



## Preparation, characterization, and antibacterial properties of mixed ligand complexes of L-asparagine and sulfamethoxazole(antibiotic) with Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II) ions

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### ABSTRACT

The research includes the synthesis and identification of the mixed ligands complexes of  $M^{+2}$  ions in general composition  $[M(Asn)_2(SMX)]$  Where L- Asparagine ( $C_4H_8N_2O_3$ ) symbolized (AsnH) as a primary ligand and Sulfamethoxazole ( $C_{10}H_{11}N_3O_3S$ ) symbolized (SMX) as a secondary ligand. The ligands and the metal chlorides were brought in to reaction at room temperature in (v/v) ethanol /water as solvent containing NaOH. The reaction required the following [(metal:  $2(Na^+Asn^-)$ : (SMX)] molar ratios with M(II) ions, Where: M(II)=Mn(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Hg(II). The UV-Vis and magnetic moment data revealed an octahedral geometry around M(II), The conductivity data show a non-electrolytic nature of the complexes. The antimicrobial activities of ligands and their mixed ligand complexes were screened by disc diffusion method.

**Keywords:** Sulfamethoxazole, L- Asparagine, Mixed ligand, Metal complexes, Antimicrobial activity.

### INTRODUCTION

Chemistry of drugs attracts many researchers because of its application in medicinal study. The metal complexes of drugs play an important role in drug action and metabolism. Metal complexes are widely used in various fields, such as biological processes, pharmaceuticals, separation techniques, analytical processes etc. Survey of literature reveals that no systematic study of complexes of metal ion with antibacterial drugs and amino acids had been reported [1-4].

Asparagine (figure 1- Formula 1) is one of the 20 most common natural amino acids. It has carboximide as the side chain's functional group. Its molecular formula is  $C_4H_8N_2O_3$ . The nervous system requires asparagine. It also plays an important role in the synthesis of ammonia. [1-2]

During the recent years, there has been significant interest in the coordination chemistry, the structural properties and the reactivity of metal complexes of amino acids. [3-4]

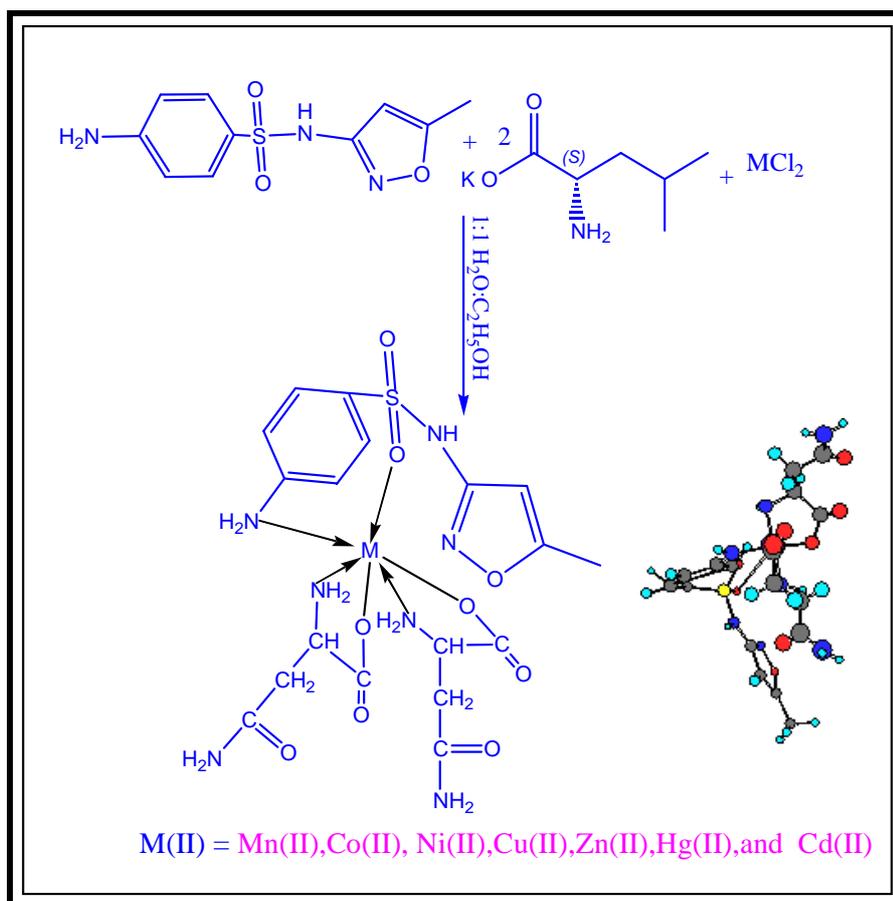
Rey and Co-worker. [5] investigated the complexation equilibrium of L-Serine and L-Leucine with Ca(II), Mg(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and Pb(II) at 25°C, I=0.1M  $KNO_3$  in various ethanol-water media. The equilibrium constants of the complexes formed were discussed in terms of the acid-base characteristics of the amino acids and the properties of the cations concerned. [2-5]. The derivatives of some amino acids function as drugs. L-Levodopa, a laevorotatory isomer of 3-(3,4-dihydroxy phenyl)L-alanine, is well known for its involvement in neurotransmission process and in the treatment of Parkinson's Disease. [6]. Sulfamethoxazole ( $C_{10}H_{11}N_3O_3S$ ) (Systematic (IUPAC) name= 4-amino-N-(5-methylisoxazol-3-yl)-benzenesulfonamide (figure 1- Formula 2) is a sulfonamide bacteriostatic antibiotic. A complex of sulfamethoxazole (SMX) and hydroxypropyl- $\beta$ -cyclodextrin



**(B) General method for Preparation of the mixed ligand metal (II) complexes:**

A metal(II) chloride [(0.197g,  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ ,  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  (0.237g, 1mmol),  $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$  (0.237g, 1mmol),  $\text{CuCl}_2 \cdot 2\text{H}_2\text{O}$  (0.176g, 1mmol),  $\text{ZnCl}_2$  (0.136g, 1mmol),  $\text{CdCl}_2$  (0.183g, 1mmol), and (0.271g, 1mmol),  $\text{HgCl}_2$  (0.271g, 1mmol)] dissolved in ethanol: water (1:1) 25ml respectively was added gradually with stirring to solution of potassium aspartate ( $\text{K}^+ \text{Asn}^-$ ), (0.253gm, 1mmole) of Sulfamethoxazole (SMX) was added to the mixture in each case by using stoichiometric amount [(1:2:1) [(metal: 2( $\text{K}^+ \text{Asp}^-$ ): (SMX)] molar ratios, the above reaction mixture to raise the pH upto ~6.0 and the mixture was stirred for (20 -30min) at room temperature. After one day a colored microcrystalline solid was obtained which was filtered and washed with ethanol. The solid was recrystallized from a  $\text{H}_2\text{O}$ /ethanol (50%) mixture. and dried in vacuum over anhydrous  $\text{CaCl}_2$ . See Scheme (1). The yields range from 65 to 90 %. The decomposition temperatures range from: 216-340 °C.

The solubility of the metal complexes were tested using various polar solvents like water, methanol, ethanol, acetone, propanol, DMF, DMSO and nonpolar solvents like benzene and diethyl ether, carbon tetrachloride. (10 mg of metal complex was taken and dissolved into (1-2) ml of corresponding solvent and checked the solubility.



Scheme (2) : Schematic representation Preparation of the Complexes,  $[\text{M}(\text{Asn})_2(\text{SMX})]$  and Proposed structure for the complexes (3D)

## RESULTS AND DISCUSSION

This study has provided an opportunity to compare the spectroscopic and other physical properties of all the complexes by using data obtained under the similar set of experimental conditions. The metal (II) complexes (1-7) were prepared in a stoichiometric [(metal: 2( $\text{K}^+ \text{Asn}^-$ ): (SMX)] of 1:2:1. of molar ratios with M(II) ions, Were  $\text{M(II)} = \text{Mn(II)}, \text{Co(II)}, \text{Ni(II)}, \text{Cu(II)}, \text{Zn(II)}, \text{Cd(II)}$  and  $\text{Hg(II)}$ . Were used as chlorides and obtained in fairly good yield (Scheme-2). The physical properties of the complexes are shown in (Table 1).

**Color Determination:**

Color of the metal complexes were determined by the visual observation. All the complexes are colored, non-hygroscopic.

**Melting Point and Solubility :**

The complexes are thermally stable and decomposed at high temperature on heating. These are insoluble in water or most of the organic solvents like methanol, benzene and carbon tetrachloride, DMF but soluble in DMSO.

**Molar conductance:**

Molar conductance's ( $\Lambda_m$ ) of  $10^{-3}$  solutions of the complexes in DMSO lie in very low range (1-11.4)  $\Omega^{-1}\text{cm}^2\text{mol}^{-1}$  supporting their non-electrolytic behavior. [11]

**Metal Analysis (AAS) and chloride ion content [12]:**

Atomic Absorption Spectroscopy (AAS) analysis of the complexes was carried out by direct method which gave total metal content. The experimental percentage of metal in the complexes was obtained from the AAS data using the following formula:

$$M(\%) = \text{Absorbance}(A, \text{ppm}) \times \frac{\text{volume of metal solution}}{\text{weight of complex}} \times \frac{100}{1000}$$

The calculated and experimental values of metal percentage in each complex are in fair agreement. These results are very supportive of the proposed formulae of the complexes (Table 1).

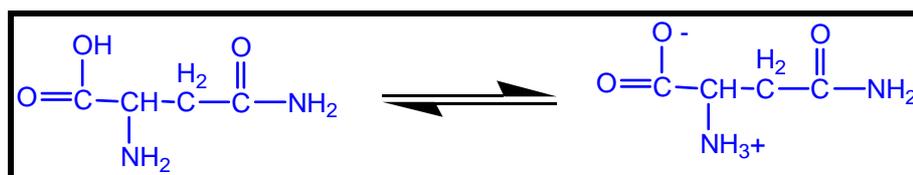
The atomic absorption measurements (Table-1) and chloride ion content (Cl % = Nil) for all complexes gave approximated values for theoretical values. In conclusion, our investigation suggests that the ligands L-Asparagine and Sulfamethoxazole (antibiotic) coordinate with M (II) forming octahedral geometry.

**Fourier-transform infrared spectra and mode of coordination :**

The important infrared frequencies exhibited by the ligands (AsnH) and (SMX) and their mixed ligand complexes are given in the Tables (2, 3 and 4).

The relevant vibration bands of the free ligands and the complexes are in the region  $4000-400\text{ cm}^{-1}$  [8-15]. The most important infrared spectral bands that provide conclusive structural evidence for the coordination of the ligands to the central metal ions.

As regards the chelation of amino acids, the IR spectra exhibited significant features in  $\nu\text{NH}_2$ ,  $\nu\text{COO}^-$  regions. It is worth while mentioning here that the free amino acids exist as zwitterions ( $\text{NH}_3^+\text{AsnH} \cdot \text{COO}^-$ ) and the IR spectra of these cannot be compared entirely with those of metal complexes as amino acids in metal complexes do not exist as zwitterions. [10-12] see Scheme (3).



Scheme (3): zwitterions of L-Asparagine

In the ligand spectra the  $\nu(\text{N-H})$  stretching vibration appears at  $3115\text{ cm}^{-1}$  is shifted at  $3244\text{ cm}^{-1}$ ,  $3196\text{ cm}^{-1}$ ,  $3182\text{ cm}^{-1}$ ,  $3184\text{ cm}^{-1}$ ,  $3188\text{ cm}^{-1}$ ,  $3190\text{ cm}^{-1}$  and  $3191\text{ cm}^{-1}$  (in the Mn (II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II), and Hg(II) respectively, spectra proving the involvement of the  $-\text{NH}_2$  group in the complex formation [13-14]. Table (2), displays the (FT-IR) spectrum for the (AsnH) exhibited a band around  $\nu(3452)\text{ cm}^{-1}$  that corresponds to the stretching vibration of  $\nu(\text{N-H}) + \nu(\text{O-H})$ , while another strong absorption band at  $\nu(3115)\text{ cm}^{-1}$  is due to the  $\nu(\text{N-H})_{\text{sym}}$  while the bands at  $(1557)\text{ cm}^{-1}$  and  $(1431)\text{ cm}^{-1}$  were assigned to the  $\nu(-\text{COO})_{\text{asy}}$  and  $\nu(-\text{COO})_{\text{sym}}$  respectively.  $\nu\Delta(-\text{COO})_{\text{asy-sym}} = 126\text{ cm}^{-1}$ . [8-13].

A general tendency in the relationship between  $\nu(\text{COO}^-)$  (the difference between the wavenumbers of the asymmetric ( $\nu_{\text{asy}}$ ) and the symmetric ( $\nu_{\text{sym}}$ ) stretches of carboxylate group from the FT-IR spectra) and the types of coordination of the  $(\text{COO}^-)$  group to metal ions by examining the structures. [13-14].

In case of (SMX) molecule the  $\nu\delta(\text{N-H})$  vibrations of  $-\text{NH}_2$  (aromatic sec. amine) occur at  $(3468\text{ and }3378)\text{ cm}^{-1}$  for free (SMX) due to  $\nu_{\text{as}}(\text{NH}_2)$  and  $\nu_{\text{s}}(\text{NH}_2)$ , respectively. The hypochromic effect (decreasing in the intensity of  $\nu(\text{NH})$  vibrations in case of mixed ligand complexes rather than (SMX) alone as well as the blue shifted in the

wave numbers from 3299  $\text{cm}^{-1}$  to range (3149  $\text{cm}^{-1}$ ) (mixed complex). [8,12, 13] Such these changes clearly indicate that the lone pair of electron of  $\text{NH}_2$  and in sulfamethoxazole donor is participated in the complexation process with metals. acting as bidentate ligand. [8] .Some new bands of weak intensity observed in the regions around (513-663  $\text{cm}^{-1}$ ) and (437-574  $\text{cm}^{-1}$ ) may be ascribed to M-N and M-O vibrations, respectively [15-16]. It may be noted that, these vibrational bands are absent in the spectra of the ligands.

#### **Electronic spectra and Magnetic moment:**

The electronic spectral studies of Mixed Ligand Complexes of Mn(II) , Co(II) , Ni(II), Cu(II) ,Zn(II) , Cd (II) and Hg (II) with (AsnH) and (SMX) were carried out in DMSO solution. The values of band positions (nm) and molar absorptivity's ( $\epsilon_{\text{max}} \text{L cm}^{-1} \text{mol}^{-1}$ ) with the magnetic moment values for complexes are listed in Table 5 were calculated from the measured magnetic susceptibilities after employing diamagnetic corrections. And together with the proposed assignments and suggested geometries. The results obtained are in good agreement with other spectra and the literatures. [17-24]

#### **[Mn(SMX)(Asn)<sub>2</sub>]**

The (U.V- Vis) spectrum, exhibits two peaks , the first weak peak at (536 nm) ( $18656 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 64 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ), which assigned to d-d transitions ( $6A_{1g}(S) \rightarrow 4T_{2g}(G)$ ) , while the second high intense peak with shoulder at (260 nm) ( $36630 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 1492 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ) is due to the (C.T) and  $\mu_{\text{eff}} = 6.191 \text{ B.M.}$ , which suggests a high spin octahedral geometry around the central metal ion, [17].

#### **[Co(SMX)(Asn)<sub>2</sub>]**

The (U.V- Vis) spectrum, exhibits five peaks , the first three weak peaks are typical of Co(II) ground state . The assignment of the electronic spectral bands, their positions, and the spectral parameters for Co(II)  $4T_{1g}(F) \rightarrow 4T_{2g}(F)$   $\nu_1 = (895 \text{ nm}) 11173 \text{ cm}^{-1}$  , ( $\epsilon_{\text{max}} = 86 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ),  $4T_{1g}(F) \rightarrow 4A_{2g}$ ,  $\nu_2 = (868 \text{ nm}) 11520 \text{ cm}^{-1}$  , ( $\epsilon_{\text{max}} = 74 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ) ,  $3A_{2g}(F) \rightarrow 4T_{1g}$ ,  $\nu_3 = (534 \text{ nm}) 18726 \text{ cm}^{-1}$  , ( $\epsilon_{\text{max}} = 68 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ),  $\nu_2/\nu_1 = 1.03$ ,  $\nu_1/\nu_2 = 0.96$ ,  $\nu_3/\nu_2 = 1.62$ ,

In this case first transition equal splitting energy  $\Delta_o(10 Dq) = 11520 \text{ cm}^{-1}$ ,  $LFSE = 24.86 \text{ kcal} \cdot \text{mol}^{-1}$ ,  $B = 971$  , and the fourth peak (350 nm) ( $38610 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 95 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ) and fifth intense maxima peak at (259 nm) ( $28571 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 987 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ) due to (C.T) intra ligand transitions of the organic moiety. The room temperature magnetic moment ( $\mu_{\text{eff}} = 4.952 \text{ B.M.}$ ) which lie in range (4.82-5.5) BM corresponded to a high spin octahedral geometry. [19,20]

#### **[Ni(SMX)(Asn)<sub>2</sub>]**

The (U.V- Vis) spectrum, exhibits four peaks , the first weak peaks at (860 nm) ( $11627 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 45 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ) which assigned to  ${}^3A_{2g}(F) \rightarrow {}^3T_{1g}(F)$  ( $\nu_1$ ) (d-d), while the second and third peaks , (584 nm) ( $18248 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 41 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ), which assigned to  ${}^3A_{2g}(F) \rightarrow {}^3T_{1g}(F)$  ( $\nu_2$ ) (d-d), and (355 nm) ( $28196 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 75 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ), which assigned to  ${}^3A_{2g}(F) \rightarrow {}^3T_{1g}(F)$  ( $\nu_3$ ) (d-d), respectively and high peak at (290 nm) ( $34482 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 1241 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ) is due to the (C.T) transition. the complex exhibited a value of  $\mu_{\text{eff}} = 2.262 \text{ B.M.}$ , which suggests a high spin octahedral geometry around the central metal ion. [19,20]

The spectral parameters of the Ni(II) complex are as follows [21] :  $\nu_1/\nu_2$  ratio is 0.637,  $Dq$  is for an octahedral Ni(II) complexes [12-22].

#### **[Cu(SMX)(Asn)<sub>2</sub>]**

The (U.V- Vis) spectrum, exhibits two peaks , the first weak peaks at (644 nm) ( $15527 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 104 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ), mainly due to ( ${}^2E_g \rightarrow {}^2T_{2g}$ ), transition suggesting the distorted octahedral geometry [16]. while the second high broad peak at (262 nm) ( $38167 \text{ cm}^{-1}$ ) ( $\epsilon_{\text{max}} = 1206 \text{ molar}^{-1} \cdot \text{cm}^{-1}$ ) may be due to ligand to metal charge transfer (LMCT) which is a characteristic of copper(II) complexes with amines. [23-24] Cu(II) complex exhibited a value of  $\mu_{\text{eff}} = 1.638 \text{ B.M.}$ , [2,21,25] .The observed magnetic moments of Cu(II) lie in the range 1.80- 1.87 BM showing one unpaired electron with paramagnetic nature and suggested a high spin distorted octahedral geometry in terms of Jahn-Teller effect. [19-21]

#### **[Zn(SMX)(Asn)<sub>2</sub>], [Cd (SMX)(Asn)<sub>2</sub>] and [Hg (SMX)(Asn)<sub>2</sub>]**

The Zn(II), Cd(II) and Hg(II) complexes did not display any peak in the visible region, no ligand field absorptions band was observed, therefore the bands appeared in the spectra of three complexes could be attributed to charge transfer transition. in fact this result is a good agreement with previous work of octahedral geometry and magnetic susceptibility measurements for Zn(II), Cd(II) and Hg(II) ( $d^{10}$ ) (white complexes) showed diamagnetic as expected from their electronic configuration . [15,16].

**Antibacterial Activity of Metal Complexes, L-Asparagine and Commercial Drug Sulfamethoxazole(antibiotic)**

Table 5 reveal that the synthesized compounds were potent as bacteriostatic agents. The synthesized metal complexes were screened for their antimicrobial activity by well plate method in nutrient agar. The plates were incubated in incubator at 37°C for 24 hours. In order to ensure that solvent had no effect on bacteria, a control test was performed with DMSO and found inactive in culture medium. Antibacterial activities were evaluated by measuring inhibition zone diameters. (IZ) and compared with the standard DMSO (as control).[24-26]. The zones of inhibition was formed by these complexes was recorded in mm by scale figure -2-complexes have been tested for their antibacterial activity 38, against *E. coli*, *staphylococcus*, *Pseudomonas* and *S. aureus* and *Acineto*. The comparison of the biological activities of the synthesized complexes and known antibiotic shown the following results:

1-The prepared [Hg (SMX)(ASN)<sub>2</sub>] complexes show positive effect towards four organisms have exhibited very good activity with the zone of inhibition 25-30 mm and the complexes also show higher activity than the ligand. [24-25].

2-The prepared [Mn (SMX)(ASN)<sub>2</sub>] complex show negative towards 3- organisms except *Acineto*

3- The prepared [Cu(SMX)(ASN)<sub>2</sub>] complex shows weakly active with the zone of inhibition 12 mm. [26-27].

4-The prepared [Cd(SMX)(ASN)<sub>2</sub>] and [Co (SMX)(ASN)<sub>2</sub>] and [Mn(SMX)(ASN)<sub>2</sub>] complexes show negative towards *E-coli*.

5-The rate of inhibition diameter was varied according to the variation in the complexes ,ligands type and Bacterial type.[27].The antibacterial activity is found to be in the order;

*Acineto*>*staphylococcus*>*Pseudomonas*> *E-coli*

Ligand (Drug)SMX>Ligand(amino acid)ASN

**Table 1 : Analytical and some physical data of the complexes**

Ligand / Complex, Molecular Formula	Color	Yield %	M.P / decomp. Temp. °C	M% Theory (exp)	$\Delta m$ $\Omega^{-1} \cdot \text{cm}^2 \cdot \text{mole}^{-1}$
[Mn(SMX)(Asn) <sub>2</sub> ] C <sub>18</sub> H <sub>25</sub> MnN <sub>7</sub> O <sub>9</sub> S	light-Brown	70	217 -220	9.63 (8.22)	2.2
[Co(SMX)(Asn) <sub>2</sub> ] C <sub>18</sub> H <sub>25</sub> CoN <sub>7</sub> O <sub>9</sub> S	Red- brown	65	230 D	10.26 (8.28)	9.3
[Ni(SMX)(Asn) <sub>2</sub> ] C <sub>18</sub> H <sub>25</sub> NiN <sub>7</sub> O <sub>9</sub> S	Green	72	245D	10.23 (9.21)	5.2
[Cu(SMX)(Asn) <sub>2</sub> ] C <sub>18</sub> H <sub>25</sub> CuN <sub>7</sub> O <sub>9</sub> S	Blue	81	269D	10.97 (9.31)	1
[Zn(SMX)(Asn) <sub>2</sub> ] C <sub>18</sub> H <sub>25</sub> ZnN <sub>7</sub> O <sub>9</sub> S	White	73	201D	11.26 (10.33)	11.4
[Cd(SMX)(Asn) <sub>2</sub> ] C <sub>18</sub> H <sub>25</sub> CdN <sub>7</sub> O <sub>9</sub> S	White	78	289D	17.91 (16.11)	5.9
[Hg(SMX)(Asn) <sub>2</sub> ] C <sub>18</sub> H <sub>25</sub> HgN <sub>7</sub> O <sub>9</sub> S	White	90	315D	28.03 (26.63)	2.7

<sup>a</sup> Calculated values in parentheses

**Table 2-FT-R spectral data of the L-Asparagine**

$\nu(\text{N-H}) + \nu(\text{O-H})$	$\nu(\text{N-H}_2)\text{sym}$	$\nu(\text{C-H}) + \nu(\text{CH}_3)$	$\nu(\text{C-C})$	$\nu(-\text{COO})\text{asy}$	$\nu(-\text{COO})\text{sym}$	$\nu\Delta(-\text{COO})\text{asy-sym}$
3452vs 3452vs	3115s	2966s,2949s	1359vs	1557vs	1431vs	126

**Table 3-FT-R spectral data of Sulfamethoxazole**

$\nu_{\text{as}}(\text{N-H}); -\nu_{\text{s}}(\text{NH}_2) \& -\nu_{\text{s}}(\text{NH})$	$\nu(\text{C-H});$ aromatic	$\nu(\text{C-H}) + \nu(\text{CH}_3)$	$\nu(\text{C=C})$	$\nu\delta_{\text{of}}(\text{N-H})$ Ring breathing band	$\nu \text{C-H}$ deformation	$\nu \text{SO}_2\text{asy}$	$\nu(\text{C-N})$	$\nu(\text{C-O})$	$\nu(\text{SO}_2)\text{sy}$	$\nu(\text{S-N})$	$\nu(\text{C-S})$	$\nu(\text{C-H})$ bend $\delta_{\text{rock}}; \text{NH}$	CNC deformation
$\nu_{\text{as}}$ 3468 s $\nu_{\text{s}}$ 3300vs	3378 vs, , 3143 s	2929 w, 2858 w	1622vs	1597vs	1504s 1469s	1365s	1309s	1266 ms	1157vs 1143s 1091s	987w	831 vs	927 ms	547s

Table 4-FT-R spectral data of mixed ligand complexes

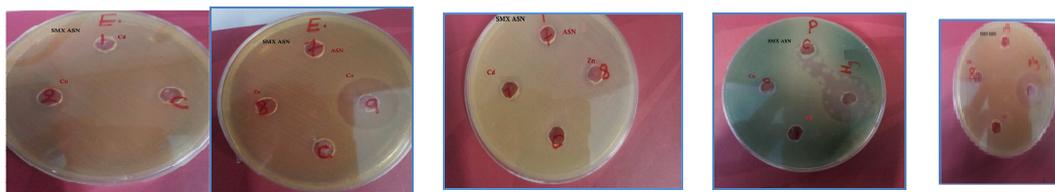
No.	$\nu_{\text{as}}$ (N-H); $\nu_{\text{s}}$ NH <sub>2</sub> & -NH	$\nu$ (C-H); aromaticity	$\nu$ (C-H) + ; CH <sub>3</sub>	Stretch grouping of $\nu$ (C=C)	$\nu_{\text{def}}$ h(N-H) Ring breathing bands	$\nu$ C-H deformation	$\nu$ (SO <sub>2</sub> ) <sub>asy</sub>	$\nu$ (-COO) <sub>asy</sub>	$\nu$ (-COO) <sub>sym</sub>	$\nu$ (C-N)	$\nu$ (SO <sub>2</sub> ) <sub>sy</sub>	M-N	M-O
1 Mn	3437m 3244s	3317 3244	2960 s, 2920m	1680w	1550 vs	1456	1367s	1415s	1301	1307	1180 1159 1026	513 544	437 457
2 Co	3408s 3196s	-	2933w	1651vs	1550 s	1516m	1338w	1462m	1303m	1303m	1170 1134 1095m	663 582	459
3 Ni	3385vs 3182s	3348 3273	2953vs 2929s	1656vs	1593vs	1527mw	1359s	1475s	13459s	1313w	1170 1149 1062m	603m 584m	507 493w
4 Cu	3387vs 3184vs	3333vs 3295vs	2928m ,2362m	1689 vs	1633vs	1587vs 1441s	1361vs	1411s	1361s	1309s	1170vs 1132vs 1099m	605 586	526 451w
5 Zn	3363vs 3188	3364vs 3271v	2964m ,2933m 2870w	1658	1624s	1585vs 1550	1383 Vs	1415vs	1354vs	1317m	1155m 1116vs 1078vs	642 586	574 455
6 Cd	3400vs 3190	3265s 3236	2956w	1660vs	1591vs	1591vs	1388 Vs	1550 s	1388s	1315m	1151m 1126s 1091m	642w 611m	528 462
7 Hg	3470s 3149s	3373 3242s	2929m	1631	1531vs	1599vs	1433	1473s	1363 m	1307	1168m 1136vs 1087vs	657 547	528 503

Table 5- Electronic Spectral data in DMSO, magnetic moment, of the studied compounds

Comp.	$\lambda_{\text{nm}}$	ABS	$\nu'$ (cm <sup>-1</sup> )	Assignments	$\mu_{\text{eff}}$ B.M
C <sub>6</sub> H <sub>13</sub> NO <sub>2</sub> (Asn)	297	1.934	33670	n→π*	-
SMX	275	0.086	36363	π→π*	-
[Mn(SMX)(Asn) <sub>2</sub> ]	536 260	0.064 1.492	18656 36630	<sup>6</sup> A <sub>1g</sub> ( <sup>S</sup> ) → <sup>4</sup> T <sub>2g</sub> ( <sup>G</sup> ) C.T	6.19
[Co(SMX)(Asn) <sub>2</sub> ]	895 868 534 350 259	0.086 0.074 0.068 0.095 0.987	11173 11520 18726 28571 38610	<sup>4</sup> T <sub>1g</sub> → <sup>4</sup> T <sub>1g</sub> ( <sup>F</sup> ) <sup>4</sup> T <sub>1g</sub> → <sup>4</sup> A <sub>2g</sub> ( <sup>F</sup> ) <sup>4</sup> T <sub>1g</sub> → <sup>4</sup> T <sub>1g</sub> ( <sup>P</sup> ) C.T C.T	4.95
[Ni(SMX)(Asn) <sub>2</sub> ]	860 584 355 290	0.045 0.041 0.075 1.241	11627 18248 28196 34482	<sup>3</sup> A <sub>2g</sub> ( <sup>F</sup> ) → <sup>3</sup> T <sub>1g</sub> ( <sup>F</sup> ) <sup>3</sup> A <sub>2g</sub> ( <sup>F</sup> ) → <sup>3</sup> T <sub>2g</sub> ( <sup>F</sup> ) <sup>3</sup> A <sub>2g</sub> ( <sup>F</sup> ) → <sup>3</sup> T <sub>1g</sub> ( <sup>P</sup> ) C.T	2.26
[Cu(SMX)(Asn) <sub>2</sub> ]	644 262	0.104 1.206	15527 38167	<sup>2</sup> E <sub>g</sub> → <sup>2</sup> T <sub>2g</sub> C.T	1.63
[Zn(SMX)(Asn) <sub>2</sub> ]	294	1.297	34013	C.T	Diamagnetic
[Cd(SMX)(Asn) <sub>2</sub> ]	265	1.803	37735	C.T	Diamagnetic
[Hg(SMX)(Asn) <sub>2</sub> ]	272	2.195	36764	C.T	Diamagnetic

Table6. Antimicrobial activity data of the ligands (SMX), (Asn H) and their mixed ligand complexes. (Zone of inhibition (mm))

Comp.	<i>E. coli.</i>	<i>staphylococcus</i>	<i>Pseudomonas</i>	<i>Acineto</i>
(SMX)	0	40	27	45
(ASN)	0	26	11	35
[Mn(SMX)(ASN) <sub>2</sub> ]	0	0	0	12
[Co(SMX)(ASN) <sub>2</sub> ]	0	25	30	25
[Ni(SMX)(ASN) <sub>2</sub> ]	13	18	16	19
[Cu(SMX)(ASN) <sub>2</sub> ]	11	12	15	15
[Zn(SMX)(ASN) <sub>2</sub> ]	12	18	11	23
[Cd(SMX)(ASN) <sub>2</sub> ]	0	25	10	17
[Hg(SMX)(ASN) <sub>2</sub> ]	25	30	25	33



(Figure. 2 ) Photograph of Antimicrobial Activity of M (II) complexes.

Observation  
 Inhibition zone > 15mm  
 Inhibition zone >10mm  
 Inhibition zone > 5mm  
 Inhibition zone ≤5-0 mm

Report  
 Highly active  
 Moderately active  
 Slightly active  
 Inactive

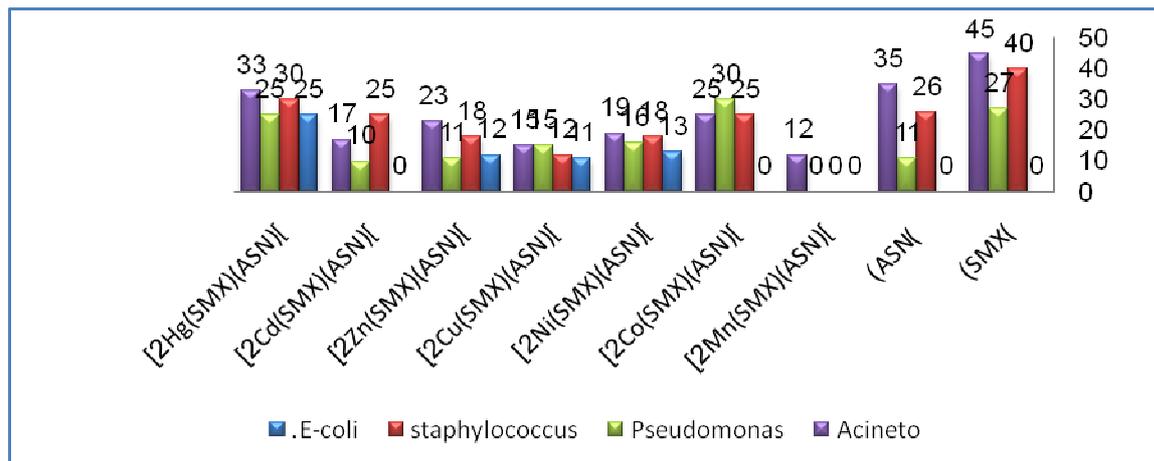


Figure. 3 Chart of biological effects of some of the studied compounds

## CONCLUSION

We have successfully synthesized the mixed ligand complex of M (II)=Mn(II),Co(II),Ni(II),Cu(II),Zn(II),Cd(II)and Hg(II) containing O-N donor ligands. The complex was also characterized by molar conductance, magnetic susceptibility measurement and also by FT- IR, UV- visible spectroscopy. The UV-Vis and magnetic moment data revealed an octahedral geometry around M(II),as proposed. (schem1).All the complexes are non-electrolyte.Based on the reported data, it may be concluded that L-Asparagineand sulfamethoxazole,coordinate to metal ions as bidentate ligand through oxygen atom of carboxylate group (COO<sup>-</sup>) and nitrogen atom of amine group (NH<sub>2</sub> in L-Asparaginewhile In sulfamethoxazole, coordination of the metal ion occur through the oxygen of the sulphone group and nitrogen of the amine group.The complexes are biologically active and exhibit enhanced antibacterial activities as compared to their parent ligands, hence further study of these complexes could lead to interesting results.

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