# Synthesis, Spectral Characterization and Nematicidal activity studies of 2-[(2 -Nitrophenylimino) Methyl] Phenol and 2-[(4-Nitrophenyliminomethyl)]phenol Ligands and their FE(II) and NI(II) Complexes.

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doi: https//doi.org/10.46912/napas.71

## Abstract

Four complexes of Fe(II) and Ni(II) with2-[(2 -nitrophenylimino) methyl] phenol($L_1$) and 2-[(4-nitrophenyliminomethyl)] phenol($L_2$) Schiff bases have been prepared via the microwave assisted method. The ligands and their corresponding complexes were characterized on the basis of physical properties, elemental analysis, MS, FTIR, $^1$H-NMR and $^{13}$C-NMR spectroscopy and electronic spectra. The FTIR spectra of the complexes showed that the ligands $L_1$ and $L_2$ had bidentate character coordinating through the nitrogen and oxygen atoms. On coordination, results showed that the $^1$H-NMR and $^{13}$C-NMR data of $L_1$ and $L_2$ confirmed the formation of the complexes of Fe(II) and Ni(II). The probable coordination geometries of Fe(II) and Ni(II) were octahedral. All the metal complexes were found to be non-electrolytes in ethanol. Nematicidal studies proved that the ligands and their metals showed appreciable nematicidal properties against the root knot nematode *Meloidogyne arenaria*with the metal complexes exhibiting higher ability than the free ligands.

**Keywords**: Synthesis, nematicidal studies, *Meloidogyne arenaria*

## Introduction

The advancements in inorganic chemistry has led to a myriad of applications of the field in finding solutions to problems emanating from diverse fields such as, biochemistry, pharmaceutical sciences etc. The use of multidentate ligands such as Schiff base ligands are no doubt a corollary to the usefulness of coordination compounds. During the past two decades, considerable attention has been paid to the chemistry of the metal complexes of Schiff bases containing nitrogen and other donors. This may be attributed to their application in many fields (Arunachalam, 2011; Iorungwa *et al.*, 2019).

Schiff-base compounds have been potentially used as fine chemicals and medical substrates (Mobinikhaledi *et al.*, 2011). These are a category of azomethine which are rapidly gaining popularity in recent years for their biocidal activities (which include anti-bacterial, anti-fungal and anti-tumor). Their usefulness and applications include bond formation reactions, polymerizations and in liquid crystal designing. Schiff bases show fascinating optical, biological and conductive properties and are used as intermediates in chemical reaction processes (Kundu *et al.*, 2009; Eta, 2013; Iorungwa *et al.*, 2020).

The Azomethine group of the Schiff base ($R_2C=N-N=CR_2$) possess lone pair of electrons on the nitrogen atoms, It becomes a very good chelant when it is attached to an aromatic ring possessing an extra donor site. It possesses N, O donor system, which are important classes of ligands and have useful applications in complex formation because of the lone pairs of electrons they possess(Jain *et al.*, 2002; Iorungwa *et al.*, 2020).

Schiff base metal complexes have played a significant role in the advancement of co-ordination chemistry. They provide a versatile and flexible myriad of ligands capable of binding with various metal ions to obtain complexes with suitable properties for application both in theory and in practice(Arunachalam, 2011; Iorungwa *et al.*, 2019; Ugama, 2020).

Schiff bases show a varying range of activities such as antimalarial, antitumour, antibacterial, anticancer (Lakhe and Mangaonka, 2012) antifungal, antitubular (Prakashand Adhikari, 2011; Hilmy *et al.*, 2012) antiviral, anti-infertility and antipyretic activities (Yadav, 2006; Sharma, 2007; Shabani *et al.*, 2010; Lakshmi *et al.,* 2011; Al-Kahraman, 2011; Ugama, 2020).

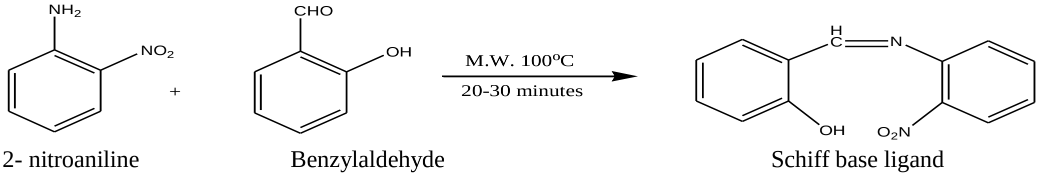
This research work is targeted at assessing the nematicidal properties of some Schiff base complexes synthesized from 2[(2-nitrophenylimino) methyl] phenol and 2-[(4-nitrophenylimino)] methyl] phenol with $Fe^{2+}$ and $Ni^{2+}$ ions.

## Materials and Method

### *Synthesis of 2[(2-nitrophenylimino) methyl] phenol ($L_1$)*

All reagents used were analytical grade and of high percent purity. To prepare the ligand $L_1$, 5.0g (0.01 mmol) of 2-nitroaniline was accurately weighed into a crucible. Using the crucible, the 2-nitroaniline was pulverized into fine powder to increase the surface area and to it were added 5mL of salicylaldehyde and 20mL of absolute ethanol as solvent. The entire mixture was stirred for 1hand then placed in a microwave oven model 2001 ETB with a rotating tray and power source 230V for 30 min. Stirring was continued and the temperature of the oven was maintained at $100^0$C. A thermocouple device was used to monitor the temperature and using on/off cycling to control temperature.

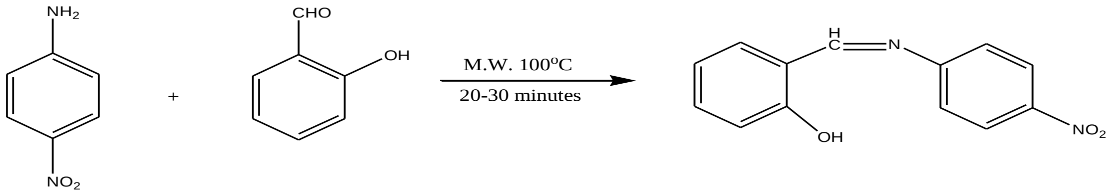
The bright yellow solid product formed was filtered, washed with distilled water, air dried for 30 minutes and preserved in a refrigerator. The presence of nitrile group in the prepared ligand was indicated by treating few amounts of the sample with aqueous sodium hydroxide, the evolution of ammonia gas after hydrolysis of nitrile group was detected by moist red litmus paper which turned blue. To check for purity, a thin layer chromatography of an equimolar quantity of ethyl acetate and trichloromethane were used as eluent.



**Scheme a:** *Synthesis of Schiff base ligand2[(2-nitrophenylimino) methyl] phenol*

### Synthesis of Ligand $L_2$ 2-[(4-nitrophenylimino)] methyl] phenol

The ligand $L_2$ 2-[(4-nitrophenylimino) methyl phenol] was prepared by adopting the method described by Iorungwa *et al.*, (2020), the apparatus were washed and rinsed with distilled water. Similar procedures used for the synthesis of $L_1$ was adopted except that 4-nitroamiline was treated with salicylaldehyde instead of 2-nitroaniline. The black solid product formed was filtered, washed with distilled water and air-dried. The presence of nitrile group in the prepared ligands was indicated by treating few amounts of the sample with aqueous sodium hydroxide, the evolution of ammonia gas after hydrolysis of nitrile group was detected by moist red litmus paper which turned blue. To check for purity, a thin layer chromatography of an equimolar quantity of ethyl acetate and chloroform were used as eluent. The equation of reaction is:



4 – nitroaniline Benzylaldehyde Schiff base ligand

**Scheme b:** *Synthesis of Schiff base ligand 2[(4-nitrophenylimino) methyl] phenol*

### Synthesis of metal complexes

Using a 250mL beaker, 5.0 (0.01 mol) of Schiff base $L_1$ and 20 mL ethanol was added dropwise of metal salts of Iron (II) chloride and Nickel (II) chloride respectively. Each mixture was stirred thoroughly and placed into a microwave oven for 30 minutes. Each metal complexes formed was filtered and washed with distilled water. Where the product was oily, 10 mL ethanol was added to the mixture, stirred and placed into a microwave. The final product formed was air-dried and preserved in a refrigerator. The same method was adopted for the synthesis of the metal complexes of the second ligand $L_2$ as described by Iorungwa *et al.*, (2020) and Ugama, (2020).

### Determination of physicochemical properties of $L_1$, $L_2$ and its complexes

### Melting point

In order to determine the melting point of the ligand and its metal complexes, a small amount of the sample was introduced into a small capillary tube and attaching it to the stem of a thermometer centred in a heating bath and heating the bath slowly while observing the temperatures at which melting begins and completes. The values obtained were recorded in Table 1. The methods adopted for the determination of melting point, conductivity percentage yield and magnetic properties as well as the spectral studies were as described by Iorungwa *et al.*, (2019).

### UV-Vis Spectra

The UV – Vis spectra were recorded on a Shimadzu UV 160 I PC UV – VIS Spectrophotometer at the Federal University of Agriculture, Makurdi, Nigeria. The results are presented in Table 2

### Nematicidal Studies

### *Sampling Location*

The study was carried out on a farmer's land by the North Bank flank of the River Benue, Nigeria. No specific permits were required for the farmer's land needed for the studies and the sites were unprotected. The test crop was peanut (*Arachis hypogea)* and the test nematode is *M. arenaria*

### Isolation and Identification of *M. arenaria*

Clean Tweezers were used to collect adult of *M. arenaria* suspect from galls of peanuts. After cleaning the galls with de-ionised water, the tweezers were used to scratch the root nodules of the *Arachis hypogea* so as to expose the mature *M. arenaria*. The crop was identified in the Department of Botany while the nematode was identified in the Department of Zoology, Federal University of Agriculture, Makurdi, Nigeria. The isolated nematode, were put into plates (one in each labeled $P_1$ to $P_{50}$) with 5mL water. The experiments were performed at the Department of Biological Science, Federal University of Agriculture Makurdi, Nigeria. The ligands $L_1$ and $L_2$ and its metal complexes were prepared at the

Research Laboratory Chemistry Department, Federal University of Agriculture Makurdi. The compounds were soaked in distilled water at different concentrations of 125ppm, 62.5ppm, 31.3ppm 15.6ppm and 7.8ppm for 1 week. After filtration, 10mL of the extracts with various concentrations were transferred to 10 petri dishes in order to study the nematicidal effects. An equal volume of distilled water was used as a control. The soil with serious root nematode diseases was used for the experiment.

## Application of synthesized ligands and metal complexes on *M. arenaria*

The synthesized ligands and metal complexes were applied to the nematodes and observed for 30 minutes. The corrected percentage mortality was calculated. The nematode, *M. arenaria* were considered alive if they were mobile or appeared as a winding shape.

The nematodes were considered dead if they did not move when probed with a needle. To check if nematodes regain mortality or not, they were transferred to distilled water for 12 hours.

The corrected percentage mortality was calculated according to:

$$\% \text{ mortality} = \frac{(mortalityoftreatment-mortalityofCo.}{(1-mortalityofCo)} x\ 100$$

## Results and Discussion

Tables 1 to 5 present data on the physicochemical and the spectral properties of the ligands and metal complexes, Table 1 shows the physicochemical data and the elemental analysis of the ligands and their complexes. Table 2 shows the spectral data of the complexes, while Tables 3, 4 and 5 present the HNMR, $^{13}$CNMR and FTIR data of the ligands and their complexes respectively.

**Table 1:** Physicochemical and Elemental Analysis of $L_1$, $L_2$ and its Metal Complexes and their conductivity values

| **Empirical Formula mw(g/mol)** | **Elemental Analysis calculated(found)** | | | | | | **Colour** | **M P(K)** | **Yield %** | **Ω $M_2$** | **Magnetic moment BM** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | C% | H% | N% | O% | M% | U% | | | | | |
| $C_{13}H,ON_2O_4(HL_1)$ (258) | 65.1 | 4.41 | 14.2 | 10.8 | - | - | Bright yellow | - | - | 11.5 | - |
| $C_{13}H_{10}N_2O_3(HL_2)$ (258) | (64.9) | (4.9) | 14.1 | 10.7 | | | Dark brown | | | | |
| $[FeL_1Cl_2]6H_2O$ (493) | 49.0 | 4.2 | 11.0 | 8.0 | 9.0 | 9.0 | Brown | 1809 | | | |
| $[FeL_2Cl_2]6H_2O$ (493) | 48.0 | 4.1 | 10.0 | 7.0 | 8.0 | 9.0 | Reddishbrown | 1890 | 82.0 | 14 | |
| $[NiL_1Cl_2]4H_2O$(460) | 50.8 | 4.0 | 11.2 | 8.5 | 7.8 | 9.4 | Pale yellow | 1726 | 80.3 | 14.3 | 1.84 |
| $NiL_2Cl_2\ ]4H_2O$ (460) | (50.7) | 3.9 | 11.1 | 8.3 | 7.7 | 9.3 | Pale green | 1726 | | | |

## Electronic Spectral studies

The ligand ($L_1$) gave a sharp band at 229 nm corresponding to $\pi-\pi^*$ transition with an additional sharp band at 230nm. A broad band appeared at 340nm corresponding to $n-\pi^*$involving molecular orbital of carbonitrile chromophore and aromatic ring while the ligand ($L_2$) showed two absorption bands corresponding to $\pi-\pi^*$ transition. At lower energy, $L_1$ equally showed sharp bands while other bands occurred after 340 nm. A wavelength of 352 nm recorded $n-\pi^*$ transition. On the other hand, $\pi-\pi^*$ remained unchanged in the metal complexes but an increase in the E value was observed. Metal complexes with the ligand in $\pi-\pi^*$ transition showed that there was an enhancement in transition. These peaks and wavelengths of transition correspond with the observations made our earlier publications (Iorungwa *et al.*, 2020; Ugama, 2020).

**Table 2:** Electronic Spectra of $L_1$, $L_2$ and its metal complexes

| | **Synthesized ligand and metal complexes** | **λ nm** | **νcm$^{-1}$** | **Transition** | **Suggested structure** |
|---|---|---|---|---|---|
| 1 | $[NiL_2Cl_2].4H_2O$ | 251 | 40000 | Ligand F | |
| | | 278 | 36102 | LF | |
| | | 346 | 28951 | CF | |
| | | 929 | 10780 | $^2A_{2g}Fx^3$ $^3T_{2g}1F_1$ | Octahedral |
| | | 572 | 17501 | $^2A_{2g}Fx$ $^3T_{2g}1F_1$ | |
| | | 395 | 25365 | $^2A_{2g}Fx$ $^3T_{2g}1F_1$ | |
| | | | | LF | |
| 2 | $[FeL_2Cl_2].4H_2O$ | 256 | 39217 | LF | |
| | | 289 | 34722 | CT | Octahedral |
| | | 411 | 24390 | $^4T_{4d}F^1$ $^4T_{2g}(F)$ | |
| | | - | 8930 | | |
| | | 606 | 16520 | $^4T_{1g}(F)$ $^2A_2(F)$ | |
| | | 496 | 20200 | $^4T_{2g}(F)$ $^4T_{ig}(P)$ | |

**Table 3:** $^1$HNMR Spectral studies of $L_1$ and $L_2$ and its metal complexes

| H-No | (1) | (5) | (7) | (11) |
|---|---|---|---|---|
| $L_1$ | 13.2(5)[2H] | 12.7(5) [2H] | 12.3(s)[2H] | 15.0(s)[2H] |
| $L_2$ | 13.2(5) [2H] | 12.7(5) [2H] | 12.3 (s) 2H | 12.75 s) [2H] |
| [F [FeL$_1$Cl$_2$]6H$_2$O | 6.9-7.6(m) [7H] | 7.0-7.8(m)[14H)] | 6.6-7.8m [7H] | 6.8 -7.5 (m) 14H |
| [FeL$_2$Cl$_2$]6H$_2$O | 6.9-7.6(m)[7H] | 7.0-7.8(m)[14H)] | 6.6-7.8m [7H] | 6.8-7.5 (m) [14H] |
| [NiL$_1$Cl$_2$]6H$_2$O | 6.9-7.6(m)[7H] | 7.0-7.8(m)[14H)] | 6.6-7.8m [7H] | 6.8 -7.5(m)[14H] |
| [NiL$_2$Cl$_2$]6H$_2$O | 8.6 (5) [1H) | 9.0(5) [2H] | 8.9 (s) [1H] | 8.9(5) [2H] |

**Key:** m = medium**;** s = sharp

## $^1$H-NMR Data

The $^1$H-NMR spectra of the synthesized compounds were recorded on 300MHZ NMR spectrophotometer. The resonance peaks in the $^1$H NMR spectra of the ligands $L_1$ and $L_2$ were recorded in $CdCl_3$ and the synthesized metal complexes in DMSO. The resultant resonance which was assigned by intensity showed promising composition of the compounds. In $L_1$ and $L_2$, the hydroxyl proton showed signal at 15.20ppm and 7.8ppm respectively which later disappeared in all the synthesized complexes due to the deprotonation of the hydroxyl proton. For the aromatic protons, $L_1$ and $L_2$ showed a simple pattern which is due to the presence of fewer protons in this region. The ratio of L to M was 2:1. The signals for 13 protons were observed after complex formation. The azomethine proton of $L_1$ and $L_2$ showed signals in the range 8.6 and 8.9 for $L_1$ and $L_2$ respectively. A downwards shift of both the signals to 9.0 and 8.9 prove a bonding of N to the metal. The trends obtained were found to be in agreement with the observations made by Ugama (2020).

## $^{13}$C-NMR

The $^{13}$C-NMR data of $L_1$ and $L_2$ and the synthesized metal complexes were recorded in DMSO. The phenolic carbon shifted to a lower field region in complexes proving co-ordination of the C-O group to the transition metal to form C-O-M bond. There was no significant shift due to the C atoms on bonding to the metal. The C-7 azomethine carbon showed a down field shift of electron density from N to the metal to form N-M bond. The $^{13}$C-NMR spectral results have been presented in our earlier publications by Iorungwa *et al.*, (2020).

**Table 4:** $^{13}$C-NMR spectral studies of $L_1, L_2$ and its metal complexes

| C/No | (1) | (5) | (7) | (11) |
|---|---|---|---|---|
| $L_1$ | 148.6. | 148.5 | 148.9 | 149.7 |
| $L_2$ | 145.0 | 145 | 145.0 | 146.1 |
| [FeL$_1$Cl$_2$]6H$_2$O | 118.4 | 118 | 118.2 | 119.4 |
| [FeL$_2$Cl$_2$]6H$_2$O | 123.4 | 123 | 121.2 | 121.4 |
| [NiL$_1$Cl$_2$]6H$_2$O | 123.5 | 125 | 123.3 | 123.4 |
| [NiL$_2$Cl$_2$]6H$_2$O | 114.0 | 119.9 | 118.4 | 119.8 |

**Table 5:** FTIR Spectra for $L_1$, $L_2$ and its metal complexes

| Codes | O – H | C = N | M – O | M – N | M – Cl |
|---|---|---|---|---|---|
| $L_1$ | 3473 | 1960 | - | - | - |
| $L_2$ | 3477 | 1997 | - | - | - |
| [FeL$_1$Cl$_2$]6H$_2$O | 3213 | 1610 | 674 | 838 | |
| [FeL$_2$Cl$_2$]6H$_2$O | 3224 | 1625 | 620 | 810 | |
| [NiL$_1$Cl$_2$]6H$_2$O | 3343 | 1617 | 667 | 389 | |
| [NiL$_2$Cl$_2$]6H$_2$O | 3481 | 1628 | 518 | 914 | |

## Fourier Transform Infared Resonance (FTIR)

Using KBr pellets in the range 4000 – 450, the FTIR spectra were recorded and the characteristic bands are listed in the Table 5. Allocation of various vibration bonds were made by comparison of ligands spectra with that of the metal ions.

The –OH vibrational stretch for the ligands occurred at 3473 and 3477 cm$^{-1}$. After complexation, the signals shifted downward in all the metal complexes. Due to the paramagnetic effect of all the M(II) ions, there was a downward shift of the signals and hence support the coordination of the Schiff bases to the metal ions. At the lower region, the bands allocated to the M – N bond ranges from 400 to 477 and for M – Cl the band allocated ranges from 332 to 440cm$^{-1}$.

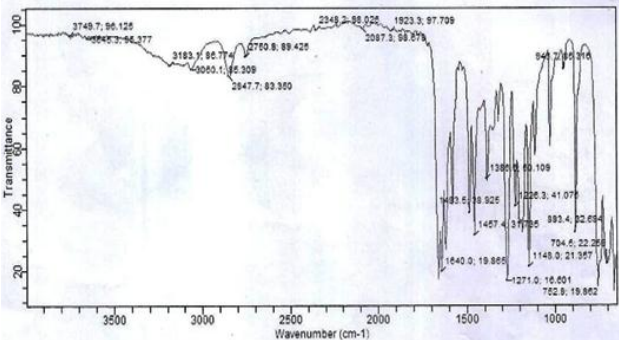


**Figure 1:** FTIR spectrum of 2[(2-nitrophenylimino) methyl] phenol ($L_1$)

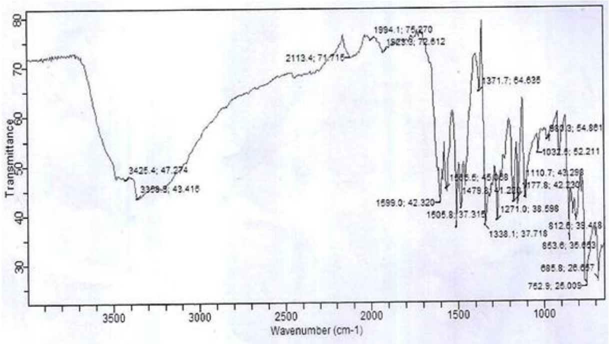


**Figure 2:** FTIR spectrum of 2-[(4-nitrophenylimino) ]methyl] phenol ($L_2$)

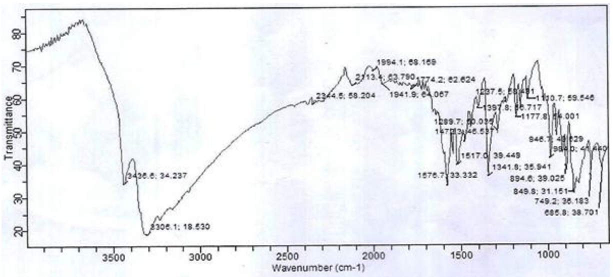


**Figure 3:** FTIR spectrum of Fe(II) complex with the ligand $L_1$

## Mass Spectra

The ligands and its metal complexes were analyzed in DMSO solution and the ESI, m/z showed a positive ion peak at m/z 258 in consonance with the proposed formula of the moiety $C_{13}H_{10}N_2O_3$ whose atomic mass was 257.9 which is very close. Serial peaks range of m/z of 64.0, 103.0, 135.0, 193.0, 245.0, 306.1 etc can be allocated to the different fragments of the Schiff base.Similar positive ESI m/z for Fe(II) was recorded and for Ni(II) complexes available peaks occurred at 479with respect to molecular ion fragments which supports the proposed structure of the complexes (M+z).Due to the presence of isotopic chlorine, fragments were seen in all the complexes. Some solvents including water molecules can show molecular ion peaks (Sharma, 2007; Shabani *et al*., 2010).

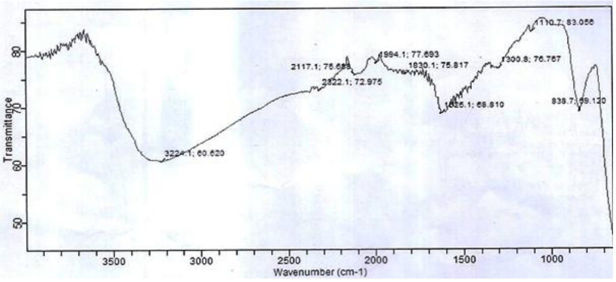


**Figure 4:** FTIR spectrum of Fe(II) complex with the ligand $L_2$

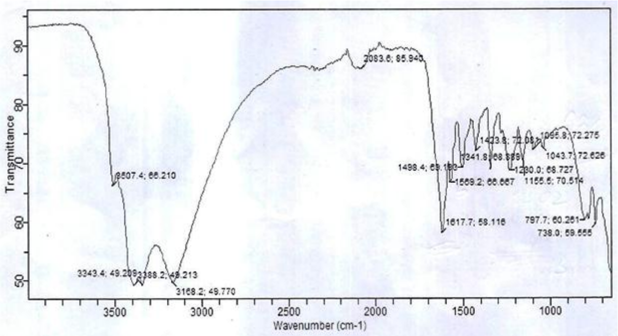


**Figure 5:** FTIR spectrum of Ni(II) complex with the ligand $L_2$

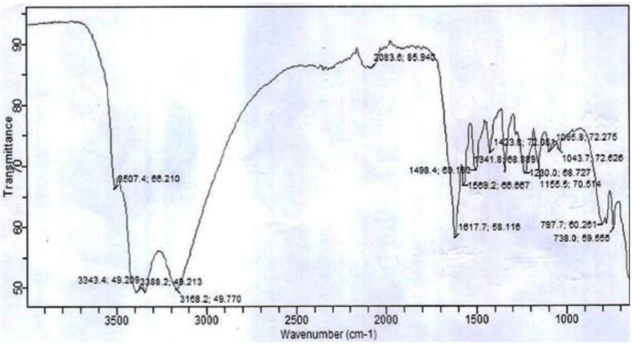


**Figure 6:** FTIR spectrum of Ni(II) complex with the ligand $L_2$

## Magnetic moment

The complexes displayed magnetic moments at different points, Ni(II) complexes showed magnetic moment of 4.39 BM indicating a distorted tetrahedral geometry (Lakshmi *et al.*, 2011). The Fe(II) complex showed a lower magnetic moment of 1.73BM which confirms the coordination of the four water molecule (Yadav, 2006).

## Evaluation of nematocidal studies of *M. arenaria* using the synthesized ligands and their metal complexes

The analyses were carried out at five different concentrations ranging from 125 to 7.8ppm for 1 week. In Schiff base ($L_1$) the corrected percentage mortality of 16 percent was observed at a concentration of 7.8 ppm, but at higher concentration of 125 and 62.5 ppm, the corrected percentage mortality was 83.0 and 80.7 respectively. On day 5, the corrected percentage mortality of 85.0 and 80.0 were observed at concentration of 125 and 625 ppm respectively. At lower concentrations of 15.3 and 7.8 ppm, the corrected percentage mortality was 35.3 and 17.9 respectively. On the seventh day of treatment at higher concentration of 125 and 62.5ppm the corrected percentage mortality was 89.0 and 80.3 respectively. At lower concentration of 15.3 and 7.8ppm the corrected percentage mortality obtained was 37.3 and 19.3 respectively was observed.

Conversely Schiff base $L_2$ at lower concentrations of 7.8 and 15.3ppm, the corrected percentage mortality were 35.0 and 30.00 respectively. At higher concentrations of 125 and 62.5ppm, the corrected percentage mortality was 87.2 and 86.2 respectively. On the seventh day, the percentage mortality was 90.2, 89.0, 63.3, 39.00 and 23.6 at the respective concentration values of 125, 62.5, 31.2, 15.2 and 7.81ppm.

On the first day of treatment with metal complex $[FeL_1Cl_2]6H_2O$, it was observed that, at concentrations of 15.3 and 7.8 ppm the corrected percentage mortality was 48.6 and 42.6 respectively. At concentration 125 and 62.3 ppm the corrected percentage mortality were 100 and 98.3 respectively. On the third day of treatment, at concentration of 15.3 and 7.8 ppm, the corrected percentage mortality were 46.3 and 45.0 whereas at 125 and 62.5 ppm, the corrected percentage mortality were 100.0 and 99.3 respectively. On the fifth day of treatment, at concentration of 15.3 and 7.8 ppm, the corrected percentage mortality was 56.0 and 55.6 respectively. At 125 and 62.5 ppm the corrected percentage mortality was 99.3 and 99.7 respectively. On the seventh day of treatment, at the concentration of 125 and 62.5 ppm the percentage mortality observed was 100.0, 98.7 respectively and 45.3 and 40.3 at concentrations of 15.3 and 7.8 ppm respectively. The observations obtained were in close agreement with the results of the research conducted elsewhere (Iorungwa *et al.*, 2020; Ugama, 2020).

Using metal complex $[FeL_2Cl_2]6H_2O$ for first treatment, at concentrations 15.3 and 7.8 ppm, the corrected percentage mortality were 57.3 and 45.7 whereas at concentrations 125 and 62.5 ppm the corrected percentage mortality were 96.5 and 95.0 respectively. On the third day of treatment, the corrected percentage mortality was 61.3 and 46.0 at concentrations of 15.3 and 7.8 ppm respectively whereas at concentrations 125 and 62.5ppm, the corrected percentage mortality obtained was 97.3 and 97.0 respectively. At concentration of 125 and 62.5 ppm the corrected percentage mortality were 99.7 and 99.5 respectively on the fifth day, whereas at concentration of 15.3 and 7.8ppm, the corrected percentage mortality recorded was 60.7 and 47.0 respectively. On the seventh day of treatment, the corrected percentage mortality was 100.0, 99.6, 88.0, 67.7 and 52.7 respectively.

Conversely, metal complex $[NiL_1Cl_2]6H_2O$ showed that the corrected percentage mortality at 15.3 and 7.8 ppm of 44.0 and 43.5 respectively, whereas at concentration values of 125 and 62.5 ppm, the corrected percentage mortality were 98.0 and 78 respectively. On the third day of treatment at concentrations of 15.3 and 7.8 ppm, the corrected percentage mortality were 42.0 and 4.6 respectively, whereas at concentration of 125 and 62,5 ppm the corrected percentage mortality were 98.6 and 83.0 respectively. On the fifth day of treatment, the corrected percentage mortality was 35.7 and 34.8 at concentration of 15.3 and 7.8ppm respectively whereas at 125 and 62.5 ppm, the corrected percentage mortality was 99.3 and 92.8 respectively.

On the seventh day, the corrected percentage mortality was 100.0, 99.3, 81.3, 47.7 and 35.0 respectively. On the first day of using metal complex $[NiL_2Cl_2]6H_2O$, the corrected percentage mortality at concentrations of 15.3 and 7.8 ppm was 44.0 and 43.7 respectively, whereas at concentrations of 125 and 62.5ppm, the corrected percentage mortality showed 94.3 and 94.0 respectively. On the third day of treatment, the corrected percentage mortality was 50.0 and 44.0 at concentrations of 15.3 and 7.8 ppm whereas at 125 and 62.5 ppm the corrected percentage mortality was found to be 99.3 and 90.3 respectively. On the fifth day of treatment, the corrected percentage mortality was 98.3 and 95.0 at concentrations of 125 and 62.5 ppm respectively, whereas at 15.3 and 7.8 ppm, the corrected percentage mortality recorded 52.7 and 52.3 respectively. The corrected percentage mortality on the seventh day gave 100.0, 99.3, 90.3 and 60.3 and 43.8 respectively.

From the results of the various determinations, it could be observed that there was a gradual increase in corrected percentage mortality with increasing time of treatment. The results showed that the synthesized metal complexes exhibited higher bioefficacy on M. *arenaria* at higher concentration than the ligands $L_1$ an $L_2$ at the same level of concentration. Conversely, the Schiff base ligand at lower concentrations of 15.3 and 7.8 ppm the mortality rate were lower in the range of 30.0 to 35.0 respectively (Iorungwa *et al.*, 2020; Ugama, 2020).

Plates 1 and 2 show the photos of the nematodes in the galls of *Arachis hypogea*, while 3 and 4 show the photos of the nematodes before and after application of the synthesized complexes. The implication here is that the synthesized complexes show a high level of efficiency in serving as nematicides for inhibiting the activities of the root knot nematodes in *Arachis hypogea*.

**Plate 1:** M. arenaria in galls of Arachis hypogeal

**Plate 2:** *photo of M. arenaria in galls of A. hypogea*

**Plate 3:** Photo of M. arenaria before application of synthesized complex

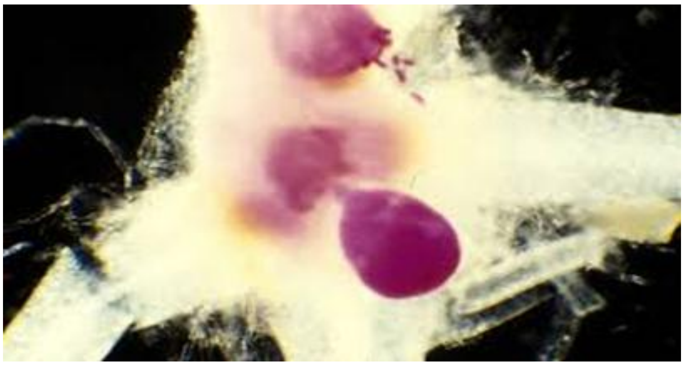


**Plate 4:** photo of M. arenaria after application of synthesized complex

**Table 6:** Nematicidal studies of *M. arenaria* using the synthesized metal complexes and Schiff bases $L_1$ and $L_2$

| Synthesized compounds | No of days | Corrected percentage mortality at various concentration | | | | |
|---|---|---|---|---|---|---|
| | | 125.0 ppm | 62.5 ppm | 31.3 ppm | 15.3 ppm | 7.8ppm |
| $L_1$ | 1 | 83.0 | 80.7 | 44.7 | 22.7 | 16.0 |
| | 3 | 84.0 | 81.0 | 61.3 | 32.7 | 16.3 |
| | 5 | 85.0 | 80.0 | 62.0 | 35.3 | 17.7 |
| | 7 | 89.0 | 80.3 | 66.3 | 37.3 | 19.3 |
| Control | 1 | 0 | 0 | 0 | 0 | 0 |
| | 3 | 0 | 0 | 0 | 0 | 0 |
| | 5 | 0 | 0 | 0 | 0 | 0 |
| | 7 | 0 | 0 | 0 | 0 | 0 |
| $L_2$ | 1 | 87.2 | 86.2 | 36.3 | 35.0 | 30.0 |
| | 3 | 87.5 | 87.0 | 55.7 | 28.3 | 22.0 |
| | 5 | 88.6 | 88.0 | 57.3 | 34.7 | 25.3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 7 | 90.2 | 89.0 | 63.3 | 39.0 | 23.6 |
| $[FeL_1Cl_2]6H_2O$ | 1 | 100.0 | 98.3 | 56.7 | 48.6 | 42.6 |
| | 3 | 100.0 | 99.3 | 56.0 | 46.3 | 45.0 |
| | 5 | 99.3 | 99.7 | 58.30 | 56.0 | 55.3 |
| | 7 | 100.0 | 98.7 | 53.7 | 45.3 | 40.3 |
| $[FeL_2Cl_2]6H_2O$ | 1 | 97.0 | 97.0 | 70.3 | 57.3 | 45.7 |
| | 3 | 97.3 | 96.0 | 72.7 | 61.3 | 46.0 |
| | 5 | 99.7 | 99.5 | 75.0 | 60.7 | 47.0 |
| | 7 | 100.0 | 99.6 | 88.0 | 67.7 | 52.7 |
| $[NiL_1Cl_2]6H_2O$ | 1 | 98.0 | 78.7 | 83.7 | 44.0 | 43.5 |
| | 3 | 98.6 | 83.00 | 51.0 | 42.0 | 41.6 |
| | 5 | 99.3 | 92.3 | 73.0 | 35.7 | 34.8 |
| | 7 | 100.0 | 99.3 | 81.3 | 47.7 | 35.0 |
| $[NiL_1Cl_2]6H_2O$ | 1 | 94.3 | 83.3 | 39.3 | 44.0 | 43.7 |
| | 3 | 99.3 | 90.3 | 52.7 | 50.0 | 44.0 |
| | 5 | 98.3 | 95.0 | 72.3 | 52.7 | 50.7 |
| | 7 | 100.0 | 99.3 | 90.3 | 60.3 | 41.7 |

The application of the ligands and its metal complexes can suppress the population of *M. arenaria* and promote the growth and yield of *Arachis hypogea.* This is attributable to the high nutrient content that will become available to the peanuts. This result is consistent with researches previously carried out by Al- kahraman *et al.*, (2011). The nematicidal properties of the ligands and its metal complexes can promote growth. The reduction in population of nematodes through the application of Schiff base and its metal complexes is a novel mechanism for enhancing high yield of *Arachis hypogea.*

## Conclusions

The research synthesized, characterized and understudied the nematicidal activities of some Schiff bases and their metal complexes against *M. arenaria.* In this study, the root knot nematode, *M. arenaria* was identified and confirmed to dominate pests affecting *Arachis hypogea*. The synthesized ligands and their metal complexes effectively sacrificed the nematodes.When compared with the ligands, the metal complexes showed higher sacrificing ability and potency than the free ligands in suppressing the repopulation of nematodes.

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