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Synthesis and Microbial Activity Determination of Synthesized Products of Iron(II) and Nickel (II) Complexes of Schiff Base Using 2-Aminoaniline and 2-Thiosylaniline

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Abstract: Four Metal complexes of Iron(II) and Nickel(II): FeNcplx, FeScplx, NiNcplx and NiScplx were synthesized in this study. Molar conductivity, elemental composition, color, melting point, and % yield were among the physical and analytical parameters measured for ligands and complexes. Analyzers for FT-IR, UV-VIS, and MS were used for characterization. The FT-IR results indicated the synthetic path rout of the functional groups of the compounds. Deprotonation and the use of phenolic OH in bond formation provide evidence of ligands losing their -OH bond to complexation. There were more peaks in the UV-VIS spectra of 2-aminoaniline complexes and Schiff bases due to the increased number of chromophoric groups. The MS of the results confirmed the proposed structures of the reaction as evident to m/z values indicating molecular weight of the ligands and complexes. The studies of Antibacterial (*Salmonella enterica, Escherichia coli, Staphylococcus aureus* and *Bacillus subtilis*) and Antifugal (*Aspergillus flavus, Rhizopus stolonifer, Fusarium moniliforme,* and *Fusarium solani*) activities with respect to the synthesized compounds showed that the complexes have greater efficacy in antifungal and antibacterial activities than with the ligands going from the area of inhibition zones. Further research can be done to incorporate these complexed synthesized into antibiotics and other drugs, as evident to antimicrobial efficacy.

Keywords: *Schiff Base, Ligands, 2-Aminoaniline, 2-Thiosylaniline, 2-Hydroxynapthaldehye, Complexation.*

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I. INTRODUCTION

Spectroscopy is seen as a broad area of science dealing with *absorption, emission or scattering* of electromagnetic radiation by molecules, ions, atoms or nuclei. The principles follow two fundamental laws: Beer's and Lamberts' laws known today as Beer-Lamberts Law [1]. Spectrophotometers are widely applied in various spheres and disciplines such as physics, molecular biology, chemistry and biochemistry [2,3,4]. In inorganic chemistry, it is used in the analysis of coordination compounds which are fashioned when ions or molecules collectively identified as ligands provide electron pairs to metal ions, forming covalent connections between the two [5].

Schiff bases are usually the products of primary amines and carbonyl (C= O) compounds which may be aldehyde or ketones. It attracted attention of chemists due to its ease of preparation and complexation [6] and possess high quality of reversible induced photochromism and thermochromism [7]. Recently, it is regarded as imines or azomethines where the C = O has been substituted by N of imine group hence contain carbon-nitrogen double bond (C = N) as the functional group and usually a condensed product of reaction containing primary amines and carbonyl groups [8]. The nitrogen is then connected to an aryl or alkyl group not to hydrogen which makes the Schiff base a stable imine [9]. Schiff bases are very important in modern coordination chemistry [10] and can create stable ions with the majority of transition metals [11] which enhance potency in pharmacological activities like anticancer [12].

An extensive range of biological activities, including antimicrobial, antifungal, anti-inflammatory, and antipyretic capabilities, has piqued the attention of the pharmaceutical and medical communities in Schiff base complexes [13, 15, 16]. Drug resistance against many pathogens can cause high morbidity and mortality in developing countries hence the need for novel antimicrobial drugs for monitoring of diseases and bacteria [17, 18] as well as employing advance methods

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including bioluminescent techniques, impedance analysis, and flow cytometry and method can give report and sensitive result with greater insight to cellular and antimicrobial integrity [19].

In this study, it was 2-hydroxy-1-naphthaldehyde that was used to create the Schiff base with 2-aminoaniline and 2-thiosylaniline. The resulting Schiff bases was complexed with iron(II) and Nickel (II) metals followed by characterization, analysis using FT-IR, UV-VIS and MS as well as antifungal and antibacterial tests.

II. MATERIALS AND METHODS

- **Materials:** 2-aminoaniline (J.B. Baker), 2-thiosylaniline (Aldrich), 2-hydroxy-1-naphthaldehyde (sigma-Aldrich), salicyladehyde (Aldrich) and Piperridine (Aldrich). Others include iron (II) acetate tetrahydrate (BDH), Nickel (II) acetate tetrahydrate (BDH), Dimethylsulphoxide (DMSO) (Aldrich), Ethanol (J. T. Baker), Methanol (J. T. Baker), Ether (J. T. Baker) and Acetone (J. T. Baker).
- **Electronic Equipment:** Various instruments such as an electronic balance model 3002 from Golden Mettle USA, a magnetic stirrer hot plate 79-1 from Techmel and Techmel USA, a J. J. I. Precision Force electronic mixer from China, a melting point apparatus, an IR-Fourier Transformed infrared spectrophotometer, an elemental analyzer LE-440 from Exeter Analytical Inc. USA, a gas chromatograph from Agilent 6840A, and an inert mass spectrometer model 5973C from Agilent Technologies, US Titan Biotech Ltd. of Rajasthem, India, produces incubators, autoclaves, microscopes, and nutritional agar-Tm medium. Other manufacturers include OPTIKA of Italy, SDA-liversaver (lis) Biotech of SanDiego, California, USA, and Titan Biotechd Ltd. of Rajasthem, India.
- **Bacteria and Fungal Species:** Bacillus subtilis, Staphylococcus aureus, Salmonella enterica, and Escherichia coli are all types of bacteria. Aspergilus flavus, Fusarium monoliforme, Rhizopus stolonifer, and Fusarium solani are the species of fungi responsible.

➢ *Preparation of Half Unit Ligands (½ LNA, ½ LSA)*

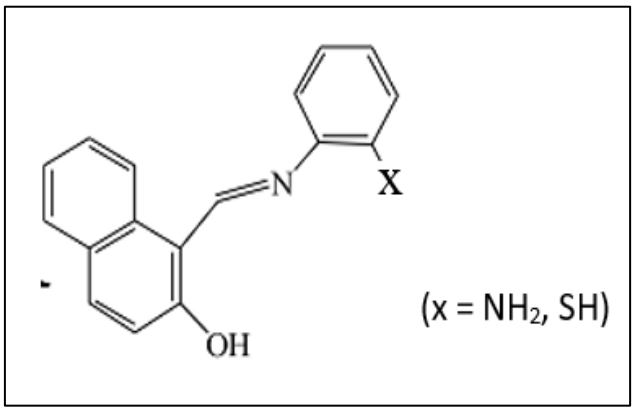

Fig 1: Half Ligand of 2-Aminoaniline and 2-Thiosylaniline

The two anilines were dissolved in 150 mL of ethanol; 2.5 g of thiosylaniline and 2.16 g of 2-amino aniline were used. With vigorous stirring, this was gradually added. 6.69% 2-hydroxynaphthalene-1-carbaldehyde, dissolved in 100 milliliters of deionized water, has a molecular weight of 20. Stirring constantly for half an hour, the two solutions were combined. After the solvent was removed by vacuum evaporation, the solid residue was filtered, washed with cold ethanol, and recrystallized using a mixture of methanol, ethanol, and acetone at a ratio of 1:1:1. The drying process allowed us to ascertain the melting point and % yield [20, 11, 21].

➢ *Preparation of Schiff Base Ligands (LNA and LSA)*

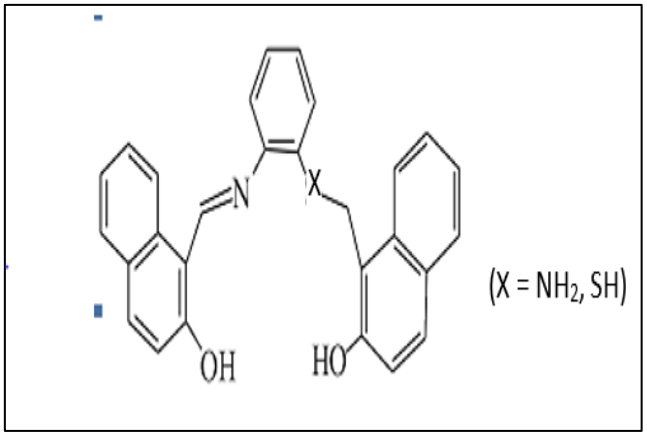

Fig 2: Schiff Base Ligands of 2-Aminoaniline and 2-Thiosylaniline

In anhydrous ethanol, a solution of salicylaldehyde containing 10mmoles (1.22g) was also made, along with a half-unit ligand solution containing ½ LNA 2.62g or (½ LSA 2.79g). Following a one-hour reflux period, the two solutions were combined. The end product was subjected to vacuum concentration until a solid crystal of a certain color precipitated out. To further enhance its purity, it underwent recrystallization. Color, melting point, and yield % were all measured [11, 21, 20].

➢ *Preparation of Fe (II) and Ni (II) Complexes (M = Fe, Ni)*

I dissolved 0.216g of Fe(OAC)2 or 0.218g of Ni(OAC) in 1 mmole of metal acetate in boiling methanol. A molecule of either the Schiff base ligands (LSA 0.435 g or LNA 0.416 g) was introduced. The liquid was refluxed for one hour after adding a few drops of piperidine. Allowing it to stand in other after refluxing caused colored crystals to deposit. It was dried in an oven set at 50 degrees Celsius after being rinsed with cold ether and methanol [20, 18, 22].

➢ *Determination of Microbial Activities*

The antibacterial activities were determined using the following standard methods: [23, 24].

➢ *Procedure for Antibacterial Activity Test*

The paper disc diffusion technique was used to assess the antibacterial activity of the test substance against several bacterial species, including gram-negative Salmonella enterica, gram-positive Escherichia coli, gram-positive Staphylococcus aureus, and gram-positive Bacillus subtilis.

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Using two-fold serial dilution, the test compounds were dissolved in a Dimethyl sulfoxide (DMSO) solution. From this solution, various concentrations of the test compounds were produced, ranging from 50 mg/mL to 12.5 mg/mL, from the stock solution.

The test microbe was diluted to 0.5 McFarland Standard (in 108 CFU/mL) and then seeded onto a Mueller Hinton agar plate following the manufacturer's instructions using a sterile cotton swab. So, in a strict protocol, the plates were put on top of paper discs that had been soaked with varying quantities of the substances under evaluation. As a negative control, DMSO was also added to the plates. For 16–18 hours, the plates were placed in an incubator set at 35°C. The disc's inhibitory zone diameter was measured to the closest millimeter (mm) in order to assess the antibacterial activity.

➢ *Procedure for Antifungal Activity Test*

The paper disc diffusion technique was used to assess antifungal activity against several fungal species, including Aspergillus flavus, Fusarium monoliforme, Rhizopus stolonifer, and Fusarium solani. Suspensions of fungus were cultured for 5 days and then added to sterile saboranes dextrose agar (SDA) plates. Cotton swabs were used to distribute the fungal suspension of each test fungus equally across the medium. Hence, using forceps in an aseptic manner, discs of paper impregnated with varying concentrations of the test chemicals (50mg/mL, 25mg/mL, and 12.5mg/mL) were deposited on the plates. For three days, the plates were kept at a temperature of 26 ± 2oC.

Antifungal action was confirmed during incubation when a distinct inhibition zone formed around the disc and was evident on the plates. To the closest millimeter (mm), the diameter of the inhibition zones were reported as follows: fungal growth (indicating no antifungal action), moderate growth (indicating moderate antifungal activity), and no growth of inoculation fungus (indicating antifungal activity).

III. INSTRUMENTAL ANALYSIS

The samples were subjected to molar conductivity measurements at 25 ± 0.50C using a 10-3M solution of absolute ethanol and acetone. A conductivity meter, the HACHHQ 40d, was used to ascertain the conductivity. Using a spectrophotometer (spectra lab 725s UV-VIS spectrophotometer) scanned in the 200–800 nm range with a 2 nm spectral band width, we were able to record the UV–VIS spectra of the complexes (10–3M) in absolute ethanol. The data from the absorbance versus wavelength plot is presented in Table 2.0.

Using an EDC 630 FT-IR spectrometer with KBr optics and accompanying diamond ATR attachments, the samples' FT-IR spectra were acquired in the 400-650 cm-1 range. The apodization process made use of the HappGenzel function. Table 3.0 shows the results of the data acquisition and processing performed using the Agilent Microlab Expert FT-IR spectrometer software.

The elemental analyzer used to assess the sample's C, H, and N.O.S levels was the LE-440 Elemental Analyzer from Exeter Analytical Inc. in the UK (table 1.0). The temperatures for combustion and reduction were 9750C and 6000C, respectively, whereas the temperature in the oven was 810C. A thermal conductivity detector was used as the detector, and a Porapak PQS column as the chromatographic column.

The samples underwent gas chromatography mass spectrometry analysis utilizing an Agilent 6890A gas chromatograph connected to an inert mass spectrometer 5973C equipped with a triple axis detector and an electron impact source. Located in Lagos, Nigeria, ISI Analytical Laboratory conducted all of the instrumental analyses [25] (Table 4.0).

IV. REACTIONS LEADING TO COMPLEXATION

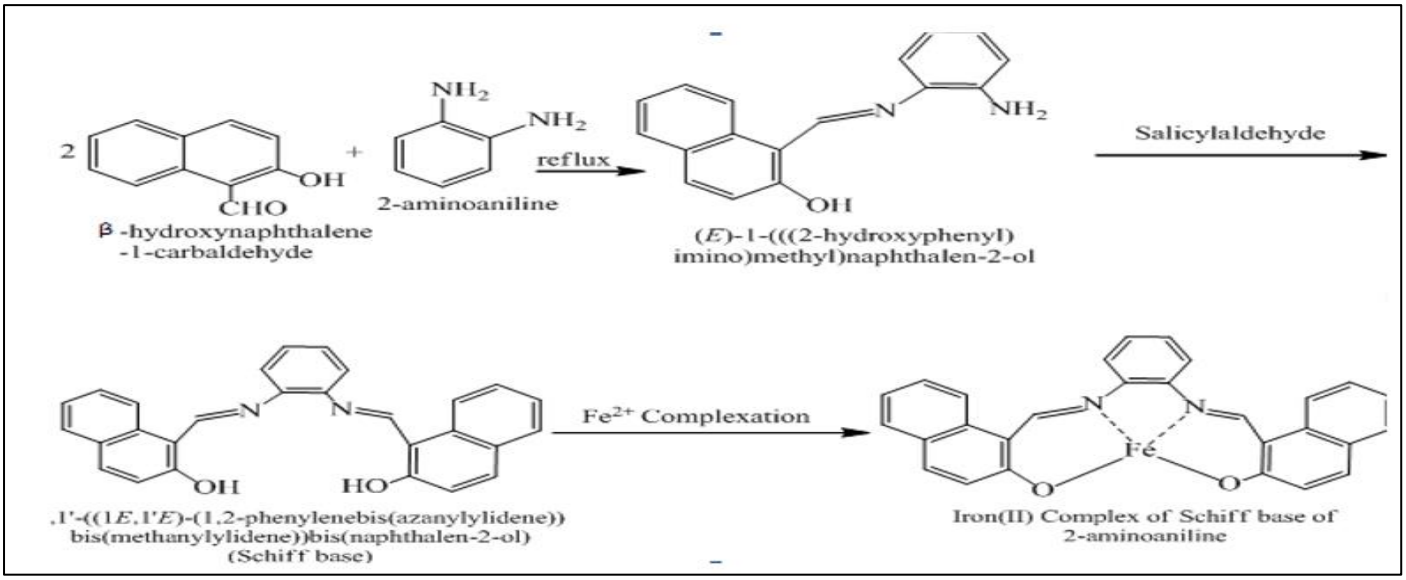

Fig 3: Formation of Fe(II) Complex with 2-Aminoaniline

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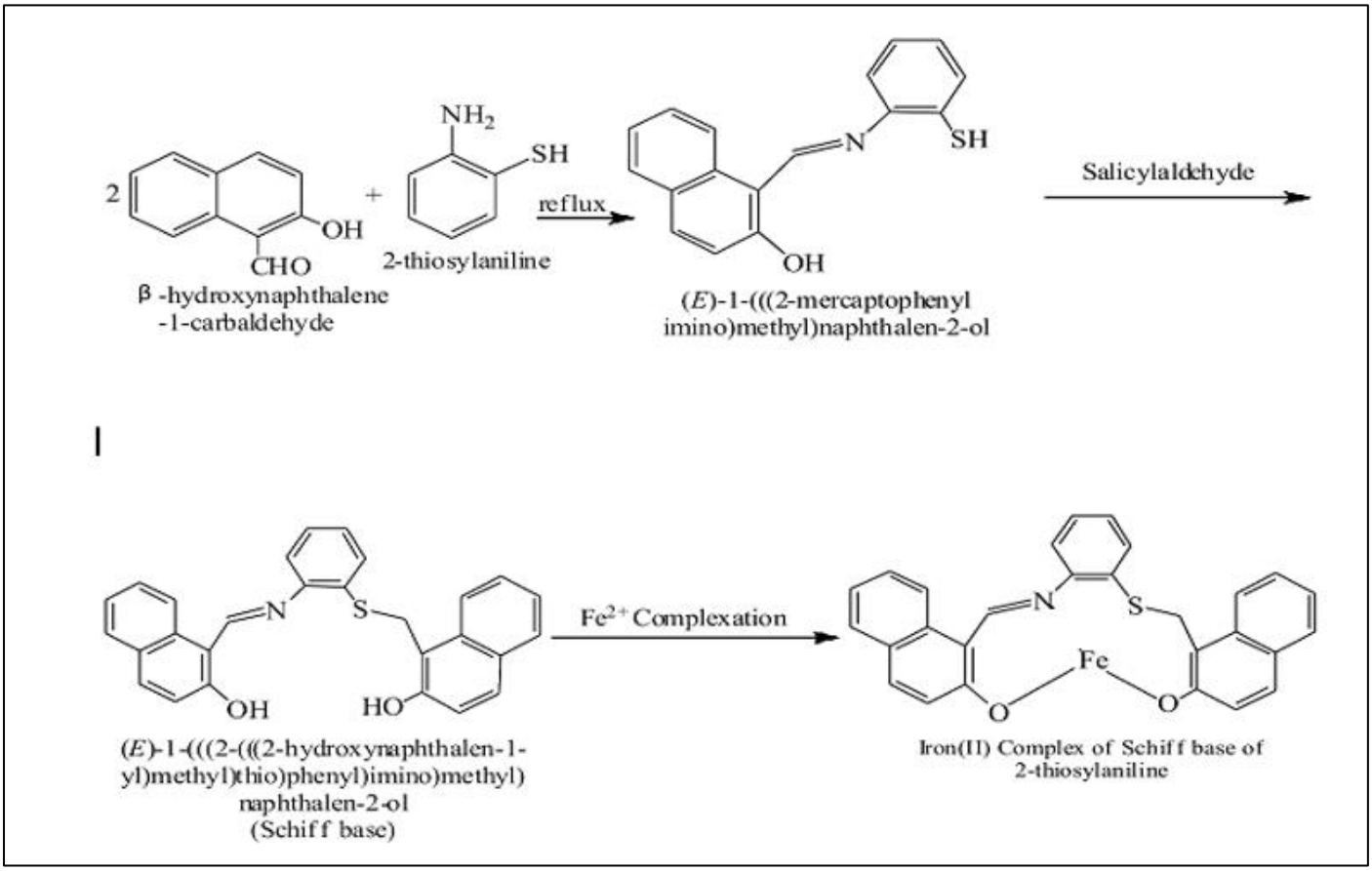

Fig 4: Formation of Fe(II) Complex with 2-Thiosylaniline

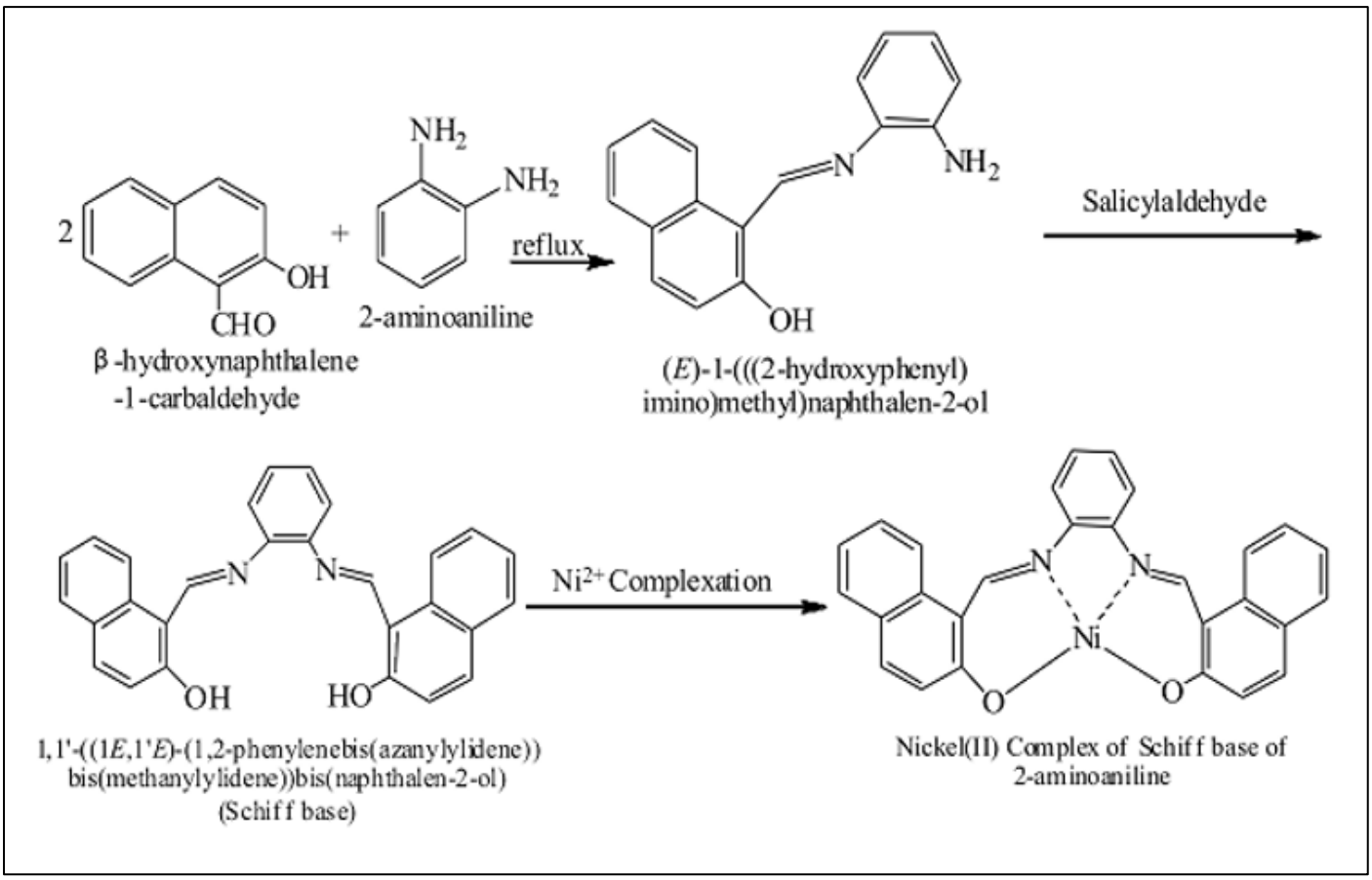

Fig 5: Formation of Ni(II) Complex with 2-Aminoanline

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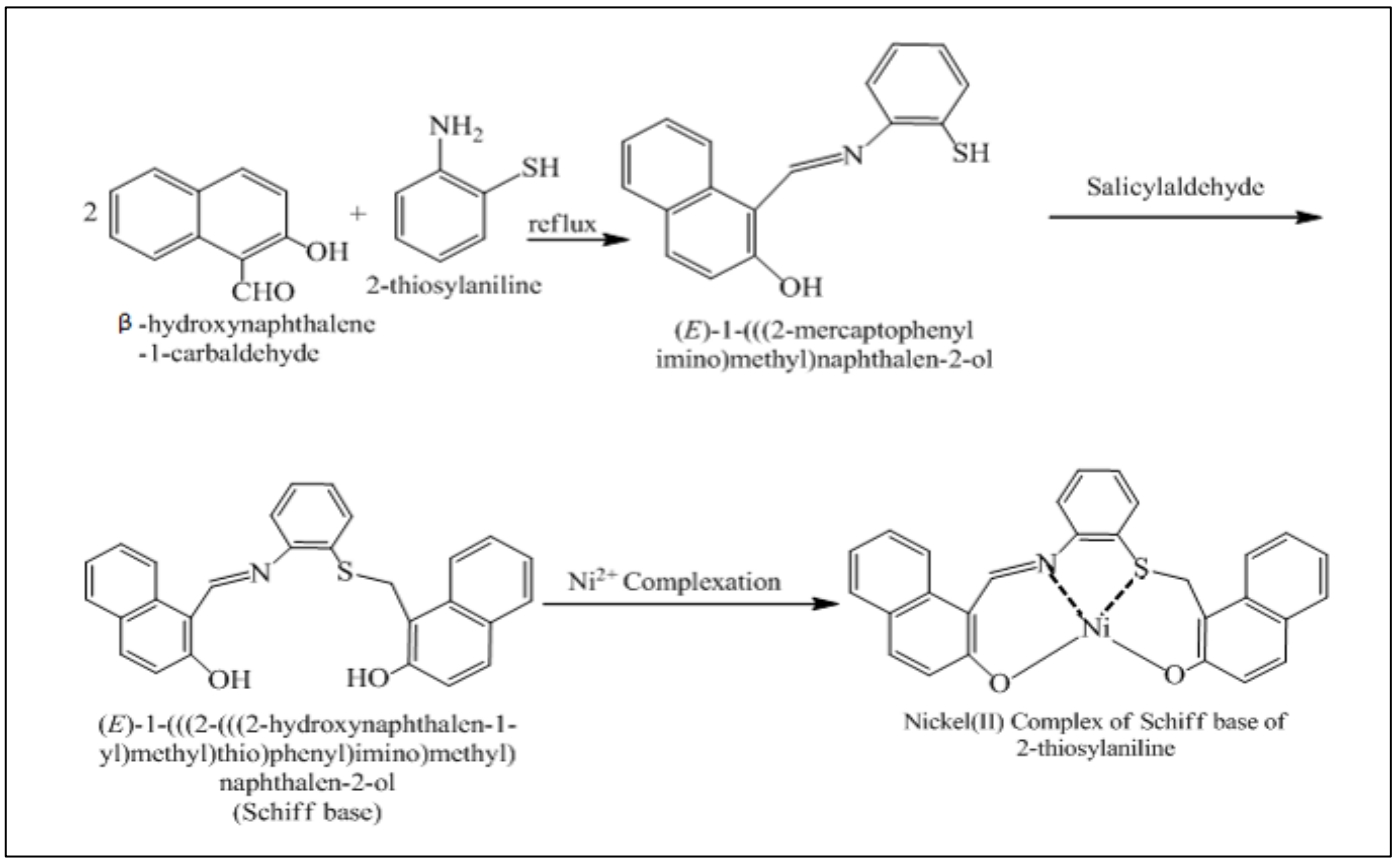

Fig 6: Formation of Ni(II) Complex with 2-Thiosylaniline

V. RESULTS AND DISCUSSION

The analytical reagents for this research were used as supplied without further purification.

Table 1.0 displays the analytical and physicochemical data of the complexes and ligands. They were isolated in their respective colours, melting points and percentage yield. It was observed that the melting points of the ligands and their Shiff bases were lower than their respective metal complexes.

The IR analysis were performed at every stage of the synthesis and complexation to monitor the progress of work which served as a guiding principle in the reaction mechanism. The infrared results (table 3.0) show that the v(OH) which appeared in the region (3167.59-3321.97) cm^{-1} of the half unit ligands and their Schiff bases disappears in complexation due to the hudroxyl oxygen's role in metal-organic bond formation [26, 20, 24] and non participation of OH group in bonding [25].

Coordination of azomethine nitrogen to metal ions is responsible for the changes in values seen in the infrared absorption of v (C = N) of the ligands, which exhibit similar rising trends with their respective complexes, ranging from the lowest value of 1599.03 cm-1 for FeScplx to the maximum value of 1621.39 cm-1 for FeNCplx [28, 29]. Phosphoryl oxygen v(C-O) absorption bands were detected in all of the metal complexes; the strongest signal was attained by FeScplx (1360.48 cm-1) and the weakest by FeNcplx (1274.75 cm-1), suggesting that phenolic oxygen coordinates with metal ions via deprotonation [22].The V(C-S) stretch were observed in FeScplx (1461.12cm^{-1}) and NiScplx (1431.30cm^{-1}). These values reduced drastically in the M-S bond of the same compounds (879.65 cm^{-1} and 887.11cm^{-1}) respectively indicating coordination of metal ions to sulphur. Other M-N and M-O bonds also fall under the same category. These high ranges opposed to low values (445-581 cm^{-1}) recorded by [28, 27] but agrees that of 1318 cm^{-1} (Skimadul *et al.*, 2016). Some have characterized these discrepancies in the assignment of far-infrared bands to metal bonding as contentious [28] and purely uncertain [22] due to all the skeletal vibrations caused by the metal ligand connections.

Complexes and ligands with chromorphoric functional groups, such as carbonyl and thiocarbonyl groups, benzene rings, double or triple bonds, or other similar structures, have significantly altered UV-VIS absorption. Adding auxochromes like OH, NH2, CH3, NO2, etc., which do not absorb much in the UV region but affect the molecules they are attached to, can further enhance it by causing absorption to longer wavelengths (low energy) or a red shift associated with the electron-donating effect [31]. Table 2.0 shows the UV-VIS absorption of the result, which shows characteristic behavior in the number of peaks. The highest number of peaks is the Schiff base of 2-aminoaniline, which has three peaks. The presence of functional groups causes the splitting of peaks due to the excitation of different electronic, vibrational, and rotational transitions, 32. Therefore, the peaks are attributed to n $\rightarrow\pi^*$ and π-π^* transitions [33]. The mass spectrometry of ligands and complexes gave mass-to-charge (M/Z) ratio of the compounds as well as the molecular

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weight of the sample components. The summary of M/Z values of the analysis are shown on table 4.0, depicting that of the molecular ions and their respective fragments, thereby authenticating the proposed structural formulas of the synthetic compounds.

Table 1: Physical and Analytical Data of Ligands, Complexes and their Elemental Composition (%)

Formula of compounds	**Molecular weight**	**Melting Point (^{O}C)**	**Colour**	**Percentage Yield (%)**	**Molar Conductivity π^{-1} cm^2 mol^{-1}**		**Elemental Composition (%)**				
					In Acetone	In Ethanol	C	H	N	O	S
$C_{17}H_{14}N_2O$ (½ LNA)	262	148-150	Light Brown	80	3.4	1.5	67.60	6.70	25.40	-	-
$C_{17}H_{13}NSO$ (½ LSA)	279	78-80	Yellow	79	2.7	1.4	57.72	5.66	11.05	-	25.57
$C_{28}H_{20}N_2O_2$ (LNA)	416	180-182	Black	60	4.5	3.32	50.48	2.91	6.01	6.79	-
$C_{28}H_{21}NSO_2$ (LSA)	435	102-104	Orange yellow	80	2.5	1.0	50.91	4.60	18.34	5.18	20.80
$FeC_{28}H_{18}N_2O_2$ (FeNCplx)	440	280-282	Grayish Brown	65	5.2	1.8	39.80	3.40	4.62	15.91	-
$FeC_{28}H_{18}NSO_2$ (FeSCplx)	459	300 $\leq$ 0^{o}C	Yellowish Brown	75	2.6	1.6	32.98	2.96	11.85	3.34	13.50
$NiC_{28}H_{18}N_2O_2$ (NiNCplx)	442	280 $\leq$ 0^{0}C	Light Brown	85	4.1	5.1	45.42	2.24	5.30	6.10	-
$NiC_{28}H_{18}NSO_2$ (NiSCplx)	461	285-287	Orange red	75	4.0	8.5	40.95	3.69	14.72	8.41	16.82

➢ *Key:*

- ½ LNA – Half Unit Ligand of 2-aminoaniline
- ½ LSA – Half Unit Ligand of 2-thiosylaniline
- LNA – Schiff Base Ligand of 2-aminoaniline
- LSA – Schiff Base Ligand of 2-thiosylaniline
- FeNCplx – Iron (II) complex of 2-aminoaniline
- FeSCplx – Irom (II) complex of 2-thiosylaniline
- NiNCplx – Nickel (II) complex of 2-aminoaniline
- NiSCplx – Nickel (II) complex of 2-thiosylaniline

Table 2: Summary of UV-VIS Spectral Absorbance Results of Ligands and Complexes

S/No	**Sample ID**	**UV-VIS Absorbance (200-880nm)**
1.	Half Unit Ligand of 2-aminoaniline	575
2.	Half Unit Ligand of 2-thiosylaniline	584
3.	Schiff Base Ligand of 2-thiosylaniline	575, 590, 760
4.	Schiff Base Ligand of 2-thiosylaniline	584,598
5.	Iron (II) complex of 2-aminoaniline	578, 592
6.	Iron (II) complex of 2-thiosylaniline	578
7.	Nickel (II) complex of 2-aminoaniline	573, 586
8.	Nickel (II) complex of 2-thiosylaniline	586

Table 3: IR Results of Ligands, Schiff Bases and Complexes

Samples: Ligands, Schiff Bases and Complexes	**V(N-H) cm^{-1}**	**V(OH) cm^{-1}**	**V(C = N) cm^{-1}**	**V (C-O) cm^{-1}**	**V (S-H) cm^{-1}**	**V (C-S) cm^{-1}**	**V (M-N) cm^{-1}**	**V (M-O) cm^{-1}**	**V (M-S) cm^{-1}**
½ LNA	3414.76	3321.97	1613.33	-	-	-	-	-	-
½ LSA	3498.40	3321.22	1618.18	-	2626.56	-	-	-	-
LNA	-	3262.96	1621.20	-	-	-	-	-	-
LSA	-	3167.59	1610.89	-	2540.35	-	-	-	-
FeNCplx	-	-	1621.39	1274.75	-	-	887.11	790.20	-
FeSCplx	-	-	1599.03	1360.48	-	1461.12	678.38	741.74	879.65
NiNCplx	-	-	1602.76	1282.20	-	-	812.29	741.74	-
NiSCplx	-	-	1610.21	1308.30	-	1431.30	820.01	738.01	887.11

Table 4: Mass Spectral Results Showing M/Z Values of Ligands, Schiff Bases, Complexes and Fragments

Mass-to-charge (M/Z)	**Assignment/Formula**	**Structure**
262.3	½LNA-Half Unit Ligand of 2-aminoaniline	$C_{17}H_{14}N_2O$ (Molecular ion)

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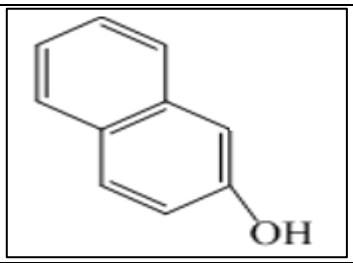
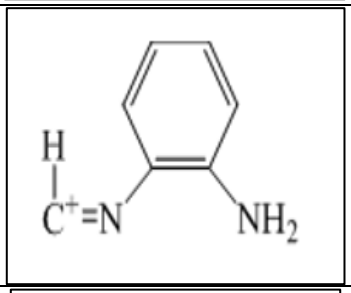
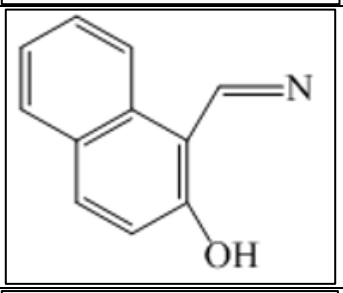
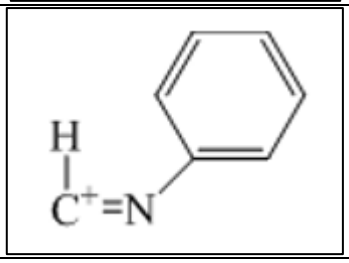
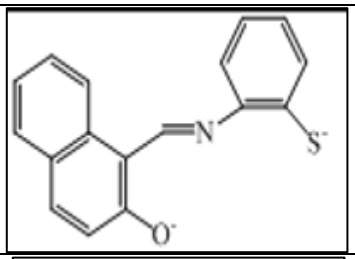
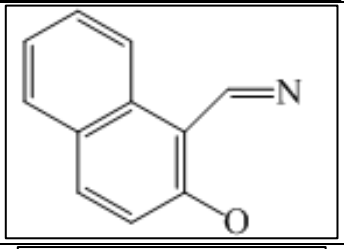
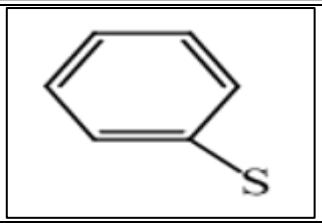
144	$C_{10}H_8O$	
119	$C_7H_7N_2$	
170	$C_{11}H_8NO$	
104	C_7H_6N	
279.37	½ LSA – Half Unit Ligand of 2-thiosylaniline	$C_{17}H_{13}NSO$ (Molecular ion)
277	$C_{17}H_{11}NSO$	
169	$C_{11}H_2NO$	
109	C_6H_5S	

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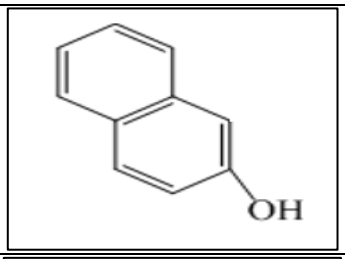
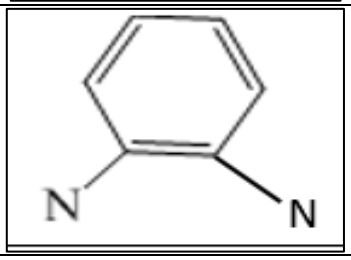
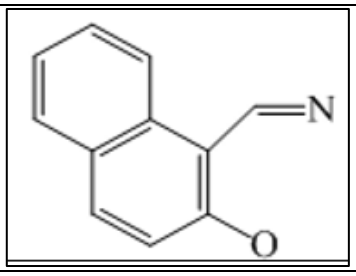
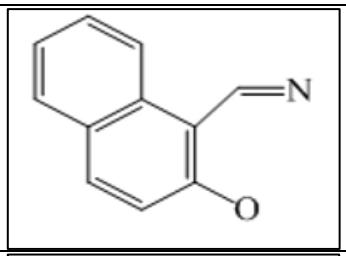
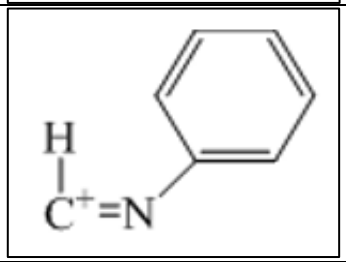
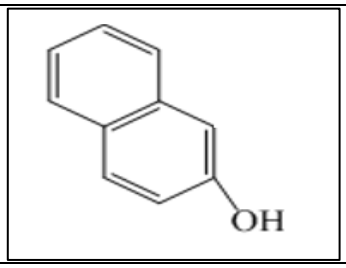
416.5	**LNA – Schiff Base Ligand of 2-aminoaniline**	**$C_{28}H_{20}N_2O_2$ (Molecular ion)**
144	$C_{10}H_8O$	
104	$C_6H_4N_2$	
435.56	**LSA –Schiff Base Ligand of 2-thiosylaniline**	**$C_{28}H_{21}NSO_2$ (Molecular ion)**
169	$C_{11}H_7NO$	
473.19	**NiNCplx – Nickel Complex of 2-aminoaniline**	**$NiC_{28}H_{18}N_2O_2$ (Molecular ion)**
169	$C_{11}H_7NO$	
104	C_7H_6N	
492.28	**NiScplx – Nickel complex of 2-thiosylaniline**	**$NiC_{28}H_{19}NSO_2$ (Molecular ion)**
143	$C_{10}H_7O$	

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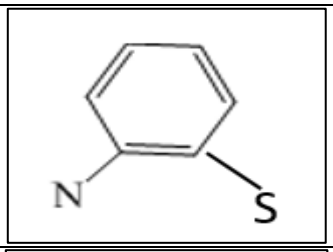
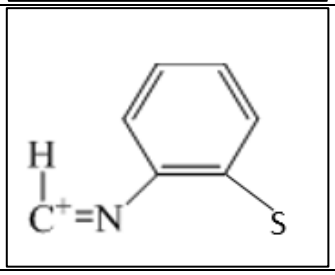
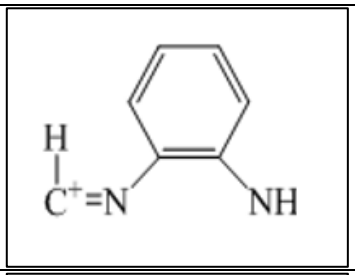
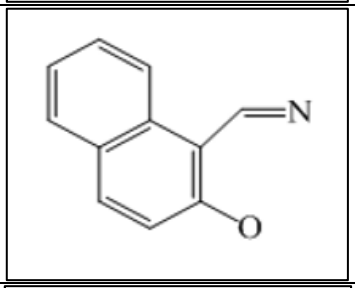
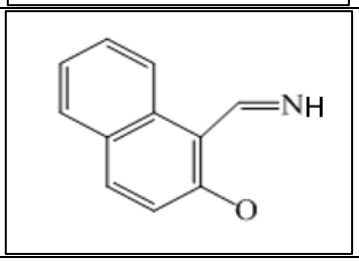
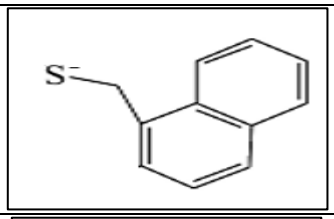
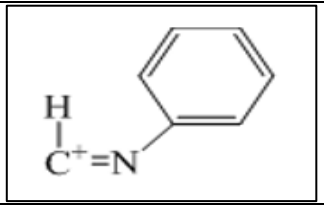
122	C_6H_4NS	
135	C_7H_2NS	
470.48	**FeNcplx –Iron(II) complex of 2-amionaniline**	**$FeC_{28}H_{18}N_2O_2$ (Molecular ion)**
119	$C_7H_7N_2$	
169	$C_{11}H_7NO$	
170	$C_{17}H_8NO$	
489.54	**FeScplx – Iron(II) Complex of 2-thiosylaniline**	**$FeC_{28}H_{19}NSO_2$ (Molecular ion)**
173	$C_{11}H_9S$	
104	C_7H_6N	

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Table 5: Antibacterial Activities of the Ligands and Complexes Diameter of Inhibition Zone (mm)

Compound	***Salmonella enteric* Concentration (mg/ml)**			***Escherichia coli* Concentration (mg/ml)**			***Staphlococcus aureus* Concentration (mg/ml)**			***Bacillus subtilis* Concentration (mg/ml)**			
	50	25	12.5	*50*	25	12.5	*50*	25	12.5	*50*	25	12.5	
½ LNA	10	7	-	7	-ve	-ve	-ve	-ve	-ve	8	-ve	-ve	
½ LSA	8	7	-	-	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	
LNA	8	7	7	-ve	-ve	-ve	-ve	-ve	-ve	11	-ve	-ve	
LSA	7	7	-ve	-ve	-ve	-ve	-ve	-ve	-ve	10	-ve	-ve	
FeNcplx	16	14	10	14	12	8	13	11	8	14	12	9	= 141
FeScplx	12	10	9	13	11	11	14	12	11	16	13	10	= 142
NiNcplx	13	11	9	12	11	7	12	9	-ve	12	11	11	= 118
NiScplx	12	11	-	13	11	10	12	12	7	12	9	8	= 117
DMSO Control	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve		

Table 6: Antifungal Activities of the ligands and their Metallic Complexes Diameter of Inhibition Zone (mm)

Compound	***Aspergillus flavus* Concentration (mg/ml)**			***Fusrium monilforme* Concentration (mg/ml)**			***Rhizopus stolonifer* Concentration (mg/ml)**			***Fusarium solani* Concentration (mg/ml)**			
	50	25	12.5	*50*	25	12.5	*50*	25	12.5	*50*	25	12.5	
½ LNA	7	7	-ve	7	-ve	-ve	-ve	-ve	-ve	7	-ve	-ve	
½ LSA	-ve	-ve	-ve	7	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	
LNA	7	-ve	-ve	7	-ve	-ve	-ve	-ve	-ve	7	-ve	-ve	
LSA	7	-ve	-ve	7	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	
FeNcplx	10	9	-ve	11	9	7	11	10	8	11	10	-ve	= 96
FeScplx	12	9	8	9	-ve	-ve	9	7	-ve	10	7	-ve	= 71
NiNcplx	9	7	-ve	10	9	-ve	10	9	-ve	8	-ve	-ve	= 62
NiScplx	13	8	-ve	9	9	-ve	10	10	-ve	9	-ve	-ve	= 68
DMSO Control	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve	-ve		

Research studies of antimicrobial activity are very essential due to some resistance encountered during the treatment of several pathogenic microorganisms using chemotherapeutic agents. Complexes of the bioessential metals iron (II) and nickel (II) have antimicrobial and antifungal effects against a wide variety of harmful bacteria and fungi [34, 35, 36]. The results (tables 5.0 and 6.0) show that the metal complexes have greater antimicrobial activity than the ligands as observed from the total inhibition zones of the selected organisms [37]. Going by the total calculated inhibition zones table 5.0, FeScplx (142mm) has the highest antibacterial activity followed by FeNcplx (141mm), then NiNcplx (118mm) and finally NiScplx (117mm), while in antifungal activity (table 6.0), it followed almost the same trend but for NiNcplx (62mm) with the least activity instead of NiScplx (68mm). The antibacterial activity of metal complexes is higher than that of ligands alone because metal complexes facilitate the activation of ligands, which are the primary cytotoxic species, and the breakdown of cell membranes [38, 39, 40].

VI. CONCLUSION

2-hydroxy-1-naphthaldehyde Fe(II) and Ni(II) complexes were designed, synthesised, and characterized utilizing 2-aminoaniline and 2-thiosylaniline, respectively. In addition to being soluble in organic solvents, the Schiff bases and metal(II) complexes retain their distinctive coloration and exhibit stability. With a favorable percentage yield, they are non-hygroscopic. Since the complexation stage is characterized by the loss of certain functional groups, such as OH, the IR data provide insight into the reaction mechanism and chelation process. Table 2.0 shows that the ligands and complexes exhibit certain UV-VIS spectral behaviors, and mass spectroscopy validates the suggested structures by revealing the compounds' m/z values. When compared to the ligands, the produced complexes exhibit higher antimicrobial effectiveness; specifically, FeNcplx exhibited the strongest antifungal activity and FeScplx the strongest antibacterial activity.

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