) of the prepared complexes were obtained by Atomic Absorption Spectrophotometer (Model Thermo Scientific ICE-3000) from B.C.S.I.R. Laboratories, Chittagong. Microanalyses on CHN CORDER MT-5, Yanaco, were performed in Prof. Shiumyozu's Lab. in the Dept. of Applied Chemistry at Kyushu University, Japan. The Infrared spectra of the prepared complexes were obtained by FTIR spectrophotometer (Model-8900, Shimadzu, Japan) using KBr as the matrix in the range 400-4000 cm<sup>-1</sup> from B.C.S.I.R. Laboratories, Dhaka. Polystyrene was used as the standard to calibrate the spectrophotometer. Electronic absorption spectra were run on Shimadzu UV-Visible Recording Spectrophotometer (Model-1800) using 1 cm cell in the research laboratory of the Department of Chemistry, University of Chittagong. Mass spectra were obtained from Shiumyozu's Lab. in the Dept. of Applied Chemistry at Kyushu University, Japan, by Ultra-light Performance Mass Spectrometer (Model- JMS-HX 11 OA).

An electrothermal melting point apparatus was used for the determination of the melting or decomposition points of the complexes and the ligands.

Using N, N-dimethylformamide (DMF) as the solvent the solutions of the complexes (of the order of 10<sup>-3</sup> M) were used for conductivity measurements. Conductivity measurement was performed on a Philips Conductivity Meter (Model-HI 9255). Determination of conductivity of an electrolytic solution involves measuring of the electrical resistance of that solution at a particular temperature, usually 25°C.

Magnetic susceptibility of some of the prepared complexes was determined using the Sherwood Scientific Magnetic Susceptibility Balance from Rajshahi University, Bangladesh.

### 2.3. Schiff base Ligands of Orthoaminophenol

#### 2.3.1. Salicylaldehyde-orthoaminophenol, Sal-OAPH<sub>2</sub>:

A mixture of salicylaldehyde and orthoaminophenol (25 mmol each) in ethanol (70 mL) was stirred at 30°C for one hour when an orange red crystalline solid appeared. This was filtered off,

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washed with and recrystallized from ethanol. Similar preparation procedures yielded the Schiff bases listed in Table 1.

**Table 1.** Physical properties and infrared Spectral bands of the prepared Schiff base ligands

Ligands	Color	Yield %	M.P. (°C)	Infrared Spectral bands (cm <sup>-1</sup> )			
				$\nu_{C=N}$	$\nu_{C=C}$	$\nu_{C-N}$	$\nu_{C-O}$
Sal-OAPH <sub>2</sub>	Bright Orange	84	182-184	1631(vs)	1535(vs)	1362(ms)	1313(ms)
<sup>5</sup> BrSal-OAPH <sub>2</sub>	Brown	84	180-182	1583(s)	1518(w)	1345(ms)	1277(w)
Bzac-OAPH <sub>2</sub>	White	70	135-137	1598(w)	1505(ms)	1375 (w)	1257(ms)
HNP-OAPH <sub>2</sub>	Brown	80	248-250	1618(w)	1545(ms)	1357(w)	1271(ms)
HAP-OAPH <sub>2</sub>	Liquid						

### 2.4. Preparation of Lead(II) Complexes

For the preparation of various complexes of the Schiff base ligands, the metal ion, Pb<sup>2+</sup>, was used in the form of lead acetate trihydrate, Pb(CH<sub>3</sub>COO)<sub>2</sub>.3H<sub>2</sub>O. Pure and dry solvent was used in all the preparations.

White colored lead acetate trihydrate [Pb (CH<sub>3</sub>COO)<sub>2</sub>.3H<sub>2</sub>O] (10 mmol) was dissolved in ethanol (30 mL) with gentle warming. In another beaker, the prepared Schiff base ligand (10 mmol) was dissolved in the same solvent. The Pb(II) solution was then added to the ligand solution drop wise with continuous stirring. In some cases, immediate precipitation occurred on mixing of the components. In most cases, the mixture was refluxed for about two-three hours with continuous stirring by a magnetic stirrer to complete the reaction. Then the mixture was allowed to stand and the precipitate formed was filtered off. It was then washed with ethanol and dried over calcium chloride.

The other lead (II) complexes listed in Table 2 were prepared by following the same procedure as stated above.

**Table 2.** Some physical properties and analytical data of the prepared Schiff base complexes

Complexes	Color	M.P. (°C)	Elemental analysis (Calc.)				BM	$\lambda_m^\circ$ ohm <sup>-1</sup> cm <sup>2</sup> mol <sup>-1</sup>
			% M	% C	% H	% N		
[Pb(Sal-OAP)]	Yellow	>250	49.52 (49.52)					1.70
[Pb( <sup>5</sup> BrSal-OAP)]	Yellow	>250	38.60 (41.73)	31.50 (31.45)	1.68 (1.61)	2.78 (2.82)		2.74
[Pb(Bzac-OAP)]	Off. White	>250						3.45
[Pb(HNP-OAP)]	Orange	>300	46.48 (44.23)	43.38 (43.58)	2.40 (2.35)	2.94 (2.99)	Dia.	2.84
[Pb(HAP-OAP)]	Black	>250	36.86 (47.92)				Dia.	2.06

### 2.5. Evaluation of Chemicals Against Bacteria

For the detection of antibacterial activities and sensitivity spectrum analysis, the disc diffusion method by Chowdhury *et al.* [21, 22] was followed. Nutrient Agar (NA) was used as basal medium for culture of test bacteria and N, N-dimethylformamide (DMF) was used as the solvent to prepare the desired solution (1%) of the compounds initially.

Nutrient Agar (NA) medium was prepared using the composition Beef extract (3 gm), Peptone (5 gm), NaCl (0.5 gm), Agar (15 gm) and Distilled water (1000 mL). 1000 mL of distilled water was taken in a beaker and 15 gm of agar powder, 3 gm of beef extract, 5 gm of peptone and 0.5 gm of

NaCl were added slowly in and they were mixed thoroughly with a glass rod and then heated to boiling for 10 minutes. After 10 minutes of boiling, the medium was transferred in 250 mL conical flasks at the rate of 200 mL per flask. The conical flasks were closed with the cotton plugs and autoclaved at 121°C and 15 psi pressure for 15 minutes and then culturing of different micro-organisms was performed.

Sensitivity spectrum analysis: Paper discs of 5 mm diameter were soaked with 10 µL of 2% solution of the test complexes. 0.2 mL of the suspension of test organism was taken in sterilized glass Petri plates of 100 cm diameter and then the molted and cooled (45°C) NA medium was poured at the rate of 10 mL per Petri plate and shaken gently. Then the discs with test complexes were placed on the seeded agar plate. A control plate was also maintained in each case with solvent. The plates were kept firstly for 24 hours at low temperature (4°C) and the test complex diffused from the disc to the surrounding medium by this time. The plates were then incubated at 35±2°C for growth of test organisms and were observed at 24 hours interval for two days. The activity was determined by measuring the diameter of the zone of inhibition in mm.

### 3. RESULTS AND DISCUSSION

#### 3.1. On Preparation of Schiff Bases

Orthoaminophenol contains one hydroxyl group (-OH) and one amino group (-NH<sub>2</sub>) attached to the benzene ring at the ortho positions. When an active carbonyl group reacts with -NH<sub>2</sub> group of this compound, a Schiff base product containing the azomethine (>C=N-) functional group is obtained. Two series of Schiff base ligands were prepared using ethanol as the solvent. The ligands were washed properly but with minimum amount of solvent to protect the loss due to solubility. All the products were filtered under suction and dried in a desiccator over calcium chloride. Finally all ligands were preserved in a desiccator over silica gel.

Four dibasic tridentate Schiff bases were prepared by the condensation of 2-aminophenol (OAP) and salicylaldehyde (Sal), 5-bromosalicylaldehyde (<sup>5</sup>BrSal), 2-hydroxyacetophenone (HAP) and 2-hydroxy-1-naphthaldehyde (HNP) in their 1:1 molar ratio. The Sal-OAPH<sub>2</sub> ligand appeared as bright orange colored precipitate immediately after mixing of the ethanolic solutions of the component reagents. On the other hand, HNP-OAPH<sub>2</sub> and <sup>5</sup>BrSal-OAPH<sub>2</sub> were obtained as brownish precipitate. Due to high solubility of 2-hydroxyacetophenone, the HAP-OAPH<sub>2</sub> ligand couldn't be isolated in the solid state. Physical properties and IR spectral bands of the ligands are shown in Table 1.

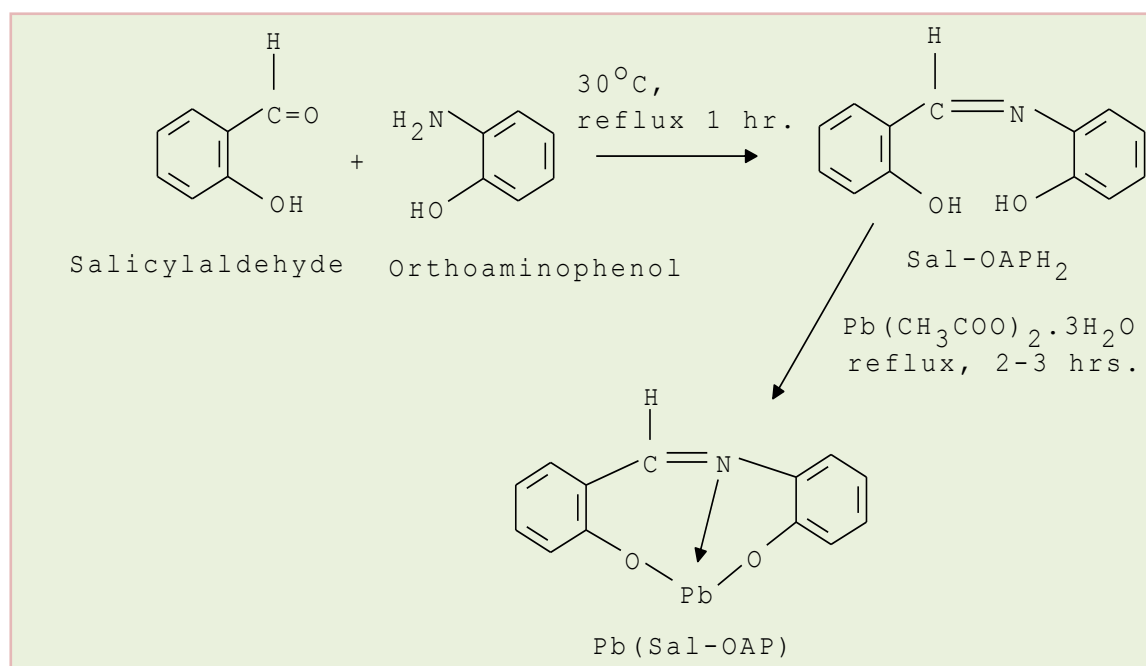
#### 3.2. On Preparation of Pb(II) Complexes

Pb (II) complexes of the dibasic tridentate Schiff bases were prepared by the reaction of 1:1 molar ratio of Pb(II) acetate trihydrate and the Schiff base solutions in ethanolic medium. Here all ligands acted as dinegative anion on removal of their two hydroxyl protons.

Due to high solubility, the HAP-OAPH<sub>2</sub> ligand couldn't be separated. In this case, the complex was prepared by the reaction of Pb<sup>2+</sup> solution with ligand solution in their 1:1 ratio. The reaction mixture was concentrated to half of its volume and the solution was kept in a refrigerator for a few days. After about a week very deep brown (almost black) precipitate was observed. The precipitate was separated out from the solution and preserved in a desiccator. A representative schematic diagram for the preparation of one of the Schiff base ligands and its Pb(II) complex is shown in Figure 1.

Most of the complexes are insoluble in methanol; some of them are moderately soluble in chloroform. The complexes of Sal-OAPH<sub>2</sub>, <sup>5</sup>BrSal-OAPH<sub>2</sub>, HAP-OAPH<sub>2</sub> and HNP-OAPH<sub>2</sub> ligands are moderately soluble in DMF. From elemental analysis it is observed that the values are in good agreement with those of calculated ones indicating the formation of the desired complexes with 1:1 metal-ligand ratio. Some physical properties, magnetic measurement data and conductance values of complexes are presented in Table 2.

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**Figure 1.** A representative schematic diagram for the preparation of one of the Schiff base ligands and its Pb(II) complex

### 3.3. Characterization of Complexes

#### 3.3.1. Infra-red Spectra

For the present systems, the infrared spectra of the metal complexes provide information about their formation in respect to the presence and coordination of the ligands. The absence of any O-H and N-H vibrations indicate the complexes to contain the dibasic tridentate Schiff base as the ligand. Comparison of the metal complex spectra with those for the free ligands themselves was most useful in rationalizing the infrared results and assigning of the various stretching modes. The tentative assignments of the characteristic infrared peaks of various complexes have been made empirically by comparison of the spectra of the corresponding ligands. Of the present compounds the infrared band assignments, that were made tentatively, are given in Table -3. Representative IR spectrum of [Pb(5BrSal-OAP)] has been given in Figure 2.

The  $\nu_{\text{O-H}}$ ,  $\nu_{\text{C=O}}$  (keto form),  $\nu_{\text{C=N}}$ ,  $\nu_{\text{C-N}}$ ,  $\nu_{\text{M-O}}$ ,  $\nu_{\text{N-H}}$  etc. stretching modes which are found in the ligands and their complexes have been identified by many authors [7,10]. It is a general observation that the spectral behavior of the free ligands changes by chelation but the interpretation of the band shifts depends on the attribution of the observed frequencies to the various bands, C-N, C-O etc.

The present Schiff base ligands contain the  $\nu_{\text{C=N}}$  modes. The peak between 1620 and 1580  $\text{cm}^{-1}$  have been assigned to  $\nu_{\text{C=N}}$  by Aliyu and Ado [4] and Johari *et al.* [5]. The bands appearing between 1520 and 1600  $\text{cm}^{-1}$  have been assigned to aromatic  $\nu_{\text{C=C}}$ . The  $\nu_{\text{C=N}}$  modes are often mixed with higher frequency  $\nu_{\text{C=C}}$  (near 1600  $\text{cm}^{-1}$ ) and are seen as a strong band. The bands appearing at 1315-1400  $\text{cm}^{-1}$  (specially the highest frequency ones near 1400  $\text{cm}^{-1}$ ) have been assigned to  $\nu_{\text{C-N}}$  mode. Aliyu and Ado [4] have assigned a band near 1400  $\text{cm}^{-1}$  to  $\nu_{\text{C-N}}$  for M(II) (M=Mn, Ni, Cu) Schiff base complexes. The  $\nu_{\text{C-O}}$  (Phenolic) stretching frequency of ligand seen at around 1380  $\text{cm}^{-1}$  gets shifted to a lower frequency region in the complexes in the range of 1372- 1326  $\text{cm}^{-1}$ , and this is indicative of bonding through the phenolic oxygen [6]. On the basis of these studies, the band observed for the present complexes in the regions of 1580-1670, 1520-1600, 1360-1401 and 1260-1300  $\text{cm}^{-1}$  have been assigned as due to  $\nu_{\text{C=N}}$ , aromatic  $\nu_{\text{C=C}}$ ,  $\nu_{\text{C-N}}$  and  $\nu_{\text{C-O}}$ , respectively. El-ajaily *et al.* [12,13] have prepared and investigated new Schiff base complexes of Cr(II), Pb(II) and TiO(IV) and observed new bands at 575-671  $\text{cm}^{-1}$  and 444-540  $\text{cm}^{-1}$  in the spectrum which were attributed to  $\nu_{\text{M-O}}$  and  $\nu_{\text{M-N}}$  vibration's respectively

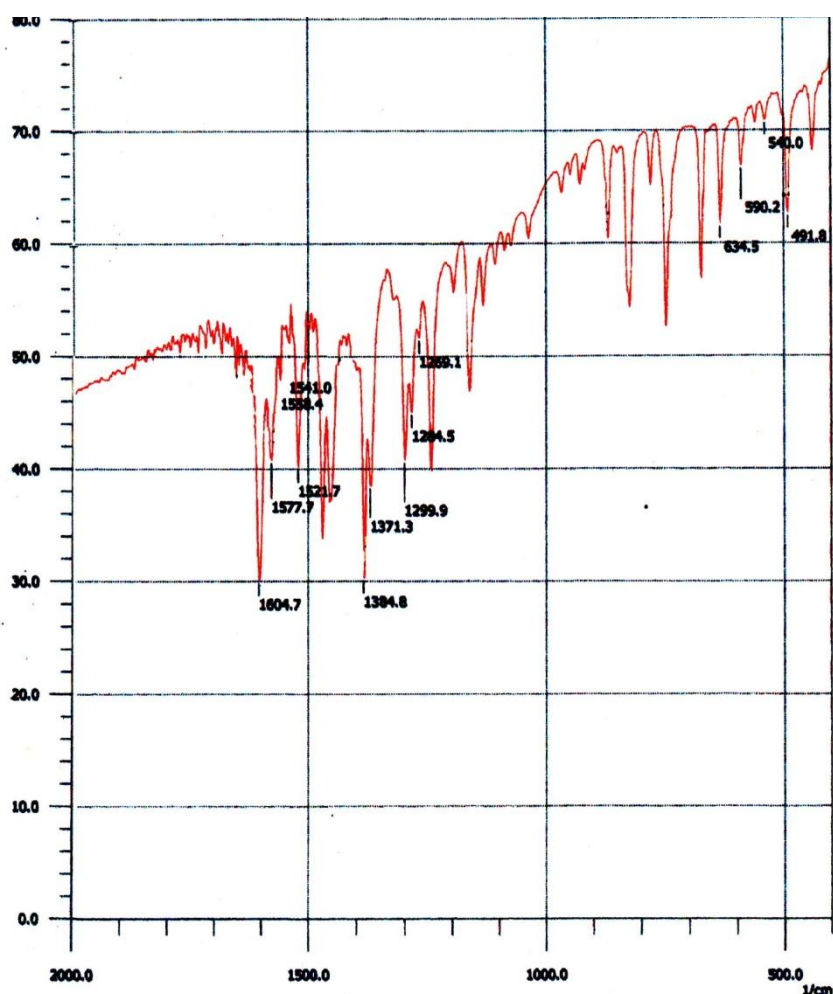
For the present systems the infrared spectra of the metal complexes and their respective ligands provide information about their formation in respect to the presence and coordination of the

ligands. The presence of  $\nu_{C=N}$  and  $\nu_{C=O}$  modes in the ligand and their negative shift on complexation confirm that the ligands act as N- donor and O- donor bases. For the complexes, the presence of  $\nu_{Pb-N}$  vibration in the region  $575-671\text{ cm}^{-1}$  indicates coordination of N- donors and  $\nu_{Pb-O}$  vibrations in the region  $444-540\text{ cm}^{-1}$  indicate the O- donor character of the ligands to the lead(II) ion.

**Table 3.** Spectral bands of some Schiff base complexes of lead (II)

Complexes	Infrared Spectral Bands ( $\text{cm}^{-1}$ )						Electronic Spectral Bands (nm) (DMF/ $\text{CHCl}_3$ )
	$\nu_{C=N}$	$\nu_{C=C}$	$\nu_{C-N}$	$\nu_{C=O}$	$\nu_{Pb-O}$	$\nu_{Pb-N}$	
[Pb(Sal-OAP)]	1579(vs) 1606(s)	1537(s)	1328ms 1377(s)	1271(s) 1286ms	596(s) 644(w)	489(s) 532(w)	445, 355, 269
[Pb( $^{5}\text{Br}$ Sal-OAP)]	1577(w)	1521ms	1371ms	1269(sh)	590(w)	491ms	443, 388, 342
[Pb(Bzac-OAP)]	1604(ms)	1541(sh)	1299 ms	1284(sh)	634(ms)	540(w)	488, 342, 324
[Pb(HAP-OAP)]	1654(sh)	1533vw	1363(sh) 1288(w)	1271ms 1251(sh)	584(s) 669(ms)	526(sh) 545(w)	468, 388, 342, 324
[Pb(HNP-OAP)]	1577(ms) 1596(ms)	1535(s) 1568(sh)	1355(w) 1382(s)	1269(s) 1296(s)	594(s) 646(s)	461(s) 488(s)	433, 355, 269

\* vs = very strong; s = strong; ms = medium strong; m = medium; w = weak; vw = very weak; sh = shoulder



**Figure 2.** Representative IR spectrum of [Pb( $^{5}\text{Br}$ Sal-OAP)]

### 3.3.2. Mass Spectra

Mass spectra of the compounds, [Pb(<sup>5</sup>BrSal-OAP)] and [Pb(HNP-OAP)], were obtained. The spectra, however, didn't look that clean and explicit as lead has isotopes ranging from <sup>82</sup>Pb<sup>194</sup> to <sup>82</sup>Pb<sup>214</sup>.

- i) The spectrum of [Pb (<sup>5</sup>BrSal-OAP)]: This complex did not display the molecular ion peak at m/e 496. The peak observed at 391 is due to the loss of C<sub>6</sub>H<sub>4</sub>NO. The peak observed at m/e 371 is thought to be due to the loss of C<sub>7</sub>H<sub>5</sub>NO. The peak at m/e 329 is due to the loss of C<sub>6</sub>H<sub>3</sub>BrO.
- ii) The spectrum of [Pb (HNP-OAP)]: This complex did not show molecular ion peak at m/e 468. The peak observed at m/e 391 is due to the loss of C<sub>6</sub>H<sub>4</sub>. The peak at m/e 371 is thought to be due to loss of C<sub>6</sub>H<sub>4</sub>O. The peak observed at m/e 360 is due to the loss of C<sub>6</sub>H<sub>4</sub>NO.

The mass spectra of the complexes indicated formation of the titled complexes.

### 3.3.3. Electronic Spectra

Being a d<sup>10</sup> system, the present Pb(II) complexes show no d-d transition in the visible region, and are colored only through their intense charge transfer absorptions tailing in from the ultraviolet. Besides, the other bands are due to intra-ligand transitions. The peaks observed below 350 nm are tentatively assumed as due to  $\pi \rightarrow \pi^*$ ,  $n \rightarrow \pi^*$  and  $n \rightarrow \sigma^*$  transitions. The peaks observed above 350 nm are assumed to be due to charge transfer [13].

### 3.3.4. <sup>1</sup>H NMR Spectra

The <sup>1</sup>H NMR spectrum of the ligands are carried out in CDCl<sub>3</sub>. The phenyl multiplet is seen at 6.5 - 7.3  $\delta$  and the azomethine proton is seen at 7.6  $\delta$  (singlet). The peak at 10.8  $\delta$  is attributed to phenolic OH group present in the ligand which is being absent in respective complex.

### 3.3.5. Magnetic Measurements

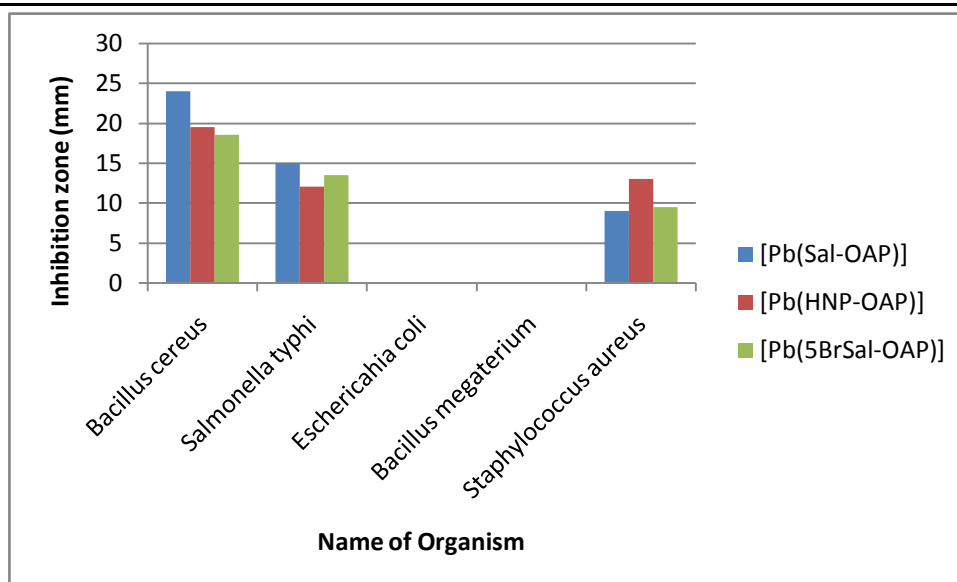
From the experimental values of magnetic measurements of some of the prepared complexes, it is revealed that lead(II) complexes of the tridentate Schiff bases are diamagnetic thus indicating the d<sup>10</sup> electronic configuration of Pb(II) in such complexes.

### 3.3.6. Molar Conductance

The molar conductance values of the presently prepared complexes are shown in Table 2. The low conductance values of the prepared complexes in DMF solutions indicate their non-electrolytic nature. This suggests +2 oxidation state of lead which is satisfied by the dinegatively charged tridentate ligands as expected.

## 3.4. Microbial Activities

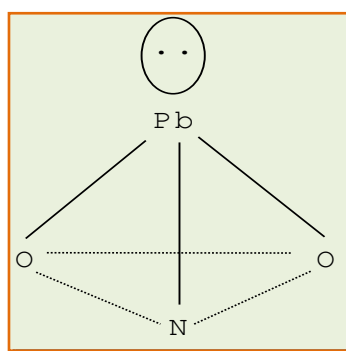
It is known from literature that a large number of biologically active compounds possess aromatic and heteroaromatic nucleus. It is also known that, if an active nucleus is linked to another nucleus, the resulting molecule may possess greater potential for biological activity. It is recognized that nitrogen and sulphur containing heterocyclic compounds show marked microbial activities. Antibacterial and antifungal activities of a series of dithiocarbamate [21] and Schiff base [22] complexes have been carried out in this laboratory. In the present investigation, antibacterial activity of the prepared lead(II) complexes have been evaluated against the five selective human pathogenic bacteria such as: *Bacillus cereus* (BTCC 19, Gram-positive), *Salmonella typhi* (AE 14612, Gram-negative), *Escherichia coli* (ATCC 25922, Gram-negative), *Bacillus megaterium* (BYCC 18, Gram-positive) and *Staphylococcus aureus* (ATCC 25923, Gram-positive). The inhibition zone of test organisms for different complexes is presented in Figure 3. All the tested complexes are quite effective against *Bacillus cereus*, *Salmonella typhi* and *Staphylococcus aureus*. On the other hand, they were not effective against *Escherichia coli* and *Bacillus megaterium*. Figure 4 represents zone of inhibition against *Staphylococcus aureus* by complexes [Pb(HNP-OAP)] and [Pb(5BrSal-OAP)].



**Figure 3.** Zone of inhibition produced by the prepared complexes against the test organism.



**Figure 4.** Zone of inhibition against *Staphylococcus aureus* by complexes, (i) [Pb(HNP-OAP)] and (ii) [Pb(<sup>5</sup>BrSal-OAP)]



**Figure 5.** Proposed skeleton diagram of the prepared complexes

#### 4. CONCLUSIONS

The Schiff bases were derived by the condensation of o-hydroxyaldehydes or ketones with amines. The prepared Pb (II) complexes with such ligands have been found to be of the type PbL (where, LH<sub>2</sub> = dibasic tridentate ligands). The analytical data indicate that the complexes have 1:1 (metal: ligand) stoichiometry. Conductivity measurement indicates their non-electrolytic nature. The magnetic measurement along with electronic spectral data of the prepared complexes support



$5d^{10}$  electronic configuration of the central metal ion consistent with the +2 oxidation state of lead ion. The IR data and mass spectra are indicative of the monomeric structures of the complexes. The Schiff base ligands possess a planar configuration with respect to the positions of the donor atoms or ions. The structures of the prepared PbL complexes seem to be trigonal pyramidal with the  $6s^2$  electron pair in the  $4^{th}$  position of the  $sp^3$  hybrids. However, it is difficult to suggest the exact structure of any of the prepared compounds without crystal structural evidences.

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