Preparation, Characterization, and Antibacterial Properties of mixed ligand Complexes of L-leucine and Sulfamethoxazole 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(Leu)$_2$(SMX)] Where *L-leucine*(C$_6$H$_{13}$NO$_2$)symbolized (LeuH) as a primary ligand and Sulfamethoxazole (C$_{10}$H$_{11}$N$_3$O$_3$S)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$^+$ Leu$^-$): (SMX)] molar ratios with M(II) ions, Were   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(antibiotic*), L-leucine*, Mixed ligand, Metal complexes, Antimicrobial activity.

INTRODUCTION :

L- leucine is one of the twenty major amino acids and is considered an essential amino acid [1]. (figure 1- Formula 1) It is branched chain amino acid and taken up by brain and muscle. In leucine metabolism, transamination gives -keto isocaproic acid, which is converted into corresponding   CoA, this is similar to oxidative decarboxylation of alfaketoglutarate and pyruvate. The enzyme complex is very important in the body of living organism. A deficiency of the enzyme causes maple syrup urine disease. In this disease the urine gives odor of maple syrup or burnt sugar   deterioration is rapid and results in mental retardation. [2].The amino acid L-leucine   and various transition metals are important in the biological functions of humans, animals, and plants. [1-2].

(C$_{10}$H$_{11}$N$_3$O$_3$S) (IUPAC name = 4-amino-N-(5-methylisoxazol-3-yl)- Sulfamethoxazole

4-amino-N-(5-methylisoxazol-3-yl)-benzenesulfonamide (figure 1- Formula 2) is a sulfonamide bacteriostatic antibiotic. It is most often used as part of a synergistic combination with trimethoprim in a 5:1 ratio in co-trimoxazole, also It is commonly used to treat urinary tract infections. In addition it can be used as an alternative to amoxicillin-based antibiotics to treat sinusitis. It can also be used to treat toxoplasmosis.[4] It is also applicable for antiseptique, atitubercular   and anti-inflammatory agent.

Sulfamethoxazole (2)	L-leucine (1)

figure -1-
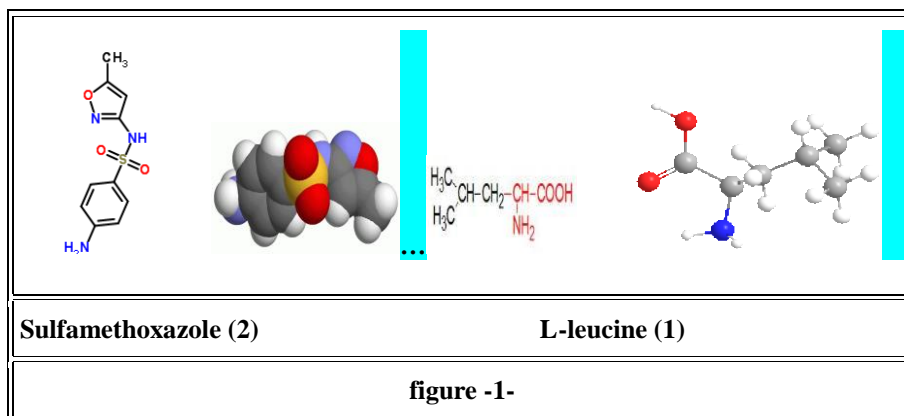
The investigation of metal sulfonamide compounds has received much attention due to the fact that sulfonamides were the first effective chemotherapeutic agents to be employed for the prevention and cure of bacterial infections in humans [4-5]. The sulphur containing ligands are well known for their anticarcinogenic, antibacterial,tuberculostatic, antifungal, insecticidal, and acaricidal activities [5]. Such sulfonamide derivatives widely used in clinical medicine as pharmacological agents with a wide variety of biological actions, were designed from the simple sulfanilamide lead molecule [6], also Schiff base known as anticancer and antiviral agents [7]., and its metal complexes have been widely studied because they have industrial, anti-fungal, anti-bacterial, anticancer herbicidal applications, anti-tubercular activities [8].N-Substituted sulfonamides are still among the most widely used antibacterial agents in the world, mainly because of their low cost, low toxicity, and excellent activity against bacterial diseases. [6],

Literature survey shows that no studies on the synthesis and characterization of mixed ligand complexes of L-leucine and Sulfamethoxazole(antibiotic) have been reported.

In this paper we present the synthesis and study of   Mn(II),Co(II),Ni(II),Cu(II),Zn(II),

Cd(II)and Hg(II) complexes with amino acid   (L-leucine)   as a primary ligand and Sulfamethoxazole (antibiotic) as a secondary ligand.

2. Experimental

2.1. Materials and instruments

All chemicals were purchased from Merck / Aldrich. The reagents were used without further purification . Double distilled water was used.

b- Instruments: FT-I.R spectra were recorded as K Br discs using Fourier transform Infrared Spectrophotometer Shimadzu 24 FT-I.R 8400s. Electronic spectra of the prepared complexes were measured in the region (200- 1100) nm for 10^{-3} M solutions in N, N-dimethylsulphoxide (DMSO) at 25 ℃ using shimadzu-U.V-160.A Ultra Violet Visible- Spectrophotometer with 1.000 ± 0.001 cm matched quartz cell. While percentage of the metal in the complexes were determined by Atomic Absorption(A.A)Technique using Japan A.A-67G Shimadzu. Electrical conductivity measurements of the complexes were recorded at at room temperature for 10^{-3} M solutions of the samples in (DMSO) using pw9527 Digital conductivity meter (Philips). Melting points were recorded by using Stuart   melting point apparatus. ,Magnetic susceptibility measurements were measured using Bruker magnet BM6 instrument at 298°K following the Farady's method. The proposed molecular structure of the complexes were drawing by using chem. office program, 3DX (2006).

2.2. Preparation of Complexes :

The complexes of the series [M (SMX)(Leu)$_2$]. were prepared by the following general method :

  (A) Sodium leucinate(Na$^+$ Leu$^-$): The amino acid   L-leucine [0.262 gm, 2 m mol] was dissolved   in 10 ml H$_2$O/ethanol (50%) mixture containing Na OH (2 m mol 0.8 g) in a flask and stirred at room temperature (20 ℃)., the solution was deprotonated according to the   Scheme (1).

(B) **General synthesis of the mixed ligand metal complexes[11]**

A metal(II) chloride [(0.197g , MnCl$_2$.4H$_2$O , CoCl$_2$.6H$_2$O(0.237g,1mmol),NiCl$_2$.6H$_2$O (0.237g, 1mmol), CuCl$_2$.2H$_2$O(0.136g, 1mmol), ZnCl$_2$ (0.137g, 1mmol), CdCl$_2$ (0.183g, 1mmol),and HgCl$_2$ (0.271g,1mmol)]dissolved in   in ethanol: water (1:1) 25ml respectively was added gradually with stirring   to solution   of Sodium leucinate (Na$^+$ Leu$^-$).(0.253gm , 1mmole) of Sulfamethoxazole (SMX) was added to the mixture in each case by using stichiometric amount [(1:2:1) [(metal: 2(Na$^+$ Leu$^-$): (SMX)] molar ratios, the above reaction mixture to raise the pH upto ~6.0 and the mixture was stirred for (20 -30mint)at room temperature. scheme (1) After one day a colored microcrystalline solid was obtained which was filtered. and   washed with ethanol. The solid was recrystallized from a H$_2$O/ethanol (50%) mixture. and dried in vacuum over anhydrous CaCl$_2$. The yields range from 75 to 92 %. The decomposition temperatures range from: 216-340 ℃.

3-Results and Discussion

Resent study involves synthesis of seven new metal mixed ligand complexes with their Characterization using spectroscopic techniques and studying their Antibacterial Properties Application .A number of metallic complexes of L-leucine and Sulfamethoxazole with Mn(II),Co(II),Ni(II),Cu(II),Zn(II),Cd(II)and Hg(II) ions ,were synthesized from ethanol –aqueous medium 1:1 ratio ;General schem (1) of reaction as follow .The physical properties of the complexes are shown in (Table 1), All the complexes are colored, non-hygroscopic The complexes 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.

     The observed molar conductance (ΛM) of 10^{-3} solutions of the complexes in DMSO. lie in very low range (3-28) Ω^{-1}cm^{2}mol^{-1} supporting their non-electrolytic behavior [9]. The atomic absorption measurements (Table-1-Calculated values in parentheses) for all complexes gave approximated values for theoretical values .The analysis data (Table-1) of metal complexes are consistent with their general formulation as 1:2:1, mixed ligand complexes of the type [M (Leu)$_2$ (SMX)].
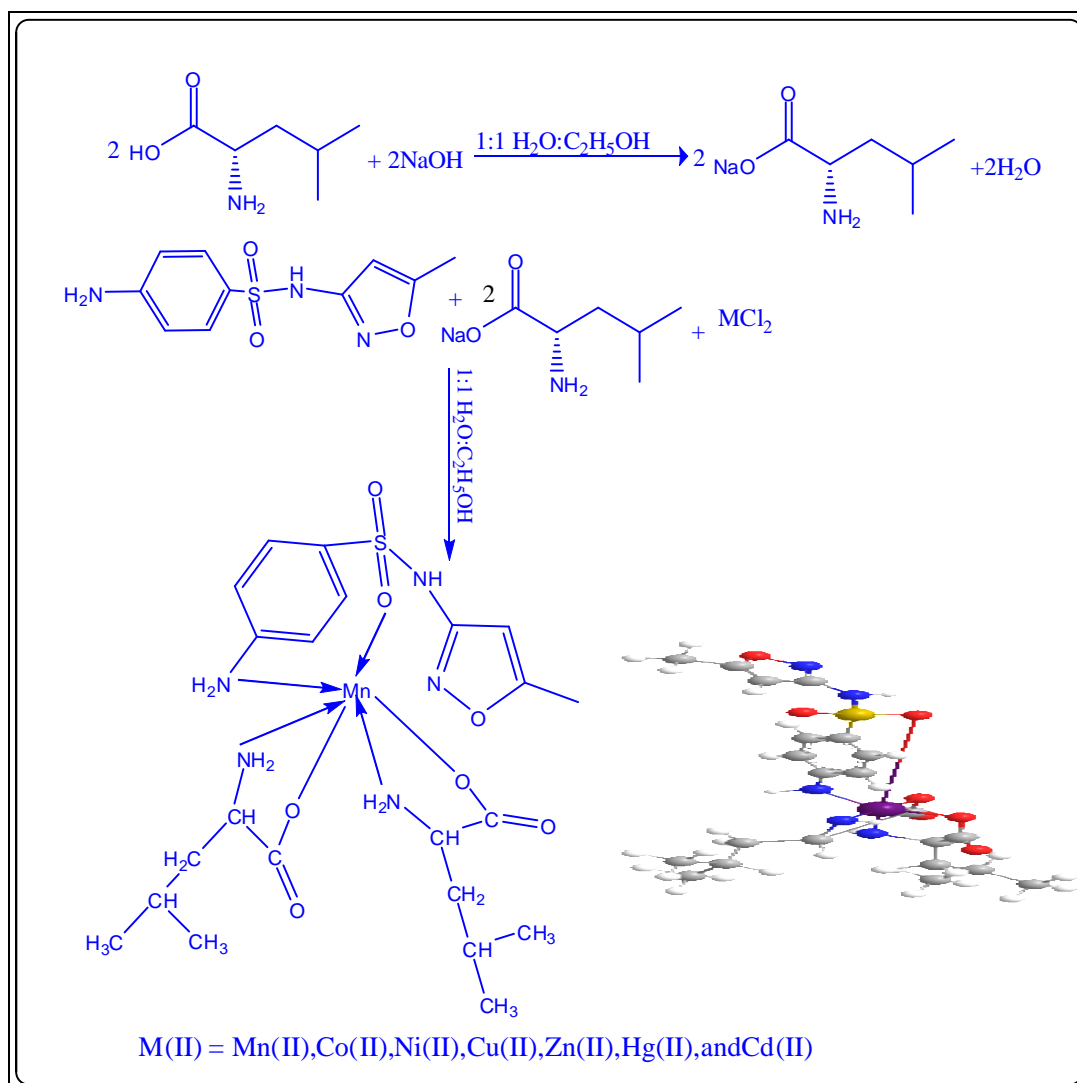
Scheme (1) : Preparation of [M(Leu)$_2$(SMX)] complexes

Fourier-transform infrared spectra and m[of coordination :

The relevant vibration bands of the free ligands and the complexes are in the region 400–4000 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 .

The assignment of some of the most characteristic FT-IR band of the complexes are shown in Tables (2-4) together with those of two ligands   recorded for comparative purposes and facilitate   the spectral analysis . In amino acids, υNH_3+ appears in 3130-3030   cm^{-1} region [9]. Table (2), displays the (FT-IR) spectrum for the (L-leucine)exhibited a band around $\upsilon(3458)$ cm^{-1} that corresponds to the stretching vibration of $\upsilon(N-H) + \upsilon (O-H)$, while another strong absorption band at $\upsilon (3055)$ cm^{-1} is due   to the $\upsilon(N-H2)sym$ while the bands at (1581) cm^{-1} and (1408) cm^{-1} were assigned to the $\upsilon(-COO)asy$ and $\upsilon(-COO)sym$ respectively. $\upsilon\Delta (-COO)asy-sym =171$ cm^{-1}. [8-10].

A general tendency in the relationship between υ (COO$^-$) (the difference between the wave numbers of the

asymmetric (υ asym) and the symmetric (υsym) stretches of carboxylate group from the FT-IR spectra) and the types of coordination of the (COO$^-$)   group to metal ions by examining the structures.

In the experimental FT-IR spectra of leucinate the wave numbers of asymmetric and symmetric stretching vibrations of carboxylic anion change their position along the series of metals

M*(II) = Mn(II),Co(II),Ni(II),Cu(II),Zn(II),Cd(II)and Hg(II)* (see Table 4). Namely, the band of υsym(COO$^-$) is shifted toward higher wave numbers in spectra of mixed ligand, whereas the band of υ $_{asym}$(COO$^-$) is shifted towards lower wave numbers[11].Thus, (L-leucine) molecule acts as bidentate monobasic ligands, coordinating through deprotonated carboxylic   oxygen(-COO-) group, and its nitrogen of (-NH$_2$) group [12, 13]. Table (3), displays the (FT-IR) spectrum for the (sulfamethoxazole).

In case of (SMX)   molecule the υ δ (N–H) vibrations of –NH$_2$(aromatic sec. amine) occur at

3468 and 3378 cm^{-1} for free (SMX) due to υas (NH$_2$) and υs (NH$_2$),respectively. The hypochromic effect (decreasing in the intensity of υ (NH) vibrations in case of mixed ligand complexes rather than (SMX)   alone as well as the blue shifted in the wave numbers from 3299 cm^{-1} [12, 13]

to   range (3208 cm^{-1}) (mixed complex). Such these changes clearly indicate that the lone pair of electron of NH$_2$ and in sulfamethoxazole donor is participated in the complexation process with metals. acting as bidentate ligand. Where as sulfoxide (S=O) stretching occurs at , 1365 [v, vas(SO$_2$], (1148and 1025)cm^{-1}[s, vs(SO2)]. The band of C=C occurs at 1622-1469   cm^{-1} ,aromatic (C=C) at 1469 cm^{-1} and alkenes (C=C) at 1622-1680 cm^{-1}, cm^{-1} [12]. and imine   peak (C=N) 1622   cm^{-1}.The υ(C–N) of isoxazol-3-yl   group occurs at 1309 cm^{-1} , this band remains ~ (in the same region free ligand and in solid complexes. Thus, indicating its non involvement in coordination of the ligand with the metal ions .Finally, the bands at 1336 and 1162cm^{-1} represent the asymmetric and symmetric stretching frequencies, respectively, of the sulfonyl group (S =O str) [12, 13].In case of complexes, [M(Leu)$_2$(SMX)] , whereas sulfoxide stretching shifts to   higher and lower frequencies   respectively   at ~106/55 cm^{-1} due to coordination of the sulfonyl oxygen with metals in all the complexes. Hence in these complexes sulfamethoxazole, also acts as bidentate ligand coordinating through the oxygen of the sulphone group and nitrogen of the amine group. All the complexes are in agreement with octahedral geometry as proposed.[14,15].In the IR spectra new bands have been observed in the region 600- 400cm^{-1} which may be due to υ (M-N) and υ (M-O) bonds respectively. [14-17]

Magnetic Susceptibility:

Magnetic susceptibility was determined at room temperature using solid sample by Gouy method. Diamagnetic correction of metal- ligand system was calculated using the Pascal's constant. .The magnetic moments of the complexes shown in(Table -3) were calculated from the measured magnetic susceptibilities after employing diamagnetic corrections and revealed their diamagnetic nature as expected for Zn(II), Hg(II),Cd(II), with (3d^{10},4d^{10},5d^{10})configurations .The magnetic moment values o,[Mn(Leu)$_2$(SMX)] lie in 6.182 BM indicating high spin octahedral stereochemistry of the complex. The magnetic moments of , [Co (Leu)$_2$(SMX)]complex lie   in 4.635 BM which are in agreement with the generally accepted values for high spin octahedral Co(II) complexes. The magnetic moment values for the [Ni(Leu)$_2$(SMX)]complex lie in 3,007 BM which reveals the octahedral stereochemistry of the ligands around Ni(II) ion. The observed magnetic moments of [Cu (Leu)$_2$(SMX)] lie in 1.478BM showing one unpaired electron with paramagnetic nature and suggested a distorted octahedral geometry in teams of Jahn-Teller effect. [17- 18]

Electronic spectral :

The (U.V- Vis) spectrum for the spectrum of   Leucine show an absorption band at 305 nm (32786 cm^{-1}) in (DMSO) solvent, this band is attributed to ($\pi\rightarrow\pi^*$).The UV -Vis spectrum   of the free ligand (SMX)in (DMSO) solvent appeared a high intense absorption bands at 275 nm   (36363 cm^{-1})

(ε_{max}=1951 L. mol$^-$. cm^{-1}) ,this band is attributed to ($\pi\rightarrow\pi^*$).[19-20]

The parameters ligand Field Splitting Energy 10 Dq, Racah's Interelectronic Repulsion Parameters (B'), Nephelauxetic Ratio β and B' are calculated.[21]

The [Mn (SMX) (Leu)$_2$] complex with d5 configuration exhibits absorption bands in the   region 11135, 11402 & 19083 cm^{-1}. These bands may be attributed to number of spin forbidden transitions involving 6A1g ground and several higher energy quartet states, which were in consistent with octahedral geometry around Mn (II) metal ions. 10 D q =11.135 ,υ1/ υ2 = 0.97, υ2/ υ1 =1.02 from Tanabe-Sugano diagram for d^5 octahedral field, These values are found in   accordance as reported   in the literature for Mn(II) octahedral complexes.

The (U.V- Vis) [Co (SMX) (Leu)$_2$] spectrum, exhibits four peaks , the first high intense peak at (257 nm)(38910   cm[-1])(ε_{max} =1225   molar[-1]. cm^{-1}), is due to the ligand field, and at 11135, 11402 and 19083   cm[-1], there are assigned to 4T1g(F)→ 4T2g(F) (υ1) 4T1g(F)→ 4A2g(F) (υ2) and 4T1g(F)→ 4T1g(p) (υ3) transition respectively, which are characteristic of octahedral stereo geometry **:** .[22-24].

,υ1/ υ2 = 0.97, υ2/ υ1=1.02 from Tanabe-Sugano diagram for d^7 octahedral field the value of 10Dq equal to 11.135 cm^{-1} , B'=950 cm^{-1}, β =0.997 cm^{-1}.The Co(II) complex under present investigation process interelectronic repulsion parameter (B') 950   cm[-1]. The Racha parameter (B) is less than free ion value (973) suggesting a considerable orbital overlap and delocalization of electrons on the metal ion. The nephelauxetic ratio (β) for the present Co(II) complex (0.997). This is less than one, suggesting partial covalence in the metal ligand bond. [23- 25] suggest the octahedral geometry .

(U.V- Vis) [Cu(SMX) (Leu)$_2$] spectrum, exhibits two peaks , the first high peak at (265

nm)(37735 cm^{-1})(ε_{max} =1905molar[-1]. cm^{-1}) is due to the (CT) , while the second weak broad peak at (610 nm)(16393 cm^{-1})(ε_{max} =112 molar[-1]. cm^{-1}), which assigned to (2Eg→2T2g), transition . Hence the Cu(II) mixed ligand complexes showed distorted octahedral geometry.

The (U.V- Vis) spectrum of [Ni (SMX))(Leu)$_2$], exhibits five peaks , the first middle peak at (251 nm)(37453cm^{-1})(ε_{max} =1391 molar[-1].cm^{-1}) is due to the ligand field and the second high peak at (263 nm)(38022 cm^{-1})(ε_{max} =1.248 molar[-1]. cm^{-1}) is due to (C.T) , third, fourth,   and fifth peaks assignment of the electronic spectral bands for, Ni(II) are 3A2g →3T2g(F) υ1=(891nm) 11223 cm[-1](ε_{max} =72 molar[-1]. cm^{-1}), 3A2g (F) →3T1g(F) υ2= (885 nm)(11299   cm[-1])(ε_{max} =56 molar[-1]. cm^{-1}),and at (873 nm)

(11454cm^{-1})(ε_{max} =5 molar[-1]. cm^{-1}) can be assigned to the   ,3A2g(F) →3T1g(p) (υ3), υ2/ υ1 =1.006 , υ1/ υ2 =0.99, 10Dq=11.223, B'=966 cm^{-1}, β=0.85, typical of Ni(II) ground state 3A2g(F)] octahedral complexes.

The υ2/υ1 = 1.006   value   are found in the usual   range (1.056-1.082) reported for the majority of octahedral Ni(II) compounds. [21]

The electronic spectra of d^{10}[Zn(II) ,C d(II)and Hg(II)]complexes   do show the charge transfer , and the magnetic susceptibility shows that all complexes have diamagnetic moments., because d-d transitions are not possible hence electronic spectra did not give any fruitful information. in fact this result is a good agreement with previous work of octahedral geometry. [21-22]

Antibacterial Activities studies:

The zone inhibition of bacterial growth were measured in mm depending upon the diameter as shown in Table (6) Figure. (2)

Table 6 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 invitro antibacterial activity was carried against 4 hold cultures of pathogenic bacteria like gram (+)and gram (-) at 37° C. In order to ensure that solvent had no effect on bacteria, a control test was performed with DMSO and found inactive in culture medium. All the metal complexes showed good activity against gram (+)*Acineto* .Ni(II) complex have no effect on E-coli., *staphylococcus* and *Psedomonas. S-aureus* and gram (-) Except Ni(II) complex. Table (5).while the Mn(II) complex was active against two organisms *staphylococcus* and *Acineto*. The *staphylococcus* was affected vigorously by mixed ligand, Hg(II), Co(II), Cu (II) ,Zn(II)and Cd(II) respectively. *E-coli*. was moderately affected by the ligands, Zn(II),and Co(II), complexes.[23-24] .In metal complexes, on chelation the polarity of the metal ion will be 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 donor groups. Further, it increases the delocalization of π- electrons over the whole chelate ring. This increased lipophillicity enhances the penetration of the metal complexes into lipid membranes and block the metal binding lists in the enzymes [25] .

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), (schem1 -3D).The conductivity data show a non-electrolytic nature of the complexes.

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	Table 1 : Analytical and some physical data of the complexes						
N O.	Complexes	Formula weight g/mol	Color	Yield %	Decomposition temperatures °C	Λ m Ω^{-1}.cm^2.mole^{-1}	Metal% (theory)
1	[Mn(SMX)(Leu)$_2$]	569.55	Brown	86	261-264	28	(9.65) 9.98
2	[Co(SMX)(Leu)$_2$]	573.54	Viol	75	254-258	19	(10.28) 11.08
3	[Ni(SMX)(Leu)$_2$]	573.30	Green	78	240-247	18	(10.24) 8.63
4	[Cu(SMX)(Leu)$_2$]	577.16	Blue	92	241-250	18	(10.99) 8.63
5	[Zn(SMX)(Leu)$_2$]	580.02	White	80	216-220	17	(11.28) 9.98
6	[Cd(SMX)(Leu)$_2$]	627.02	White	85	280-285	11	(17.93) 15.37
7	[Hg(SMX)(Leu)$_2$]	715.20	White	90	291-296	3	(28.05)

	Table 2-FT-R spectral data of Leucine						
Leucine	υ (N-H)+ υ (O-H)	υ (N-H$_2$)sym	Δυ	υ (C–H) + ; CH$_3$	υ (-COO)asy	υ (-COO)sym	υΔ (-COO) asy-sym
C$_6$H$_{13}$NO$_2$	3417m	3055s	347	2958,2874m	1516vs	1408vs	108

	Table 3-FT-R spectral data of Sulfamethoxazole										
υas (N–H); –υs NH$_2$ & –NH	υ (C–H); aroma ticy	υ (C–H) + ; CH$_3$	υ (C=C)	υδ def (N–H) Ring breathing bands	υ C–H	υSO$_2$ asy	υ C–N	υ (C–O)	υ (SO$_2$) sy	υ (S-N	υ (C-S)
3468υas 3300υs	3378 3143 s	2929 w, 2858	1622 vs	1597 vs	1504 1469	1365 s	1309 s	1266 ms	1157 1143 1091	987w	831 vs

Table 4-FT-R spectral data of complexes												
No.	υas (N–H); υs NH₂ & –NH	υ (C–H) aromaticy	υ C–H + ; CH₃	υ C=C	υδ def (N–H) Ring reathing bands	υ C–H defor mation	υ SO₂ asy	υ COO)a sy	υ -COO) sym	υ C–N	υ (SO₂) sy	M-N	M-O
1 Mn	3419m	3392s , 3271vs	2956 vs, 2872w	1660 w	1581 vs	1516 s 1469 s	1384	1408	13611 m	1307 w	1172 m 1049 m 1025 mw	515 522	497 459
2 Co	3460s	3394vs ,3234	2958 ,2878w	1654 vs	1621vs	-	1371	1467s	1333	1313 w	1179 m	640 601	574
3 Ni	3459vs	3298vs	2953vs ,2929s	1635 vs	1595vs	1469w	1365	1471s	1346s	1307 w	1120 m 1091 s 1058m	609 584 m	522 497
4 Cu	3387m 3317vs	3246vs, 3128s	2958vs ,2929s	1620 vs	1566s	1494m 1454m	s 1396	1496m s	1375s	1307 w	1136vs 1111vs 1053m	570 557	522 w 495 w
5 Zn	3481w 3325s	3302vs	2958vs ,2928s 2870s	1612 vs	1560s	1469s	s 1411	1452s	1344s	1307 m	1155m 1116vs 1078vs	642 586	561 497
6 Cd	3350vs	3252vs	2956vs ,2920s 2874v	1591 vs	1560s	1471s	s 1471	1452s	1342s	1305 m	1193m 1122s 1078vs	651 m 599 m	555
7 Hg	3470vs 3375vs	3336 3242s	2926m	1674 vs 1631	1531vs	1502vs	1475 s	1431s	1359m	1307 m	1168m 1134 1078	684 545	530 505

Table 5- Electronic Spectral data, magnetic momen, of the studied compounds						
Comp.	λnm	ABS	υ' (cm^{-1})	Assignments	μeff (BM)	geometry
$C_6H_{13}NO_2$ (leu)	305	1.951	32786	$\pi \rightarrow \pi^*$	-	-
SMX	275		36363	$\pi \rightarrow \pi^*$	-	-
[Mn(SMX) (Leu)$_2$]	246	1.362	42344	Lf	6.182	Octahedral
	350	0.209	19083	6A1g → 4A1g (G) (v3)		
	881	0.128	11402	6A1g → 4T2g (G)(v2)		
	894	0.127	11135	6A1g→ 4A1g (G))(v1)		
[Co (SMX) (Leu)$_2$]	257	1.225	38910	Lf	4.635	Octahedral
	524	0.033	19083	4T1g(F)→ 4T2g(F)(v3)		
	877	0.013	11402	4T1g(F)→4A2g(F)(v2)		
	898	0.013	11135	4T1g(F)→ 4T1g(p)(v1)		
[Ni (SMX))(Leu)$_2$]	251	0.544	38022	Lf	3.007	Octahedral
	263	1.248	11454	CT		
	873	0.054	11299	3A2g(F) →3T1g(p)(v3)		
	885	0.056	11223	3A2g (F) →3T1g(F) (v2)		
	891	0.072		3A2g →3T2g(F)(v1)		
[Cu (SMX) (Leu)$_2$]	265	1.905	37735	CT	1.478	distorted
	610	0.112	16393	2Eg →2T2g		Octahedral
[Zn (SMX))(Leu)$_2$]	268	0.355	37313	CT	Dia	Octahedral
[Cd (SMX))(Leu)$_2$]	265	2.794	37735	CT	Dia	Octahedral
[Hg (SMX))(Leu)$_2$]	262	1.419	38167	CT	Dia	Octahedral

Table 6- Represent the antimicrobial activity of compounds				
Comp. Test Bacteria	*E-coli.*	*staphylococcus*	*Psedomonas*	*Acineto*
SMX	---------	40	27	45
LeuH	---------	----------	----------	23
[Mn(SMX)(Leu)	---------	21	----------	21
[Co((SMX) (Leu)$_2$]	10	26	16	17
[Ni((SMX))(Leu)$_2$]	---------	------------	------------	19
[Cu((SMX))(Leu)$_2$]	---------	25	13	16
[Zn((SMX))(Leu)$_2$]	8	20	------------	17
[Cd((SMX))(Leu)$_2$]	---------	18	18	21
[Hg((SMX))(Leu)$_2$]	21	35	23	24

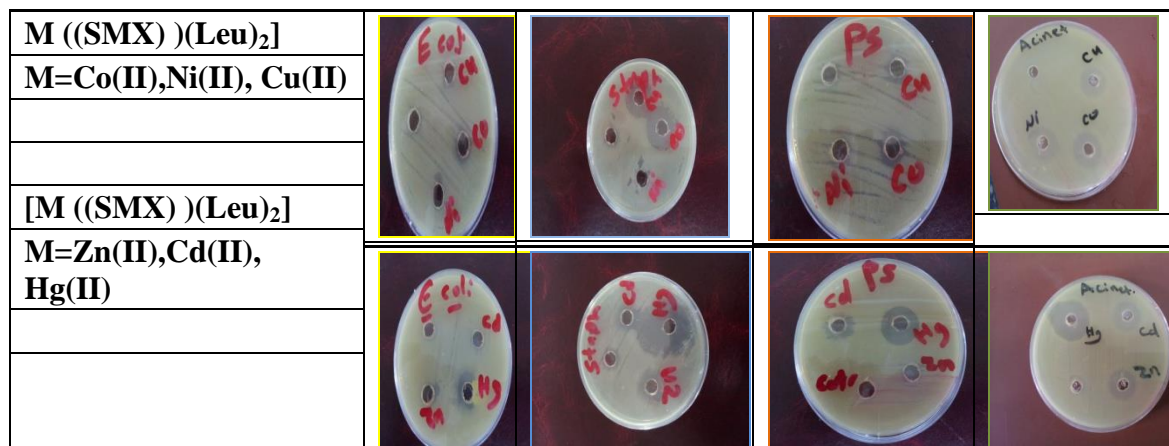| M ((SMX))(Leu)$_2$] M=Co(II),Ni(II), Cu(II) [M ((SMX))(Leu)$_2$] M=Zn(II),Cd(II), Hg(II)	
Figure-2- shows the antimicrobial activity of complex, Co(II), Ni(II), Cu(II), Zn (II), Cd(II),and Hg(II)) appear the inhibition zones against pathogenic bacteria	