



Available online at <http://proceedings.sriweb.org>

The 10th International Scientific Conference

Under the Title

“Geophysical, Social, Human and Natural Challenges in a Changing Environment”

المؤتمر العلمي الدولي العاشر

تحت عنوان "التحديات الجيوفيزيائية والاجتماعية والانسانية والطبيعية في بيئة متغيرة"

25 - 26 يوليو - تموز 2019 - اسطنبول - تركيا

<http://kmshare.net/isac2019/>

Preparation, Spectra and Biological Properties of Transition Metals ((III) and (II) Mixed - Ligand Complexes with 5-Chlorosalicylic Acid and L-Valine

Shatha M. H. Obaid
shathaobaid@yahoo.com

Taghreed H. Al-Noor
drtaghreed2@gmail.com

Noor A. Hussien
Nooraadil19@gmail.com

Department of Chemistry/ College of Education for pure Science Ibn Al-Haitham/
University of Baghdad, Iraq.

Abstract :

Mixed ligand metal complexes of Cr^{III} , $\text{Fe}^{\text{III,II}}$, Ni^{II} and Cu^{II} have been synthesized using 5-chlorosalicylic acid (5-CSA) as a primary ligand and L-Valine (L-Val) as secondary ligand. The metal complexes have been characterized by elemental analysis, electrical conductance, magnetic susceptibility measurements and spectral studies. The electrical conductance studies of the complexes indicate their electrolytic nature. Magnetic susceptibility measurements revealed paramagnetic nature of the all complexes. Bonding



of the metal ion through $-OH^-$ and $-COO^-$ groups of bidentate to the 5-chlorosalicylic acid and through $-NH_2$ and $-COO^-$ groups of bidentate to the L-valine by FT-IR studies . The agar diffusion method has been used to study the antibacterial activity of the ligands and complexes against the pathogenic bacteria *E.Coli*, *Pseudomonas*, *Bacillus* and *Staphylococcus*.

Key words : 5-Cl-Salicylic acid, L-Valine , Mixed ligand complexes, Elemental analysis, Spectral studies and Antibacterial activities .

1. Introduction:

Salicylic acid (5-CSA) (likewise recognized such as 2-hydroxy benzoic acid) is a simple carboxylic aromatic acid ; it includes both a hydroxy group as well a carboxy group. It is vastly applied at food manufacture such as a plant growth organizer, such as ingredient at antimicrobial wash to prevent damage from fresh vegetables as well like a preservative on products of food (antimicrobial agent also antifungal) [1-3] . It has lately be catchy to the experiments because of biological importance, specially on medication also chemistry [4-6] .A number of experiments approach were made at try to expound the biological effect for salicylates. One interpretation of these impacts has demonstrated the ability to bind metal salicylates [7]. Chlorosalicylic acid has been studied so extensively as unsubstituted salicylic acid. Cu(II) complexes for (5-CSA) [8] as well some lanthanide complexes for (5-CSA) as well found which anion co-ordinated like bidentate ligand [9]. Among these, compounds the metal for carboxylates were studied intensively because the carboxyl group may be coordinated with metal ion at different methods. [10]. In particular, copper compounds of salicylate are gaining increasing of both structural also biological point for view. Salicylic acid has been known for its own therapeutic for centuries [11]. Salicylic acid also its derivatives are known to be non-steroidal anti-inflammatory, anti-pyretic also analgesic. Copper compounds for anti-inflammatory drugs were offered to be more effective as well eligible than drugs compared into same ligands [12]. In addition, some of its pharmacological activities have been reported at existence from ancillary nitrogen- donor ligands [13]. Cu^{II} , was offered to work at a synergistic method for salicylic acid derivatives [14].

L-Valine (L-Val) is an α -amino acid, It is one branched protein-organic amino acids vastly distributed but seldom exists at an amount greater than 10%. It is a chain of amino acid branching as well may be derived of alanine through introduction two methyl group existing at α -carbon atom [15-16]. Mixed ligand complexes play an significant role in the biological process [17-18]. Amino acids including active $-NH_2$ and $-COOH$ groups are well known with tendency to the form compounds for metals as well have large importance in the biological also pharmaceutical fields also are directly involved in the all enzymatic metabolic activities from organism [19-21]. In present paper, the synthesis, physical spectroscopic properties of the Cr^{III} , $Fe^{III,II}$, Ni^{II} and Cu^{II} complexes of mixed



ligands(5- CSA) and (L-Val) and the present work deals with the study of the antibacterial of these reported compounds .

Material and Methods:

Experimental: All chemical were of reagent grade quality and were purchased of L-Val. and 5- CSA from commercial sources (BDH and Merck), metals salts and solvents from (B.D.H., Riedel and Merck). They were used without further purification.

Physical characterization: The measured molar conductance values (Λ_m) in DMF solution from compounds have been measured on 25°C with 10^{-3} M solution from samples utilizing PW9527 Digital Conductivity Meter (Philips) . The infrared (FT-IR) spectra were recorded in 4000-400 cm^{-1} rang of ligands and 4000-200 cm^{-1} of metal complexes on a Shimadzu IR-470 Spectrophotometer using KBr pellets . The electric spectra of the complexes in DMF solution (10^{-3}) were monitored at 25 °C in the 200-1100 nm rang with a Shimadzu-U.V-160.Altra Violet-Visible- Spectrophotometer for 1.000 ± 0.001 cm correspond quartz cell . C, H and N content of the complexes were determined by the micro analytical unit of Eurverctor EA 3000A Elemental Analyzer . When metal includes from complexes have been specified through Atomic Absorption (A.A) Technique / Flame Emission Spectrophotometer employing AA – 680 Shimadzu . Magnetic susceptibility measurements have been measured utilizing Bruker magnet BM6 instrument on 298 °K following the Faraday's manner . Melting points have been determined through employing Stuart Scientific melting point apparatus .

Preparation the Complexes [M(5-CAS)₂(L-Val)] M=Cr^{III},Fe^{III,II}, Ni^{II} and Cu^{II}:

The synthesis of the ligands solutions , 5-CAS and L-Val were prepared of reported method in literature [22]. Solution of CrCl₃.6H₂O[0.267gm, 1mmol], FeCl₃[0.1622gm, 1mmol], (NH₄)₂Fe(SO₄)₂ [0.2841gm, 1mmol], NiCl₂.6H₂O [0.237gm, 1mmol], and CuCl₂.H₂O [0.134gm, 1mmol] in the stoichiometric ratio metal: ligand[M:2(5-CAS) (L-Val)],(1:2:1). The mixtures were heated at a water bath to reflux for a period of one hour with all complex at 10 °C. The precipitated complexes were thereafter filtrated off and washed for ether followed through desiccation on room temperature and analyzed employing standard manners .

In Vitro Antibacterial Activity: All the metal complexes, ligands have been checked versus *Bacillus* and *Staphylococcus* (gram positive) and *E. Coli* also *Pseudomonas* (gram negative) bacteria through utilizing wall agar diffusion method employing solvent (DMF); condensation for ligands and complexes on reveal was (10^{-3} M) through employing disc sensitivity check. The manner includes reveal for zone inhibition toward



diffusion for micro-organism at an agar plate. Plates have been brood with 24 hours from bacteria on 37°C.

Results and Discussions :

The analytical data and some of the physical properties are collected of the aqueous solution of the metal ions and ethanolic solution of (5-CSA) and the ethanolic solution of (L-Val) in Table 1. The complexes soluble in H₂O, CH₃Cl, CH₃OH, C₂H₅OH, (CH₃)₂CO, DMF and DMSO but non soluble in CCl₄, C₆H₆ and (CH₃CH)₂O. Elemental analysis data Table- 1. From metal complexes are fixed for their general formula at (M:2(5-CSA):(L-Val)] as 1:2:1 mixed ligand complexes. Molar conductance values from complexes at DMF on 10⁻³M condensation and type of electrolyte for each compound could be determined [23].

Table - 1: Analytical and Physico-Chemical Datum for Ligands also Complexes

Compounds	M.wt.	Color	M.P C	Analysiz Calc. (Found)			
				M%	C%	H%	N%



(L-Val)	117.15	White	295-300	-	-	-	-
(5-CSA) Compounds	172.57 $\nu(\text{NH}_2) +$ $\nu(\text{OH})$	White	171-173	$\nu_{\text{as}}(\text{COO})$	$\nu_{\text{s}}(\text{COO})$	$\nu(\text{M-N})$	$\nu(\text{M-O})$
$\text{Na}_2[\text{Cr}(\text{5-CSA})_2(\text{L-Val})]$	555.23 [24]	Deep green	1504-1501 Dec.	361.99 (8.59)	41.10 - (40.77)	2.90 (2.48)	- 2.52 (1.59)
$\text{Na}_2[\text{Fe}(\text{5-CSA})_2(\text{L-Val})]$	559.08	Pale brown	>250 Dec.	10.03 (9.86)	40.82 (40.07)	2.88 (2.19)	2.51 (2.12)
$\text{Na}_3[\text{Fe}(\text{5-CSA})_2(\text{L-Val})]$	582.07	Deep brown	>250 Dec.	9.59 (8.93)	39.21 (38.71)	2.77 (2.20)	2.41 (1.70)
$\text{Na}_3[\text{Ni}(\text{5-CSA})_2(\text{L-Val})]$	584.91	Pal green	>250 Dec.	10.03 (9.31)	39.02 (37.34)	2.76 (2.37)	2.39 (2.37)
$\text{Na}_3[\text{Cu}(\text{5-CSA})_2(\text{L-Val})]$	589.77	Deep green	>250 Dec.	10.78 (8.08)	38.69 (37.62)	2.76 (1.44)	2.38 (2.93)

Dec. = Decomposition

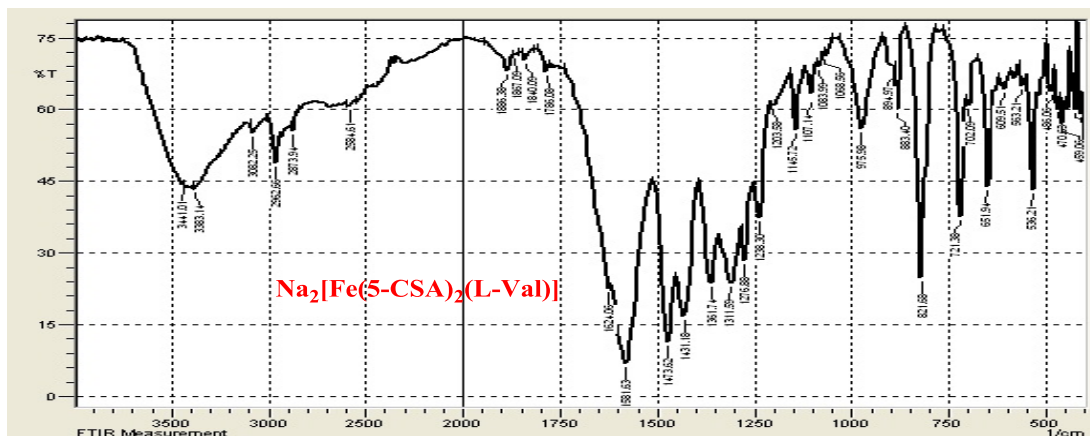
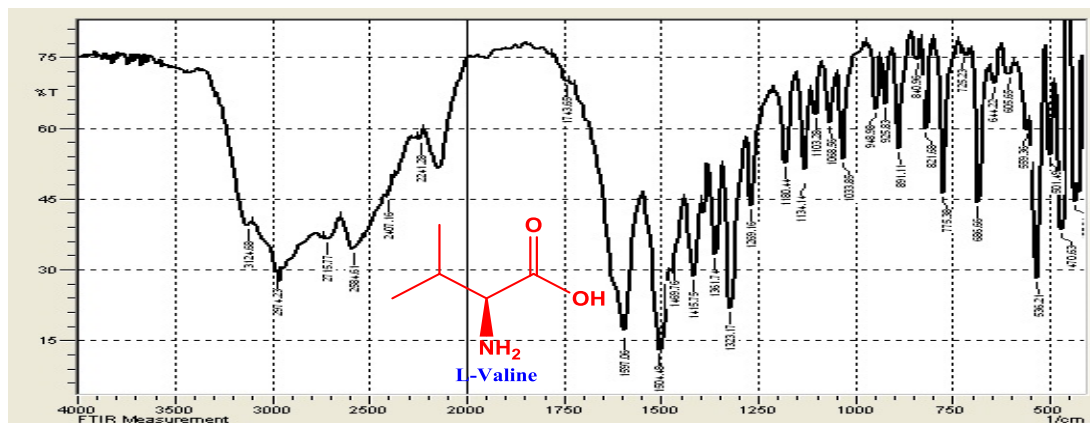
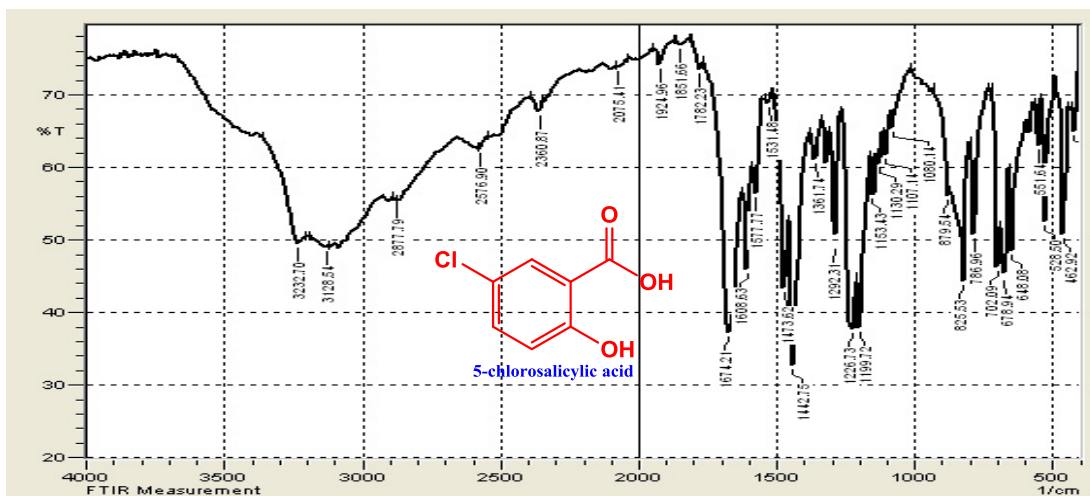
IR Spectral Study:

The characteristics frequencies of FT-IR spectral for free ligands and mixed ligand complexes from metals are given in Table -2. And the main parts to the IR spectral are presented to the (5-CSA) and (L-Val) ligands and Fe^{III} complexes in Figure -1. IR spectrum from (L-Val) displayed broad band on 3124 cm^{-1} due into stretching mode from $\nu(\text{NH}_2)$ and $\nu(\text{OH})$, in complexation a shift for change at shape have been watched of this band, when rising at intensity was observed [24]. Bands on 1504 cm^{-1} also 1361 cm^{-1} in amino acid spectrum were assigned to $\nu(\text{COO}^-)$ asymmetric and symmetric respectively, suffered a great change in position and at density at complexation for metal ion [25]. IR spectrum of (5-CSA) appeared wide band on 3232 cm^{-1} , that has been specified into stretching vibration from $\nu(\text{OH})$ group. The band was absent at spectral from prepared complexes, that specified deprotonation as well participation from enol oxygen on chelation [26]. Bands on 1608 cm^{-1} also 1361 cm^{-1} were attributed into $\nu(\text{COO}^-)$ asymmetric and symmetric respectively [14], these bands shifted in position to higher and lower frequency in the spectra of all prepared complexes which indicated the coordination for metal ion. The manifestation for new bands at region around $428\text{-}563 \text{ cm}^{-1}$ are temporarily appointed into $\nu(\text{M-N})$ also $\nu(\text{M-O})$ (Metal-Ligand) stretching bands [27-28].

Table - 2: Important IR Spectral Bands (cm^{-1}) for Ligands also Complexes



(5-CSA)	3232 br.	1608 sh.	1361 sho.	-	-
Na ₂ [Cr(5-CSA) ₂ (L-Val)]	br.3425 3321 br. -	1573 s.	1313 s.	543 w.	484 w.
Na ₂ [Fe(5-CSA) ₂ (L-Val)]	br.3444 3383 br. -	1581 s.	1311 s.	486 w.	459 w.
Na ₃ [Fe(5-CSA) ₂ (L-Val)]	br.3352 3140br. -	1597 s.	1307 s.	493 w.	428 w.
Na ₃ [Ni(5-CSA) ₂ (L-Val)]	br.3452 br.3363 -	1581 s.	1311 s.	563 w.	443 w.
Na ₃ [Cu(5-CSA) ₂ (L-Val)]	br.3298 3251 br. -	1550 sh.	1319 sh.	532 w.	466 w.
br.= broad, sh.=sharp, s.=strong, sho.=shoulder, w.= weak					



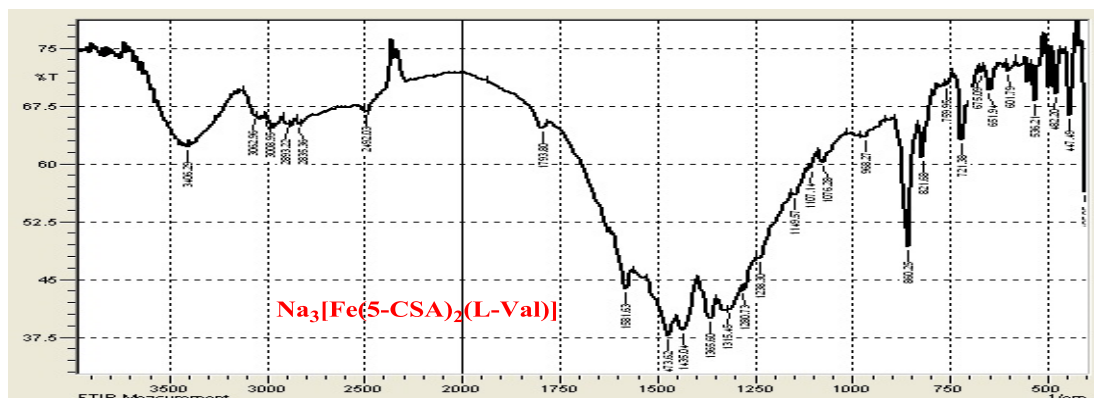


Figure-1: FT – IR Spectra of Ligands and $\text{Fe}^{\text{III,II}}$ - Complexes

Electronic Data:

Electronic spectral for ligands as well their complexes have been registered on DMF as indicate in Table- 3 . The UV spectral for free ligand of L-valine show peak on 349 nm (28653cm^{-1}) attributed into ($\pi - \pi^*$) electronic transition[29],while electronic spectral from (5-CSA) appeared peak at 301 nm (2.332cm^{-1}) attributed into ($\pi - \pi^*$) electronic transition[30].Electronic spectral for Cr^{III} complex gave absorption peaks on 272 nm also 305 nm related into ligand felid, thereafter other three peaks on 762 nm, 834 nm also 942 nm have been specified into electronic transition type ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{1g}(\text{P})$, ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{1g}(\text{F})$ and ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{2g}(\text{F})$ respectively and μ_{eff} value is 3.81 B.M. pointing three unpaired electrons close into spin only value, which agreement of the structure of Cr^{III} to be an octahedral geometry [31]. The spectral for Fe^{III} complex appeared peak on 299nm indicated to ligand felid, thereafter other peaks at 444nm and 824nm were caused by electronic transition ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{2g}(\text{G})$ and ${}^6\text{A}_{1g} \rightarrow {}^4\text{T}_{1g}(\text{G})$ respectively The value of the measured magnetic moment for [B₄] complex was (5. 76 B.M.) which could be related to high-spin d^5 ferric ion in octahedral geometry. [32].The spectral for Fe^{II} complex offered peaks on 298 nm also 463 nm due into ligand field and charge transfer respectively. Other peak at 747 nm assigned to ${}^5\text{E}_g \rightarrow {}^5\text{T}_{2g}$ and the μ_{eff} value is 5.64 B.M. suggest octahedral geometry[33]. The spectral for Ni^{II} complex offered peak on 300 nm due into ligand felid. Other peak on 811 nm has been found to be caused through (d-d) electronic transition type ${}^3\text{A}_{2g}(\text{F}) \rightarrow {}^3\text{T}_{1g}(\text{F})$ and the μ_{eff} value is 2.78 B.M. pointing out octahedral geometry about Ni^{II} ion [34]. Spectral with Cu^{II} complex gave absorption peak on 300 nm due into ligand felid. The peak on 771 nm has been caused through electronic transition ${}^2\text{E}_g \rightarrow {}^2\text{T}_{2g}$ and the μ_{eff} of this complex was found at 1.68 B.M that was very close into octahedral environment [35].

Table -3. Reflectance Datum & Magnetic Moment for Metal Complexes

Compounds	λ_{\max} (nm)	ABS	Wave number (cm ⁻¹)	ϵ_{\max} (L.mol ⁻¹ .cm ⁻¹)	Λ_m (S.cm ² .mol ⁻¹) in DMF(10 ⁻³ M)	μ_{eff} (B.M)
(L-Val)	349	0.018	28653	18	2.82	-
(5-CSA)	301	2.332	33222	2332	7.90	-
Na ₂ [Cr(5-CSA) ₂ (L-Val)]	272	0.226	36764	226	92.40	3.81
	305	0.243	32786	243		
	762	0.024	13123	24		
	834	0.021	11990	21		
	942	0.021	10615	21		
Na ₂ [Fe(5-CSA) ₂ (L-Val)]	299	2.422	33448	2422	88.60	5.76
	444	0.245	22522	245		
	824	0.012	12135	12		
Na ₃ [Fe(5-CSA) ₂ (L-Val)]	298	2.417	33557	643	90.80	5.64
	463	0.643	21598			
	747	0.016	13386			
Na ₃ [Ni(5-CSA) ₂ (L-Val)]	300	2.313	33333	2313	85.80	2.78
	811	0.009	12330	9		
Na ₃ [Cu(5-CSA) ₂ (L-Val)]	300	2.342	33333	2342	82.60	1.68
	771	0.026	0.026	26		

Based on the resulting data from spectral analysis of the ultraviolet and infrared according of the following structures (figure-2 and 3) were proposed.

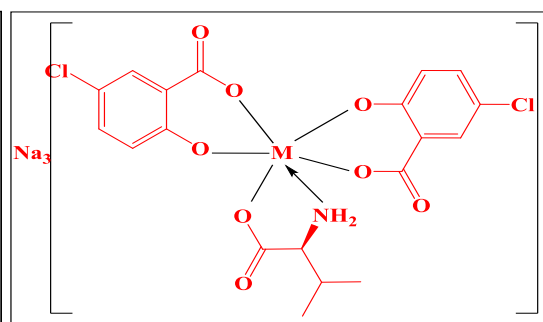
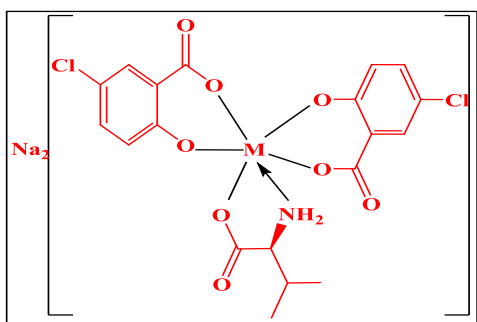


Figure-2: Structure for M^{III} Complexes **Figure-3: Structure for M^{II} Complexes**
M^{III} = Cr^{III} and Fe^{III} M^{II} = Fe^{II}, Ni^{II} and Cu^{II}

The above structures were suggested according to the following conditions of the reactions:



Antibacterial Activity:

The ligands and complexes were screened in vitro with antibacterial efficacy versus pathogenic bacterial species utilizing disc diffusion method. The outcomes for bacterial checking from synthesized compounds are registered at Table- 4. and Chart -1. As expected, growth inhibition was observed for DMF .The ligands have moderate activity with *Bacillus*, *E. Coli* and *Pseudomonas* and are no active in comparison for *Staphylococcus* for Fe^{II} , Ni^{II} and Cu^{II} complexes. They have high activity Gram negative approximately of the Cr^{III} complex with against Gram positive with *Bacillus*.

Table -4. Outcomes for Antibacterial Efficacy Checking from Ligands also Complexes

Compounds	<i>E. Coli</i> (G-ev)	<i>Pseudomonas</i> (G-ev)	<i>Bacillus</i> (G+ev)	<i>Staphylococcus</i> (G+ev)
Control (DMSO)	11	11	-	10
(L-Val)	15	15	10	11
(5-CSA)	11	11	15	-
$\text{Na}_2[\text{Cr}(\text{CSA})_2(\text{L-Val})]$	14	20	18	13
$\text{Na}_2[\text{Fe}(\text{CSA})_2(\text{L-Val})]$	11	11	13	15
$\text{Na}_3[\text{Fe}(\text{CSA})_2(\text{L-Val})]$	12	-	13	-
$\text{Na}_3[\text{Ni}(\text{CSA})_2(\text{L-Val})]$	15	16	15	-
$\text{Na}_3[\text{Cu}(\text{CSA})_2(\text{L-Val})]$	12	18	10	-

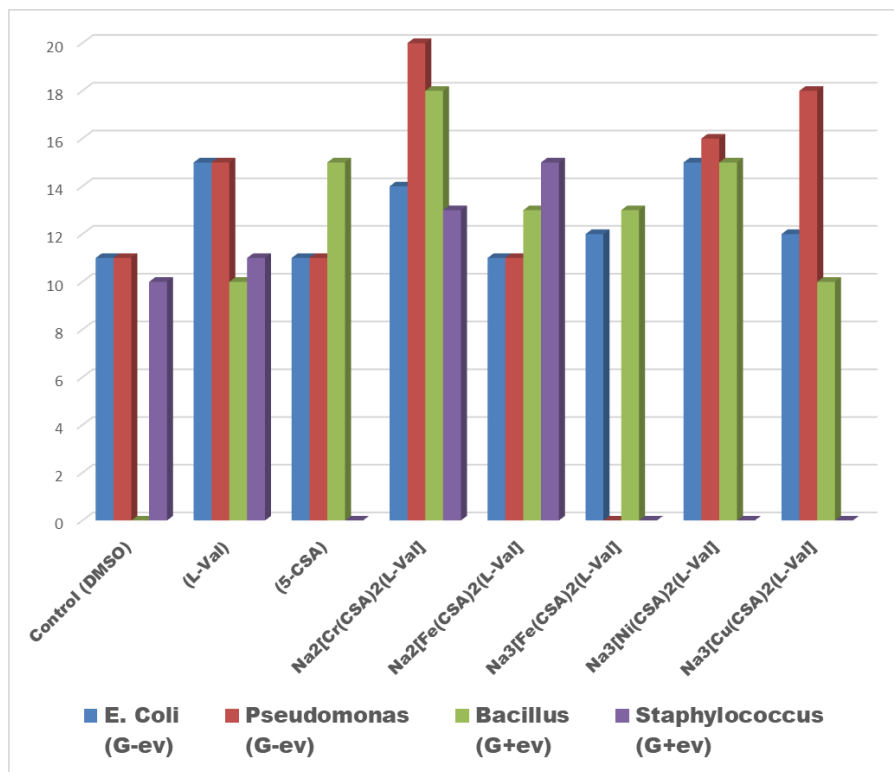


Chart - 1: Graphical representation of Ligands and Complexes against tested Bacteria *Bacillus*, *Staphylococcus*, *E. Coli* and *Pseudomonas*.

Conclusions

On this paper, we reported the synthesis, spectroscopic also structural study for complexes from Cr^{III}, Fe^{III,II}, Ni^{II} and Cu^{II} ions employing (5-CSA) like a primary ligand as well (L-Val) like a secondary ligand. It may be thus deduced that (5-CSA) is bidentate ligand into all the status tested coordinating during its –OH and –COO⁻ groups and (L-Val) acts as a bidentate ligand via coordinating by its –NH₂ and –COO⁻ groups at FT.IR. spectrum study, visible spectra and magnetic moments all complexes were high spin octahedral stereochemistry. The srtructure in Figure-4 is proposed for the Cu^{II} complex . The current work deals for the antibacterial study of these reported ligands and complexes. The results of biological screening references compared with ligands using four types of bacteria . The outcomes to the biological screening point out that at some complexes, as in case antibacterial efficiency in all its kinds for the Cr^{III} complex is more active than free ligands and rest for complexes, as well as with the complexes increased efficiency to the complexes may be expounded on basis for chelation theory.

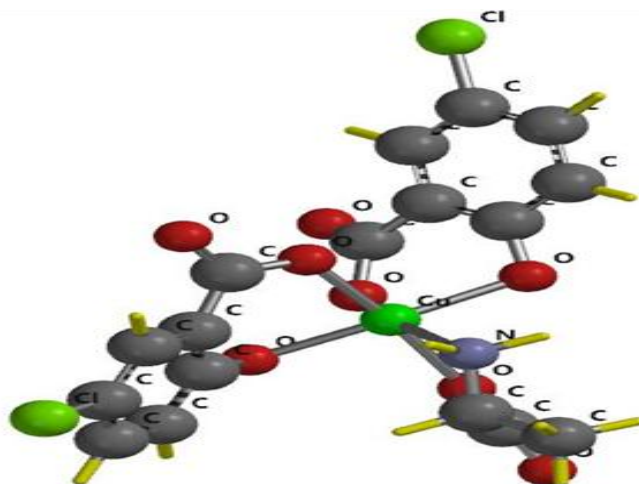


Fig.(5) :Structure of Cu^{II} complex as 3D model

References:

- [1] Greene G. E. 2012. Infectious diseases of the dog and cat, (Fourth Edition), India.
- [2] Xu Y., Yin H., Lu Y., Yin S., Wu H., Jiang T. and Wada Y. 2006. Size- and morphology-controlled preparation of extra fine salicylic acid crystallites by organic modifiers, *Mater.Lett.*, 60,2873.
- [3] El-Mougy N.S. 2002. In vitro studies on antimicrobial activity of salicylic acid and acetylsalicylic acid as pesticidal alternatives against some soilborn plant pathogens, *Egypt,J.Phytopathol*, Vol.30,No.2, 41-55.
- [4] Acton Q.A.,PhD. 2013.Salicylic acid advances in research and application, Atlanta Georgia.
- [5] Arif T. 2015. Salicylic acid as a peeling agent: a comprehensive review, *Clin Cosmet Investig Dermatol*.8, 455–461.
- [6] Purshotaman E.. 2013. International conference on biological, medical and chemical, Hong Kong.
- [7] Martiška L. , Husáriková L. , Repická Z. , Valigura D. , Valko M. and Mazúr M.2011. EPR study of 5-chlorosalicylate-Cu(II)-N,N-diethylnicotinamide ternary complex systems in frozen water–methanol solutions, *Applied Magnetic Resonance*, 40(3),405-411.
- [8] Brittain H. G. and Rivera S. 1989. Solution phase chemistry of lanthanide complexes. 9. mixed ligand Tb(III) complexes of ethylenediamine tetraacetic acid and 5-substituted salicylic acid,*Inorganic Chimica Acta*, 110,35-39.
- [9] Tong Y.-P. and Lin Y.-W. 2009. Synthesis, crystal structure, electronic structure, bonding, photoluminescence and spectroscopic property investigations of a mononuclear



- 1,10-phenanthroline and 5-bromo-salicylate ternary indium(III) complex, *Inorg. Chim. Acta*, 362, 4791–4796.
- [10] Mackowiak P.A. 2000. Brief history of antipyretic therapy, *Clin. Infect. Dis.*, 31, 154–156.
- [11] Rizzotto M. 2012. Metal complexes as antimicrobial agents. In *A Search for Antibacterial Agents*, Bobbarala, V., Ed.; InTech: Rijeka, Croatia, pp. 73–88.
- [12] Diabate P. D., Dupont L., Boudesocque S. and Mohamadou A. 2018. Novel task specific ionic liquids to remove heavy metals from aqueous effluents, *Metals*, 8, 412, 1–15.
- [13] Thiago A.D. R., Eduardo J. De A., Magda F. F., Claudio T. De C., Alessnadra R. L. and Isaias C. 2017. Copper II - polar amino acid complexes: toxicity to bacteria and larvae of *Aedes aegypti*, *Anais da Academia Brasileira de Ciências*, 89(3 Suppl.), 2273–2280.
- [14] Kucková L., Jomová K., Švorcová A., Valko M., Segl'a P., Moncol' J. and Kožíšek J. 2015. Synthesis, crystal structure, spectroscopic properties and potential biological activities of salicylate–neocuproine ternary copper(II) complexes, *Molecules*, 20(2), 2115–2137.
- [15] Shimazaki Y., Takanib M. and Yamauchi O. 2009. Metal complexes of amino acids and amino acid side chain groups. structural and properties, *Dalton Tans.*, 7854–7869.
- [16] Aliyu H.N. and Isyaku S. 2010. Spectroscopic and potentiometric studies of N-(2-Hydroxybenzyl)-L- α -valine cobalt (II) complex, *J. Biokemistri*, Vol. 22, (2), 91–97.
- [17] Patila S., Thakurb G. A. and Patil V. R. 2009. Synthesis, spectral and biological studies on some mixed ligand Ni(II) complexes, *Acta Poloniae Pharmaceutica Drug Research*, Vol. 66 (3), 271n277.
- [18] Ranford J.D. and Sadler P.J. D.A. 1993. Tocher, cytotoxicity and antiviral activity of transition-metal salicylato complexes and crystal structure of bis(diisopropylsalicylato)(1,10-phenanthroline)copper(II), *J. Chem. Soc. Dalton Trans.*, 3393–3399.
- [19] Kekare M., Vaidya V., Thakur J., Patil S. and Langi B. 2014. Synthesis, characterization and biological studies on some mixed ligand La (III) complexes, *International Journal of Science and Research*, Vol. 3, Issue 11.
- [20] Abdelkarim A. T. 2015. Spectroscopic characterization of novel Cu(II) mixed-ligand complexes involving tridentate hydrazone ligand and some amino acids as antibacterial and antioxidant agents, *International Journal of Pharma Sciences*, Vol. 5(1), 839–851.
- [21] Waheed E. J, Obaid Sh. M.H and Al-Hamdani A. A.S. 2019. Biological activities of amino acid aerivatives and their complexes a Review, *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, 10(2), 1624–1641.
- [22] Al Naimi Sh.M.H. kindeel A.S. Jarad A. J. Al-NoorT.H. 2016. Synthesis and antibacterial activities of some mixed ligand complexes, *Transactions on Engineering and Sciences*, Vol. 4, Issue 2, 42–47.



- [23] Geary W.J. 1971. The use of conductivity measurements in organic solvents for the characterization of coordination compounds . Coordination Chemistry Reviews , Vol.7(1), 81-122.
- [24] . Fayad N..K. , Al- Noor T. H. , Mahmood A. A. and Malih I.K. 2013. Synthesis, characterization, and antibacterial studies of Mn (II) Fe (II) , Co(II) , Ni(II), Cu (II) and -Cd(II) mixed- ligand complexes containing amino acid (L-valine) and (1,10 phenanthroline), Chemistry and Materials Research, Vol.3(5), 66-73.
- [25] Nakamoto K . 1996. Infrared spectra of inorganic and coordination compounds "4ED th ; J. Wiley and Sons, New York.
- [26] Sharma H., Patil Shivaputra, Sanchez T. W., Neamati N., Schinazi R. F. and Buolamwini J. K. 2011. Synthesis, biological evaluation and 3D-QSAR studies of 3-keto salicylic acid chalcones and related amides as novel HIV-1 integrase inhibitors, Bioorg Med Chem., 15, 19(6) , 1-41.
- [27] Gouvea R. L., Gabrie V. , . Sonia R. W., Batista D. G. J, Nazaré M., Soeiro C. and Teixeira L. R.. (2016). Copper(II) mixed-ligand polypyridyl complexes with doxycycline structures and biological evaluation j. Bioinorganic Chemistry and Applications, 2016, 1-11.
- [28] Obaid Sh. M H, Al Naemi H. A Sh. and Al-Hamdani A.A. S. 2018. Synthesis, spectroscopic and antimicrobial studies of mixed ligand metal (II) complexes with three amino acids, Research Journal of Pharmaceutical, Biological and Chemical Sciences, 9(6), 1560-1571.
- [29] Fayad N.K., Al-Noor T.H. and Ghanim F.H. 2012. Synthesis, characterization and antibacterial activities of manganese(II), cobalt(II), iron(II), nickel(II), zinc (II) and cadmium(II) mixed-ligand complexes containing amino acid (L-valine) and saccharin, Advanced in Physical Theories and Application, 9, 1-13.
- [30] Abdul-Latif M.H., Alsouz M.A.K., Dawood I.J., and Jarad A.J. 2014. Analytical profile of 4-(4 nitrobenzene azo)-3-aminobenzoic acid on surface of natural granulated calcined iraqi montmorillonite clay mineral, via columnar method , J, Chem. Pro.Engi.Res., 19, 1-14.
- [31] Lever ABP Inorganic electronic spectroscopy (2nd ed.). Elsevier. in Amsterdam, New York. 1984.
- [32] Andersen F. A. 2005. Cosmetic Ingredient Review Expert Panel ;Final report of the safety assessment of niacinamide and niacin". Int. J. Toxicol, 24 (5): 1–31.
- [33] Sharaby CM. 2005. Preparation, characterization and biological activity of Fe(III), Fe(II), Co(II), Ni(II), Cu(II), Zn(II), Cd(II) and UO₂(II) complexes of new cyclodiphosph(V)azane of sulfaguanidine, Spectrochimica Acta. Part A, Molecular and Biomolecular Spectroscopy, 62(1-3), 326-334.
- [34] Geeta B, Ravinder V. 2011. Synthesis, characterization and biological evaluation of mononuclear Co(II), Ni(II) and Pd(II) complexes, with New N₂O₂ schiff base ligand, chem., pharm. Bull., 95 (2), 166-171.



[35] Srivastava,K.P.,Singh,A. and Singh,S.K. 2014. Green and efficient synthesis, characterization and antibacterial activity of copper(II) complexes with unsymmetrical bidentate Schiff base ligands, IOSR -J.Appl.Chem., 7(4), 16-23.