Antimicrobial Studies Of Synthesized Zinc(Ii) Schiff Base Complexes Of L-Arginine-2-Hydroxy-1-Naphthaldehyde And Glycine-2-Hydroxy-1-Naphthaldehyde

Grace E. Iniama, Isaac Terungwa Iorkpiligh, Samson Olajire Olanrele

ABSTRACT: The Schiff base ligands, L-arginine-2-hydroxy-1-naphthaldehyde and glycine-2-hydroxy-1-naphthaldehyde and their Zn(II) complexes were prepared at room temperature. The infrared analysis proved that the ligands are bidentate and thus coordinated to the Zn (II) ion through their azomethine nitrogen atom and the oxygen atom of the carbonyl / carboxylate ion (COO-). From the UV analysis, a four coordinate tetrahedral structure was proposed for the complexes. The antimicrobial studies carried out on Escherichia coli, Staphylococus aureus, Salmonella typhi and Candida albicans strains revealed that both the ligands and their complexes exhibit promising antimicrobial properties.

Key words: Schiff base, synthesis, complexes, tetrahedral geometry, antimicrobial

INTRODUCTION

In recent times, antimicrobial resistant drugs have been seen to be a global problem, preoccupying research institutions, pharmaceutical companies and academics (1). This is because many microorganisms are naturally becoming resistant to already existing drugs due to morphological changes, cell divisions and mutations of their genome or by accepting antimicrobial genes from other microbes (2; 3). Antimicrobial resistant occur when microorganisms change in some way that reduces or eliminates the effectiveness of drugs designed to prevent alterations to cells (3) These natural microbial resistant properties shown by microbes have further complicated the world's challenge in health sector (4). Therefore to build a strong health sector in any nation, major advances towards the improvement of antimicrobial drugs have to be continuous process. These discoveries coupled with continuing developments for better antibiotics will be of very great achievement in modern science and technology (5). In order to achieve this, several research works have been done and a lot more are still going on, all gearing towards the design of novel compounds that will serve as more potent antimicrobial drugs. Such efforts have been extended to cover plant extracts and synthetic materials (6). The potentials of metal complexes in therapeutic applications have also been reported by various authors (7). In bioinorganic chemistry the study of coordination chemistry of biologically important metal ions with ligands is creating great impact in this area. (8). This work is therefore focusing on the synthesis and characterization of Zn(II) Schiff base complexes derived from L-arginine-2-hydroxy-1-naphthaldehyde and glycine-2-hydroxy-1-naphthaldehyde and their antimicrobial activities.

- *Grace E. Iniama -Department of Pure and Applied Chemistry, University of Calabar, Calabar.*
- *Isaac Terungwa Iorkipiligh - Department of Chemistry, College of Education Oju, Benue State.*
- *Samson Olajire Olanrele -Department of Pure and Applied Chemistry, University of Calabar, Calabar. Email:geiniama@yahoo.com*

EXPERIMENTAL

Perkin Elmer FT-IR spectrophotometer (spectrum BX Model using spectrum version 5.3.1 software version) in 4000-400cm1 range using KBr pellets, Perkin Elmer spectrophotometer UV-VIS double beam PC scanning spectrophotometer (UVD -2690 using UV-Winlab 2.8.5.04 software version using DMF as solvent, molar conductance of the complexes was measured using a systronic conductivity bridge at room temperature in DMSO and the elemental analysis was done using Perkin-Elmer PE 240 automatic elemental analyzer.

SYNTHESIS OF THE L-ARGININE-2-HYDROXY-1-NAPHTHALDEHYDE (LAHN)

An ethanolic solution of L-arginine (0.01M) was added while stirring into ethanolic solution of 2-hydroxy-1-naphthaldehyde (0.01M), three drops of glacial acetic acid were added followed by continuous stirring for two hours at room temperature. The yellow precipitate formed was filtered, washed several times with ethanol, then ether and dried over fused calcium chloride under vacuo. (9).

SYNTHESIS OF ZN(II) L-ARGININE-2-HYDROXY-1-NAPHTHALDEHYDE COMPLEX

Zn(II) chloride (0.003M) dissolved in ethanol was warmed and added to the ethanolic solution of the ligand (0.003M L-arginine-2-hydroxy-1-naphthaldehyde) followed by few drops of sodium hydroxide. The mixture was stirred for two hours and the precipitate formed was filtered, washed and dried over fused calcium chloride under vacuo.

SYNTHESIS OF GLYCINE-2-HYDROXY-1-NAPHTHALDEHYDE (GHN)

Few drops of aqueous sodium hydroxide were added to 50cm3 ethanolic solution containing 0.01M glycine and the solution was stirred magnetically at room temperature until it became homogenous. 50cm3 ethanolic solution of 2-hydroxy-1-naphthaldehyde (0.01M) was then added and stirred for three hours. The yellowish-brown precipitate

obtained was filtered, washed with ethanol, rinsed using ether and dried over fused calcium chloride under vacuo . (10)

SYNTHESIS OF ZINC(II) GLYCINE-2-HYDROXY-1-NAPHTHALDEHYDE

Warmed 30 cm3 ethanolic solution of zinc(II) chloride (0.003M) was gently mixed with 30 cm3 ethanolic solution of the glycine-2-hydroxy-1-naphthaldehyde (0.003M). A yellowish precipitate was formed after stirring for two hours. The precipitate was filtered, washed using ethanol and dried in over fused calcium chloride under vacuo (11).

ANTIMICROBIAL ACTIVITY TEST

The method adopted for the antimicrobial tests is the general and widely reported procedure in many literatures such as 12,13,14,15 & 16 etc,

Results and discussion

Table 1: *Physical properties of the compounds*

Compound	Molcular formula	Colour	Nature	Yield %	Melting points (^{0}C)	Conductivity (µs)	Found(Cacld%)			
							M	C	H	N
LAHN	$C_{17}H_{21}N_4O_3$	Yellow	Powdery	87.73	203.7	1.17	-	63.6 (62.0)	5.4 (6.4)	16.0 (17.0)
$Zn(LAHN)_2$	$ZnC_{34}H_{42}N_8O_6$	Yellow	Powdery	45.53	213.4	1.53	9.0 (8.9)	57.7 (56.4)	5.9 (5.8)	16.0 (15.5)
GHN	$C_{12}H_{10}NO_2$	Yellowish brown	Powdery	52.28	235.6	4.45	-	75.3 (74.6)	5.8 (5.2)	4.6 (3.6)
Zn(GHN)	$ZnC_{26}H_{22}N_2O_4$	Brown	Powdery	47.78	238.0	2.09	14.4 (13.9)	62.3 (61.9)	4.8 (4.3)	6.4 (6.0)

Important Infrared Spectra Bands in (cm^{-1})

COMPOUNDS	OH	C=N	COO^-	M-N	M-O
LAHN	3400	1590	1342s	-	-
$[Zn(LAHN)_2]Cl_2$	3240s	1570s	1346s	606m	455w
GHN	3457s	1600s	1346s	-	-
$[Zn(GHN)_2]Cl_2$	3451s	1570s	1392s	580w	499m

s=strong, m=medium, w=weak

Table 3: *Antimicrobial Studies of ligands and their metal complexes*

Compound	**Zone of Inhabitation (mm) at 1000µg /ml**			
	S. typhi	*E. coli*	*S. aureus*	*C. albican*
LAHN	16.8	17.5	17.2	10.8
$[Zn(LAHN)_2]Cl_2$	24.9	27.3	18.6	18.8
Streptomycin	25.4	11.9	23.6	NA
Ketoconazole	NA	NA	NA	11.0
GHN	13.2	16.7	17.6	12.4
$[Zn(GHN)_2]Cl_2$	18.5	17.8	18.0	18.6
Streptomycin	25	11	23	NA
Ketoconate				11

NA = Not Applicable

INFRARED ANALYSIS

Information from the infrared spectrum revealed the functional groups available and possibly in bonding with the metal ion. The ligands IR spectra show broad bands in the region of 3200-3600cm1 assignable to –OH groups. The retention of this peak in LAHN complex indicates that the –OH group is free and was not involved in complexation and its disappearance in GHN complex meant that ligand was

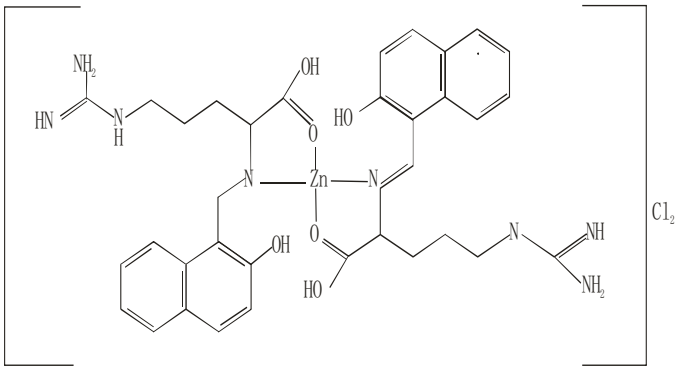
deprotonated on complexation thus coordination through carboxylate ion occurred.The strong band at 1590-1550 cm3 and 1600-1540 cm-1 in the spectra of the ligands are characteristic of the azomethine group; υ(C=N) for the L-arginine-2-hydroxy-1-naphthaldehyde and glycine-2-hydroxy-1-naphthaldehyde respectively. These bands were shifted to a lower wave number of 1570-1520 cm-1 and 1590-1510 cm-1 respectively during coordination suggesting the involvement of the nitrogen atom of the azomethine group in coordination to the Zn(II) ion. The carboxylate band (COO-) at 1342-1335 cm-1 and carbonyl band at 1646-1610 cm-1 in the spectra of L-arginine-2-hydroxy-1-naphthaldehyde and glycine-2-hydroxy-1-naphthaldehyde respectively were also shifted up by about 30-50 cm-1 during coordination to the Zn(II) ion. The bands in the spectrum of the zinc(II) L-arginine-2-hydroxy-1-naphthaldehyde complex at 606cm-1 and 455cm-1 are due to the formation of υ(M-N) and υ(M-O) respectively. While the υ(M-N) and υ(M-O) band frequencies for the zinc(II) glycine-2-hydroxy-1-naphthaldehyde were formed at 580 cm-1 and 499 cm-1 respectively Thus the ligand coordinated to the metal ion through it azomethine nitrogen atom and oxygen atom of the carbonyl / carboxylate ion. Thus implicating a bidentate mode for the ligands.

ELECTRONIC ABSORPTION SPECTRA

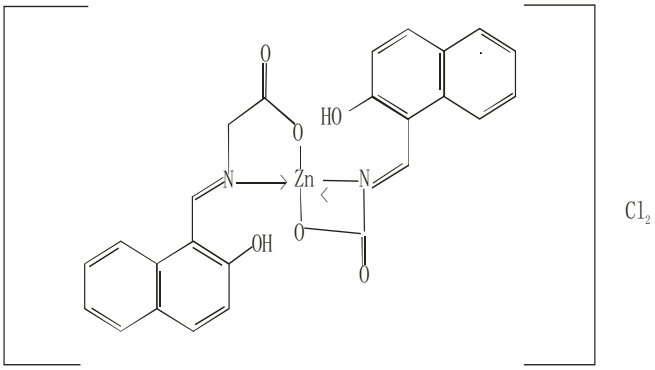
The absorption region, band assignment and the proposed geometries of the complexes are given in Table 2. The electronic absorption spectra of the ligands gave bands at 30,395cm-1 and 29,940cm-1 for LAHN and GHN respectively. These bands are attributable to π → π* transitions associated with the azomethine chromophores (17). These wavelengths shifted to lower wavelengths at 38,759 and 29,498 cm-1 in the spectra of the complexes suggesting the coordination of the azomethine group to the Zn ion. The electronic spectra of Zinc complexes gave no d-d transitions since it is a d10 ion, hence no LFSE. The bands at 30,120cm-1 and 23,866cm-1 for the zinc(II) L-arginine-2-hydroxy-1-naphthaldehyde and glycine-2-hydroxy-1-naphthaldehyde respectively are attributed to LMCT compatible with tetrahedral geometry for the Zn(II) (18).

ANTIMICROBIAL ACTIVITY

The antimicrobial studies data shown in Table 3 were obtained after the synthesized compounds were tested against the bacteria: S. typhi, E.coli,S. aureus and the fungi: C. albican . The zones of minimum inhibitory concentration values obtained are summarized in Table 3.This display shows that Zn(II) complexes gave far better antimicrobial properties than the free ligands. These increased antimicrobial activities by the chelates can be explained using chelation theory. The increased antimicrobial properties of the zinc complexes is due to the formation of the chelate which then reduced the polarity of the zinc ion and increased the lipophilic nature of the zinc ion thus facilitating its ability to cross the cell membranes of the microorganisms to block the binding site on enzymes. The polarity of the metal is reduced to a greater extent due to the overlap of the ligand orbital and partial sharing of the positive charge of the metal ion with the donor groups of the ligand (19). Secondly, the delocalization of the pie-electrons over the whole chelate ring system enhance the penetration of the complexes into the lipid membranes of the cells and thereby blocking the metal binding sites in the enzymes of microbes. The respiration process of the cells are also disturb by these. In all, the general synthesis of protein is blocked and thereby hindering further growth and proliferation of microorganisms



Proposed structure for $Zn[(LAHN)_2]Cl_2$



Proposed structure for $[Zn(GHN)_2]Cl_2$

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