Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef * **Safaa A. Ahmed** **Mahmood Y. Hammadi**

* Department of Chemistry- College of Education for Pure Sciences-Ibn-Al-Haithm - Baghdad University
Department of Chemistry-College of Education - University of Samarra

Received : 23 February 2015 ; Accepted : 25 March 2015

Abstract

The study convers preparation of four amino Ag^{+} complexes and characterization , in molecular formula: $[Ag(SMZ)(NO_3)(H_2O)].H_2O$, $[Ag(NAM)(NO_3)(H_2O)]$, $[Ag(SCM)(NO_3)(H_2O)]$, $[Ag(PAB)_2(NO_3)(H_2O)].2H_2O$. Where: SMZ=Sulfamethoxazole, NAM=Nicotinamide, SCM= Sulfacetamide and PAB=*p*-Aminobenzoic acid. All four prepared complexes have been characterized as needed by FT-IR, U.V-Vis, atomic absorption, elemental microanalysis (C.H.N), electrical molar conductivity along with melting point. The study revealed that the expected geometrical formula of the four complexes was tetrahedral.

Keywords: Amino silver(I) complexes, Sulfamethoxazole, Nicotinamide, Sulfacetamide, p-aminobenzoic acid.

Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef Safaa A. Ahmed Mahmood Y. Hammadi

تحضير و تشخيص بعض المعقدات الامينية للفضة (I)

ساجد محمود لطيف* صفاء عبد الرحمن احمد محمود يونس حمادي

*قسم الكيمياء - كلية التربية للعلوم الصرفة-ابن الهيثم - جامعة بغداد

قسم الكيمياء - كلية التربية - جامعة سامراء

الخلاصة

تضمنت هذه الدراسة تحضير اربعة معقدات امينية لايون الفضة (I) و تشخيصها، والصيغة الجزيئية للمعقدات هي: $[Ag(SMZ)(NO_3)(H_2O)].\ H_2O$، $[Ag(NAM)(NO_3)(H_2O)]$، $[Ag(SCM)(NO_3)(H_2O)]$, $[Ag(PAB)_2(NO_3)(H_2O)].\ 2H_2O$. حيث تمثل: SMZ=Sulfamethoxazole، NAM=Nicotinamide, SCM=Sulfacetamide، PAB=p-aminobenzoic Acid. شخصت جميع المعقدات المحضرة بوساطة طيف الاشعة تحت الحمراء FT-IR، طيف الاشعة فوق البنفسجية - مرئية UV-Vis، الامتصاص الذري ، التحليل الدقيق للعناصر الدقيق (C.H.N)، التوصيلية الكهربائية المولارية فضلاً عن قياس درجة الانصهار. أظهرت الدراسة ان الهيأة الهندسية لجميع المعقدات الاربعة المحضرة هي رباعية السطوح.

الكلمات المفتاحية: المعقدات الامينية للفضة (I)، سولفامثوكسزول، نيكوتين اميد، سولفاستاميد، بارا- امينو بنزوك اسد.

Introduction

In recent years, the design of silver(I) complexes has attracted particular attention due to their interesting structures, photoluminescent properties, biological, and pharmacological activities, such as anticancer, antibacterial and antifungal properties [1, 2]. It is an effective agent with low toxicity, which is especially important in the topical antibacterial treatment of burn wounds, where transient bacteremia is commonly cited [3, 4]. The design and synthesis of silver(I) complexes have attracted immense attention due to the versatility of their coordination geometries [5].

Silver ions and silver compounds are toxic to some bacteria, viruses, algae and fungi. For that reason, silver-based medicines have been widely used for centuries. Contrary to other heavy metals, silver is harmless to humans, although it may cause argyria when used

excessively. After discovery of antibiotics, the use of silver and its compounds as germicides decreased. However, the interest in silver as an anti-microbial has been renewed in the last years [6].

During recent decades silver complexes have been extensively studied for their excellent antibacterial properties, which have proven to be even more effective than silver salts. This metal is active at low concentrations and has a low toxicity. Antibacterial experiments have shown broader antimicrobial activity spectra for silver complexes with Ag-O and Ag-N bonds than with Ag-P and Ag-S bonds. Investigations on silver complexes to date have attributed their enhanced antimicrobial properties to distinctive weak Ag-O and Ag-N bonds in their structure [7]. Ligands having electron donor atoms like N, O, S, and P etc. may form coordination bond with metal ion. Chelation causes drastic changes in biological properties of ligands as well as metal moiety and in many cases it causes synergistic effect of metal ion and ligand both [8].Fig.1 shows structures for uses ligand in this research .

In this paper, we describe the prepation and structural characterization of four silver(I) complexes: $[Ag(SMZ)(NO_3)(H_2O)]. H_2O$, $[Ag(NAM)(NO_3)(H_2O)]$, $[Ag(SCM)(NO_3)(H_2O)]$ and $[Ag(PAB)_2(NO_3)(H_2O)]. 2H_2O$.

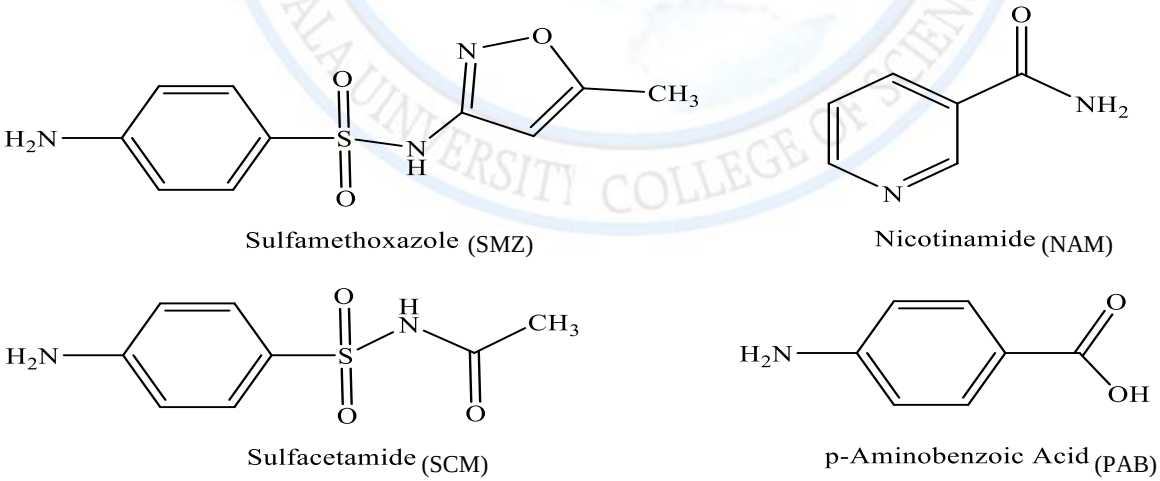


Fig.1: Structures of uses ligands

Experimental

Chemicals

Silver nitrate were available from Sigma, ethanol were available from Scharlau and DMSO were available from Fluka. While (sulfamethoxazole, nicotinamide, sulfacetamide, p-aminobenzoic acid) were available from Merck. The solvents and other chemicals were used without purification.

Instrumentation

Melting point have been determined with Büchi melting point M-565 in SDI laboratory/ Samarra. Electrical molar conductivity of the complexes were recorded at room temperature for 10^{-3} M solution of the sample in DMSO using a HI 9811-5 in SDI laboratory/ Samarra. FT-IR spectra for complexes were recorded by using FT-IR testscan Shimadzu (FT-IR)-8300 series spectrophotometer in range (4000-400) cm^{-1}. Spectra were recorded as KBr disk at College of Education for Pure Sciences, Ibn-Al-Haithm, Baghdad University. Electronic spectra of the ligands and their complexes were obtained by using a (U.V-Vis) spectrophotometer type Shimadzu–160, in the range (200-1000) nm using quartz cell of (1.0) cm length with concentration 10^{-3} M of sample in DMSO solvent at room temperature in the laboratories of Ibn-Sina state company. The metal percentage of the complexes was measured using flame atomic absorption spectrophotometer technique Shimadzu (A.A)-680A for determination Ag^{+} ion in complexes. The measurements were carried out in the laboratories of Ibn-Sina state company. Elemental microanalysis (C.H.N) for the complexes, have been determined with EuroVector EA3000 elemental analyzer. The measurements have been made at the Chemistry Dep. College of Science, Al-al-Bayt University/ Jorden.

Preparation of Ag(I) complexes

Complex-1: $[Ag(SMZ)(NO_3)(H_2O)].H_2O$

Silver nitrate (0.170 g, 1.00 mmoles) was dissolved in distilled water (10 ml). This solution was added to a solution of sulfamethoxazole (SMZ) (0.254 g, 1.00 mmoles) in ethanol (20 ml). And after the addition was complete the solution was heated to 50 ºC with

stirring for 0.5 h, then left over night. Resulted a white precipitate, which were filtered, washed with cold ethanol and dried in a desiccator over anhydrous $CaCl_2$, [scheme- 1].

Complex-2: [Ag(NAM)(NO_3)(H_2O)]

Silver nitrate (0.170 g, 1.00 mmoles) was dissolved in distilled water (10 ml). This solution was added to a solution of nicotinamide (NAM) (0.123 g, 1.00 mmoles) in ethanol (20 ml). And after the addition was complete the solution was heated to 50 ºC with stirring for 0.5 h, then left over night. Resulted a white precipitate, which were filtered, washed with cold ethanol and dried in a desiccator over anhydrous $CaCl_2$, [scheme- 2].

Complex-3: [Ag(SCM)(NO_3)(H_2O)]

Silver nitrate (0.170 g, 1.00 mmoles) was dissolved in distilled water (10 ml). This solution was added to a solution of sulfacetamide (SCM) (0.215 g, 1.00 mmoles) in ethanol (20 ml). And after the addition was complete the solution was heated to 50 ºC with stirring for 0.5 h, then left over night. Resulted a white precipitate, which were filtered, washed with cold ethanol and dried in a desiccator over anhydrous $CaCl_2$, [scheme- 3].

Complex-4: [Ag(PAB)$_2$(NO_3)(H_2O)]. 2H_2O

Silver nitrate (0.170 g, 1.00 mmoles) was dissolved in distilled water (10 ml). This solution was added to a solution of *p*-aminobenzoic acid (PAB) (0.274 g, 2.00 mmoles) in ethanol (20 ml). And after the addition was complete the solution was heated to 50 ºC with stirring for 0.5 h, then left over night. Resulted a glistening brown crystals, which were filtered, washed with cold ethanol and dried in a desiccator over anhydrous $CaCl_2$, [scheme- 4].

Results and Discussions

Table -1 :Contains some physical properties of the uses ligand . Spectroscopic methods (FT-IR, U.V-Vis elemental micro analysis and atomic absorption) along with melting point, conductivity measurement were used to characterize the prepared complexes (1–4).

physical properties of complexes and molar conductivity

All prepared complexes (1–4) are soluble in DMSO solvent only. Some physical properties were listed in [table 1]. All complexes are stable at room temperature and appeared as crystals with high melting point. The molar conductivity values of the soluble complexes in DMSO solvent in 10^{-3} M solution at room temperature refer to non-electrolytic nature.[9]

Elemental microanalysis

Elemental microanalysis (C.H.N), metal analysis are a good agreement with calculated values [table- 3], shows elemental microanalysis for all prepared complexes (1–4).

FT-IR Spectra of Prepared Complexes

Complex-1: [Ag(SMZ)(NO_3)(H_2O)]. H_2O

The FT-IR spectral data of complex-1 were listed in table-4. The FT-IR spectrum of complex-1, fig.2 exhibited two stretching bands at (3388) cm^{-1} and (3323) cm^{-1} which due to stretching vibrations $\upsilon_{asy.}(-NH_2)$ and $\upsilon_{sy.}(-NH_2)$ respectively, while the bending band at (1614) cm^{-1} which due to bending vibrations $\delta(-NH_2)$ group, which were shifted to lower frequency when it comparison with that of free ligand (SMZ), this shift as a result of hydrogen bonding [10]. The stretching band at (3234) cm^{-1} which due to υ(NH) group, which was shifted to lower frequency when it comparison with that of free ligand (SMZ), this shift indicated for the coordination between nitrogen atom of NH group with Ag^+ central ion [11]. The strong stretching bands at (1377, 1301) cm^{-1}, (1165, 1126) cm^{-1} and (908, 856) cm^{-1} which due to stretching vibrations $\upsilon_{asy.}(S=O)$ and $\upsilon_{sy.}(S=O)$ and $\delta(S=O)$respectively and the two bending bands at (709, 675) cm^{-1} which due to δ(C–S=O), which were shifted to lower or higher frequency when it comparison with that of free ligand (SMZ), this shift indicated for involvement the oxygen atom of S=O group in coordination with Ag^+ central ion [12]. The new two stretching bands at (1417) cm^{-1} and (1261) cm^{-1} in the spectrum of complex-1 which aren't observed in IR spectrum of free ligand (SMZ), refer to stretching vibrations $\upsilon_{asy.}(NO_3^-)$ and $\upsilon_{sy.}(NO_3^-)$ respectively, indicating monodentate behavior of NO_3^- ligand with Ag^+ central

ion [13]. The stretching bands at (3448, 3113) cm^{-1} and bending band (833) cm^{-1} refer to hydrated H_2O and coordinated $H_2O_{(aqua)}$ with Ag^+ central ion [14]. Also the new two stretching bands at (518) cm^{-1} and (453) cm^{-1} in the IR spectrum of complex-1 which aren't observed in IR spectrum of free ligand (SMZ), were attributed to bending vibrations υ (Ag–N) and υ (Ag–O) respectively [13], indicating that the nitrogen atom of NH group and oxygen atom of S=O group were involved in coordination with Ag^+ central ion. The stretching band at (3059) cm^{-1} due to υ(C–H) aromatic, while the bending bands at (1182, 1085) cm^{-1} which due to bending vibrations in plane and (785) cm^{-1} which due to bending vibrations out of plane of δ(C–H) aromatic. The stretching bands at (1597, 1500) cm^{-1} which due to υ(C=C) aromatic benzene ring and the stretching band at (1246) cm^{-1} which due to υ(C–N).

Complex-2: [Ag(NAM)(NO_3)(H_2O)]

The FT-IR spectral data of complex-2 were listed in table-5. The FT-IR spectrum of complex-2, displayed the stretching bands at (3402) cm^{-1} and (3161) cm^{-1} which due to stretching vibrations $\upsilon_{asy.}(-NH_2)$ and $\upsilon_{sy.}(-NH_2)$ respectively, also the bending band at (1639) cm^{-1} which due to $\delta(-NH_2)$ group, which were shifted to lower and higher frequency when it comparison with that of free ligand (NAM), indicating the involvement of nitrogen atom of $-NH_2$ group in coordination with Ag^+ central ion [13]. The two stretching bands at (1720, 1678) cm^{-1} which due to υ(C=O) group, also the bending bands at (653, 624) cm^{-1} which due to δ(N–C=O), which were shifted to lower and higher frequency also change in a shape when it comparison with that of free ligand (NAM), this shift indicated involvement the oxygen atom of C=O group in coordination with Ag^+ central ion [15]. The new two stretching bands at (1400) cm^{-1} and (1328) cm^{-1} in the spectrum of complex-2 which aren't observed in IR spectrum of free ligand (NAM), refer to stretching vibrations $\upsilon_{asy.}(NO_3^-)$ and $\upsilon_{sy.}(NO_3^-)$ respectively, indicating monodentate behavior of NO_3^- ligand with Ag^+ central ion . The stretching bands at (3539, 3327) cm^{-1} and bending band (831) cm^{-1} refer to coordinated $H_2O_{(aqua)}$ with Ag^+ central ion [13]. Also the new two stretching bands at (565) cm^{-1} and (501) cm^{-1} in the IR spectrum of complex-2 which aren't observed in IR spectrum of free ligand

(NAM), were attributed to stretching vibrations υ(Ag–N) and υ(Ag–O) respectively, indicating that the nitrogen atom of $–NH_2$ group and oxygen atom of C=O group were involved in coordination with Ag^+ central ion [16]. The stretching band at (3074) cm^{-1} due to υ(C–H) aromatic, while the bending bands at (1236, 1157) cm^{-1} which due to bending vibrations in plane and (692) cm^{-1} which due to bending vibrations out of plane of δ(C–H) aromatic. The stretching bands at (1483, 1423) cm^{-1} which due to υ(C=C) aromatic benzene ring. The stretching bands at (1600, 1577) cm^{-1} which due to υ(C=N) pyridine ring and the stretching band at (1201) cm^{-1} which due to υ(C–N).

Complex-3: $[Ag(SCM)(NO_3)(H_2O)]$

The FT-IR spectral data of complex-3 were listed in table-6. The FT-IR spectrum of complex-3, shows the strong stretching bands at (3454) cm^{-1} and (3360) cm^{-1} which due to stretching vibrations $υ_{asy.}(–NH_2)$ and $υ_{sy.}(–NH_2)$ respectively, while the bending band at (1598) cm^{-1} which due to $δ(–NH_2)$ group, the stretching band at (3246) cm^{-1} which due to υ(NH) group, which were shifted to lower and higher frequency when it comparison with that of free ligand (SCM), this shift as a result of hydrogen bonding [10]. The stretching band at (1637) cm^{-1} which due to υ(C=O) group, which were shifted to lower frequency when it comparison with that of free ligand (SCM), this shift indicated for involvement the oxygen atom of C=O group in coordination with Ag^+ central ion [17]. The strong sharp stretching bands at (1363) cm^{-1}, (1128) cm^{-1} and (900, 852) cm^{-1} which due to $υ_{asy.}(S=O)$, $υ_{sy.}(S=O)$ and δ(S=O) respectively and the bending band at (690) cm^{-1} which due to δ(C–S=O), which were shifted to lower frequency when it comparison with that of free ligand (SCM), this shift indicated for involvement the oxygen atom of S=O group in coordination with Ag^+ central ion [10]. The new two stretching bands at (1323) cm^{-1} and (1296) cm^{-1} in the spectrum of complex-3 which aren't observed in IR spectrum of free ligand (SCM), refer to stretching vibrations $υ_{asy.}(NO_3^-)$ and $υ_{sy.}(NO_3^-)$ respectively, indicating monodentate behavior of NO_3^- ligand with Ag^+ central ion [13]. While the stretching band at (3240) cm^{-1} and bending band (983) cm^{-1} refer coordinated $H_2O_{(aqua)}$ with Ag^+ central ion [14]. Also the new stretching band

at (472) cm^{-1} in the IR spectrum of complex-3 which isn't observed in IR spectrum of free ligand (SCM) attributed to stretching vibrations υ(Ag–O), indicating that the oxygen atoms of C=O group and S=O group were involved in coordination with Ag^+ central ion [16]. The stretching band at (3010) cm^{-1} due to υ(C–H) aromatic, also the bending bands at (1184, 1083) cm^{-1} which due to bending vibrations in plane and (823) cm^{-1} which due to bending vibrations out of plane of δ(C–H) aromatic. The stretching bands at (1577, 1564) cm^{-1} which due to υ(C=C) aromatic benzene ring and the stretching band at (1240) cm^{-1} which due to υ(C–N).

Complex-4: $[Ag(PAB)_2(NO_3)(H_2O)]. 2H_2O$

The FT-IR spectral data of complex-4 were listed in table-7. The FT-IR spectrum of complex-4, displayed two strong sharp stretching bands at (3352) cm^{-1} and (3255) cm^{-1} which due to stretching vibrations $\upsilon_{asy.}(-NH_2)$ and $\upsilon_{sy.}(-NH_2)$ respectively, while the bending band at (1604) cm^{-1} which due to δ($-NH_2$) group, which were shifted lower frequency when it comparison with that of free ligand (PAB), indicating that the nitrogen atom of $-NH_2$ group were involved in coordination with Ag^+ central ion [12]. The stretching band at (1685) cm^{-1} which due to υ(C=O) group, which were shifted higher frequency when it comparison with that of free ligand (PAB), this shift as a result of hydrogen bonding [10]. The two bands at (1419) cm^{-1} and (1288) cm^{-1} were attributed to stretching vibrations $\upsilon_{asy.}(COO^-)$ and $\upsilon_{sy.}(COO^-)$ respectively, the IR spectrum of complex-4 appeared no change in the position and shape of this band which means that C=O group wasn't involved in coordination with Ag^+ central ion. These observation indicated that the ligand (PAB) behaves as monodentate when it's coordination with Ag^+ central ion via nitrogen atom of $-NH_2$ group. The new two stretching bands at (1365) cm^{-1} and (1246) cm^{-1} in the spectrum of complex-4 which aren't observed in IR spectrum of free ligand (PAB), refer to stretching vibrations $\upsilon_{asy.}(NO_3^-)$ and $\upsilon_{sy.}(NO_3^-)$ respectively, indicating monodentate behavior of NO_3^- ligand with Ag^+ central ion [13]. While the stretching band at (3440) cm^{-1} and bending band (817) cm^{-1} refer to hydrated H_2O and coordinated $H_2O_{(aqua)}$ with Ag^+ central ion [14]. Also the new stretching bands at (578) cm^{-1}

(439) cm^{-1} in the IR spectrum of complex-4 which aren't observed in IR spectrum of free ligand (PAB) attributed to stretching vibrations υ (Ag–N) and υ (Ag–O), indicating that the nitrogen atom of $–NH_2$ group and oxygen atom of NO_3^- group were involved in coordination with Ag^+ central ion [16]. The stretching band at (3159) cm^{-1} due to υ(O–H) group, the strong bending band at (921) cm^{-1} which due to δ(O–H) group. The stretching band at (3066) cm^{-1} due to υ(C–H) aromatic, also the bending bands at (1172, 1130) cm^{-1} which due to bending vibrations in plane and (771) cm^{-1} which due to bending vibrations out of plane of δ(C–H) aromatic. The stretching bands at (1512, 1442) cm^{-1} which due to υ(C=C) aromatic benzene ring and the stretching band at (1211) cm^{-1} which due to υ(C–N).

Electronic Spectra of Prepared Complexes

The U.V-Vis spectral data for all of prepared complexes were listed in table -8 .

Complex-1: [Ag(SMZ)(NO_3)(H_2O)]. H_2O

The U.V-Vis spectrum of complex-1, fig.3 displayed three absorption peaks, the first peak at (278) nm (35971) cm^{-1} (ε_{max}= 1874) $mol^{-1}.l.cm^{-1}$, the second peak at (348) nm (28735) cm^{-1} (ε_{max}= 458) $mol^{-1}.l.cm^{-1}$, may be attributed to intra-ligand which were shifted to higher wave length when it was comparison with that of free ligand (SMZ), and third peak at (364) nm (27472) cm^{-1} (ε_{max}= 403) $mol^{-1}.l.cm^{-1}$ a signed to charge transfer electronic transition type (M→L). The shift in the two peaks of free ligand and appearance of charge transfer peak in the spectrum of complex-1 refer to the coordination of (SMZ) with Ag^+ ion [18, 19].

Complex-2: [Ag(NAM)(NO_3)(H_2O)]

The U.V-Vis spectrum of complex-2,displayed two absorption peaks, the first peak at (272) nm (36764) cm^{-1} (ε_{max}= 1599) $mol^{-1}.l.cm^{-1}$ refers to intra-ligand which were shifted to higher wave length when it was comparison with that of free ligand (NAM) and the second peak at (369) nm (27100) cm^{-1} (ε_{max}= 291) $mol^{-1}.l.cm^{-1}$ a signed to charge transfer electronic transition type (M→L). The shift in the peak of free ligand and appearance of

charge transfer peak in the spectrum of complex-2 refer to the coordination of (NAM) with Ag^+ ion [18, 20].

Complex-3: [Ag(SCM)(NO_3)(H_2O)]

The U.V-Vis spectrum of complex-3, displayed three absorption peaks, the first peak at (278) nm (35971) cm^{-1} (ε_{max}= 1953) $mol^{-1}.l.cm^{-1}$, the second peak at (341) nm (29325) cm^{-1} (ε_{max}= 634) $mol^{-1}.l.cm^{-1}$, may be attributed to intra-ligand which were shifted to higher wave length when it was comparison with that of free ligand (SCM) and third peak at (383) nm (26109) cm^{-1} (ε_{max}= 621) $mol^{-1}.l.cm^{-1}$ a signed to charge transfer electronic transition type (M→L). The shift in the two peaks of free ligand and appearance of charge transfer peak in the spectrum of complex-3 refer to the coordination of (SCM) with Ag^+ ion [18, 19].

Complex-4: [Ag(PAB)$_2$(NO_3)(H_2O)]. 2H_2O

The U.V-Vis spectrum of complex-4,displayed two absorption peaks, the first peak at (279) nm (35842) cm^{-1} (ε_{max}= 1925) $mol^{-1}.l.cm^{-1}$ and the second peak at (345) nm (28985) cm^{-1} (ε_{max}= 464) $mol^{-1}.l.cm^{-1}$, were a signed to intra-ligand which were shifted to higher wave length when it was comparison with that of free ligand (PAB). The shift in the two peaks of free ligand in the spectrum of complex-4 refers to the coordination of (PAB) with Ag^+ ion [20,21].

Conclusions

According to the characterization data for the prepared complexes, by FT-IR, U.V-Vis, atomic absorption, elemental microanalysis (C.H.N), molar conductivity along with melting point we found that:

Sulfamethoxazole (SMZ) behaves as bidentate ligand through its nitrogen atom of (NH) group and one oxygen atom of (SO) group of four member ring with Ag^+ ion forming complex with molecular formula [Ag(SMZ)(NO_3)(H_2O)].H_2O. Nicotinamide (NAM) behaves as bidentate ligand via nitrogen atom of (NH_2) group and oxygen atom of (CO) group of four

member ring with Ag^+ ion forming complex with molecular formula $[Ag(NAM)(NO_3)(H_2O)]$. Sulfacetamide (SCM) behaves as bidentate ligand through its two oxygen atoms of (SO) and (CO) groups of six member ring with Ag^+ ion forming complex with molecular formula $[Ag(SCM)(NO_3)(H_2O)]$. p-Aminobenzoic acid (PAB) behaves as monodentate ligand via nitrogen atom of (NH_2) group forming complex of mole ratio L:Ag(2:1) with molecular formula $[Ag(PAB)_2(NO_3)(H_2O)]$. $2H_2O$. The tetrahedral geometrical structure was suggested for prepared complexes based on the characterization data for all techniques.

References

1. Kalinowska-Lis U, Felczak A, L. Checinska, Lisowska K and Ochocki J; *J. Organom. Chem.* 749 (2014) 394−399.
2. Kharat A.N., Bakhoda A., Foroutannejad S.and Foroutannejad C. ; *Z. Anorg. Allg. Chem.* 637 (2011) 1–6.
3. Abu-Youssef M.A.M.,Dey, Y. Gohar R., Massoud A.A, Ohrstrom L. and Langer V. ; *Inorg. Chem.* 46 (2007) 5893–5903.
4. Balogh l., Swanson D. R., Tomalia D.A., Hagnauer G.L.and McManus A.T. ; *Nano Lett. 1* (2001) 18–21.
5. YesilelO.Z. , Gunay G., Semerci. F and Erkmen D. ; *Z. Kristallogr*. 227 (2012) 694–701.
6. Czoika R., Heintzb A., Johna E. and Marczak W. ; *Acta Physica. Polonica* A 114 (2008) 51–56.
7. Azócar M.I., Muñoz H., Levin P., Dinamarca N., Gómez G., Ibañez A., Garland M.T. and Paez M.A. ; *Commun. Inorg. Synth*. 1 (2013) 19–21.
8. BhartiS.K. and Singh S.K. ; *Der Pharmacia Lettre 1* (2009) 39–51.
9. Singh B.,Sing R.N. and Aggarwal R.C. ; *Polyhedron* ,4,(1985),401-405.
10. Fayad N.K., Al-Noor T.H. and Ghanim F.H. ; *Adv. Phys. Theo. Appl.* 2012; *9* (2012): 1-13.
11. Al-Noor T.H., AL- Jeboori A.T.and Aziz M.R. ;*Adv. Phys. Theo. Appl.* 2013; *18* (2013): 1-8.

12. Anacona J.R. and Rodriguez I. ;*J. Coord. Chem.* 2004; *57* (15): 1263-1269.

13. Nakamoto K. "Infrared and raman spectra of inorganic and coordination compounds". 6th ed. NJ: Wiley; 2009.

14. Abd El-Wahab Z.H., Mashaly M.M. and Faheim A.A. ;*Chem. Papers* 2005; *59* (1) 25-36.

15. Mishra A.P., Mishra R, Jain R. and Gupta S. ; *Mycobiology* 2012; *40* (1): 20-26.

16. Srivastava K.P., Vidyarthi S.N. and Singh R. ;*Chem. Sinica* 2011; *2* (2): 66-76.

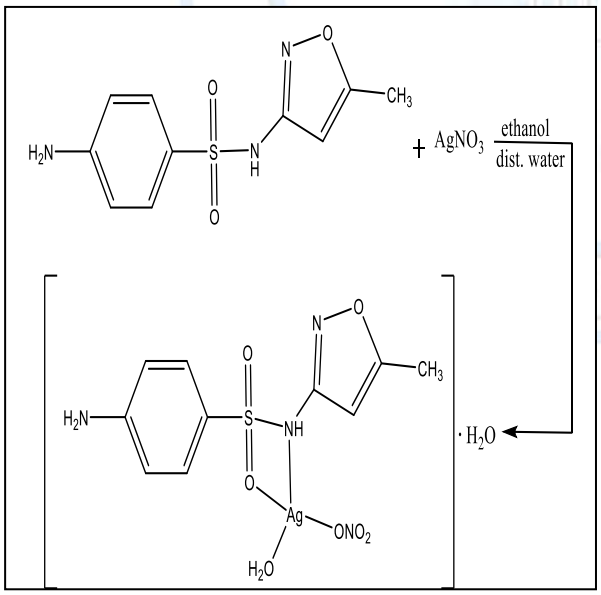
17. Jowitt R.N., Mitchell P.C.H. and ;*J. Chem. Soc. A* 1970; 1702-1708.

18. Lever A.B.P., "Inorganic electronic spectroscopy". 2nd ed. New York: Elsevier; 1984.

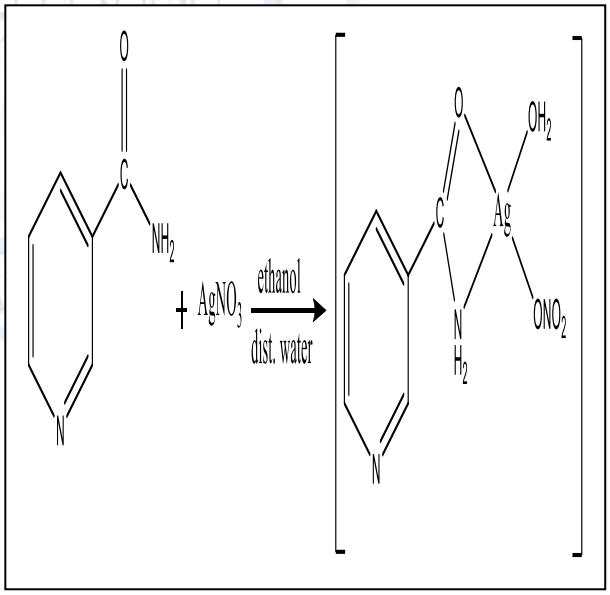
19. Pandey P.K., Pandey A.K., Mishra A.N., Ojha K.K. and Singh R.K., ;*J. Sci. Res.* 2012; *3* (1): 119-122.

20. Erdem E, Sari E.Y., Kilinçarslan R. and Kabay N. ;*Trans. Metal Chem.* 2009; *34* (2): 167-174.

21. Brittain H.G., " Spectroscopy of pharmaceutical solids". 1st ed. New York: Taylor and Francis Group; 2006.



Scheme -1: Synthesis route of complex-1: $[Ag(SMZ)(NO_3)(H_2O)].H_2O$.

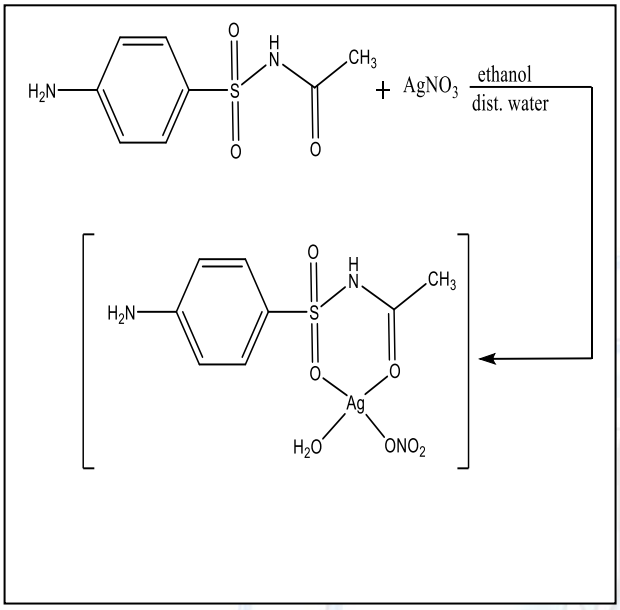


Scheme -2: Synthesis route of complex-2: $[Ag(NAM)(NO_3)(H_2O)]$.

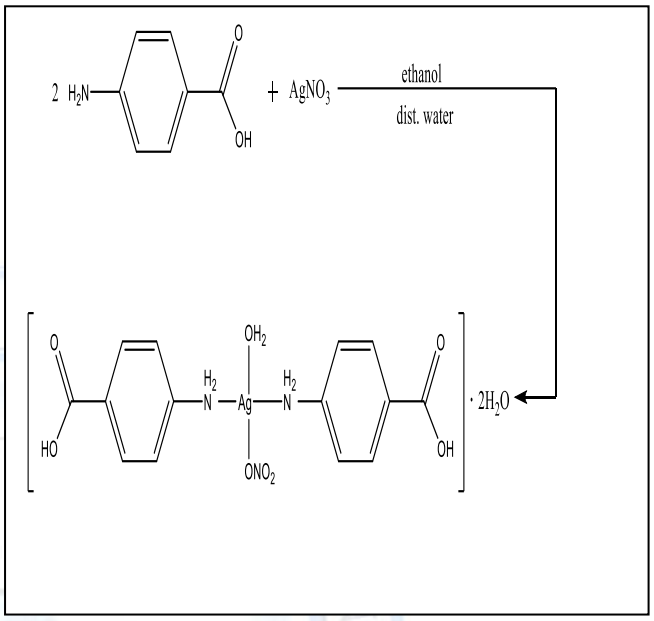
Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef **Safaa A. Ahmed** **Mahmood Y. Hammadi**



Scheme -3: Synthesis route of complex-3: $[Ag(SCM)(NO_3)(H_2O)]$.



Scheme -4: Synthesis route of complex-4: $[Ag(PAB)_2(NO_3)(H_2O)].\ 2H_2O$.

Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef **Safaa A. Ahmed** **Mahmood Y. Hammadi**

Table -1 : Some physical properties of ligands.

No.	Trivial Name	Symbol	Systematic Name	Molecular Formula	m.p.°C	b.p.°C	Solvent
1	Sulfamethoxazole	SMZ	4-Amino-N-(5-methyl-3-isoxazolyl)benzenesulfonamide	$C_{10}H_{11}N_3O_3S$	169	-	Ethanol
2	Nicotinamide	NAM	Pyridine-3-carboxa-mide	$C_6H_6N_2O$	129.5	224	Ethanol
3	Sulfacetamide	SCM	N-[(4-aminophenyl)sulfonyl]acetamide	$C_8H_{10}N_2O_3S$	183	-	Ethanol
4	p-Aminobenzoic Acid	PAB	4-Aminobenzoic acid	$C_7H_7NO_2$	187	340	Ethanol

Table -2 : Some physical properties of complexes (1-4).

No.	Complexes	M. Wt. g/mol	Yield%	M. P. °C	Λ_m ohm^{-1}cm^{-1}mol^{-1}	Colour
1	[Ag(SMZ)(NO$_3$)(H$_2$O)].H$_2$O	459	90	245-250	0.00	White
2	[Ag(NAM)(NO$_3$)(H$_2$O)]	310	90	215-220	0.00	White
3	[Ag(SCM)(NO$_3$)(H$_2$O)]	402	87	255-260	0.00	White
4	[Ag(PAB)$_2$(NO$_3$)(H$_2$O)].2H$_2$O	498	86	215-220	0.03	Glisten Brown

Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef **Safaa A. Ahmed** **Mahmood Y. Hammadi**

Table -3 : Elemental microanalysis of complexes (1–4).

NO.	Complexes	Found, (Calc.) %			
		C	H	N	Ag
1	[Ag(SMZ)(NO$_3$)(H$_2$O)]. H$_2$O	25.71 (26.14)	2.86 (3.26)	11.63 (12.20)	23.06 (23.52)
2	[Ag(NAM)(NO$_3$)(H$_2$O)]	22.84 (23.22)	1.94 (1.93)	12.96 (13.54)	34.06 (34.83)
3	[Ag(SCM)(NO$_3$)(H$_2$O)]	23.36 (23.88)	2.46 (2.98)	9.92 (10.44)	26.61 (26.86)
4	[Ag(PAB)$_2$(NO$_3$)(H$_2$O)]. 2H$_2$O	33.33 (33.73)	3.84 (4.01)	7.72 (8.43)	21.25 (21.68)

Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef **Safaa A. Ahmed** **Mahmood Y. Hammadi**

Table -4 : The important characteristic bands (cm^{-1}) for IR spectra of ligand (SMZ) and it's complex-1 : $[Ag(SMZ)(NO_3)(H_2O)]$. H_2O.

Compound	$\nu_{as},\nu_s NH_2$	ν=NH	δNH_2	ν_{as},ν_s S=O	δ S=O	νC–S=O	ν O–H (H_2O)	δ O–H (H_2O)	$\nu_{as},\nu_s NO_3^-$	νAg–N	νAg–O
SMZ	3468 3379	3300	1622	(1382, 1365) (1157, 1143)	(927, 885)	(713, 684)	. .	.	. .	.	.
Complex-1	3388 3323	3234	1614	(1377, 1301) (1165, 1126)	(908, 856)	(709, 675)	3448 3113	833	1417 1261	518	453

Table -5 : The important characteristic bands (cm^{-1}) for IR spectra of ligand (NAM) and it's complex-2 : $[Ag(NAM)(NO_3)(H_2O)]$.

Compound	$\nu_{as},\nu_s NH_2$	δNH_2	νC=O	ν O–H (H_2O)	δ O–H (H_2O)	$\nu_{as},\nu_s NO_3^-$	νAg–N	νAg–O
NAM	3367 3165	1620	1700 1681	. .	.	. .	.	.
Complex-2	3402 3161	1639	1720 1678	3539 3327	831	1400 1328	565	501

Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef **Safaa A. Ahmed** **Mahmood Y. Hammadi**

Table -6 : The important characteristic bands (cm^{-1}) for IR spectra of ligand (SCM) and it's complex-3: [Ag(SCM)(NO$_3$)(H$_2$O)].

Compound	$\nu_{as,s}NH_2$	νNH	$\nu C=O$	δNH_2	$\nu_{as,s}=O$ $\nu_{s,s}=O$	$\delta S=O$	$\delta C-S=O$	$\nu O-H$ (H_2O)	$\delta O-H$ (H_2O)	$\nu_{as,s}NO_3^-$	$\nu Ag-O$
SCM	3381 3286	3232	1685	1600	1381 1149	937 862	692	-	-	- -	
Complex-3	3454 3360	3246	1637	1598	1363 1128	900 852	690	3240	983	1323 1296	472

Table -7 : The important characteristic bands (cm^{-1}) for IR spectra of ligand (PAB) and it's complex-4 [Ag(PAB)$_2$(NO$_3$)(H$_2$O)]. 2H$_2$O.

Compound	$\nu_{as,s}NH_2$ $\nu_{s,s}NH_2$	δNH_2	$\nu_{as,s}COO^-$ $\nu_{s,s}COO^-$	$\nu C=O$	$\nu O-H$ (H_2O)	$\delta O-H$ (H_2O)	$\nu_{as,s}NO_3^-$ $\nu_{s,s}NO_3^-$	$\nu Ag-N$	$\nu Ag-O$		
PAB	3460 3363	1627	1419 1288	1662	-	-	- -	-	-		
Complex-4	3352 3255	1604	1419 1288	1685	3440	817	1365 1246	578	439		

Table -8: Electronic spectral data for all ligands and their complexes(1-4).

Compound	λ nm	$\bar{\upsilon}$ cm^{-1}	ε_{max} l. $mol^{-1}.cm^{-1}$	Assignments
SMZ	223	44843	1274	$\pi \rightarrow \pi^*$
	252	39682	2371	$\pi \rightarrow \pi^*$
Complex-1	278	35971	1874	Intra-ligand
	348	28735	458	Intra-ligand
	364	27472	403	Charge transfer
NAM	248	40322	2108	$\pi \rightarrow \pi^*$
Complex-2	272	36764	1599	Intra-ligand
	369	27100	291	Charge transfer
SCM	218	45871	944	$\pi \rightarrow \pi^*$
	250	40000	2350	$\pi \rightarrow \pi^*$
Complex-3	278	35971	1935	Intra-ligand
	341	29325	634	Intra-ligand
	383	26109	621	Charge transfer
PAB	244	40983	2287	$\pi \rightarrow \pi^*$
	281	35587	1899	$\pi \rightarrow \pi^*$
Complex-4	279	35842	1925	Intra-ligand
	345	28985	464	Intra-ligand

Preparation and Characterization Number of some Amino

Silver(I) Complexes

Sajid M. Lateef Safaa A. Ahmed Mahmood Y. Hammadi

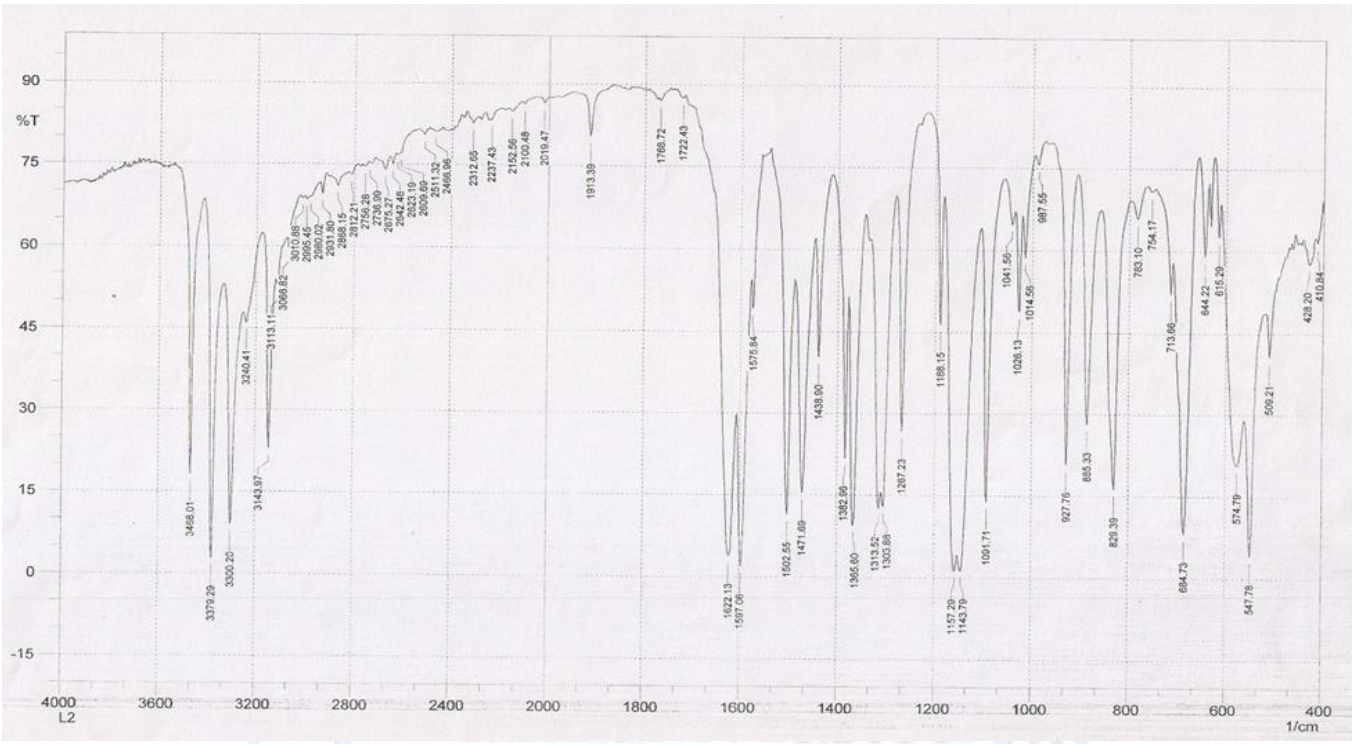


Fig.2 : FT-IR spectrum of complex-1: [Ag(SMZ)(NO_3)(H_2O)]. H_2O.

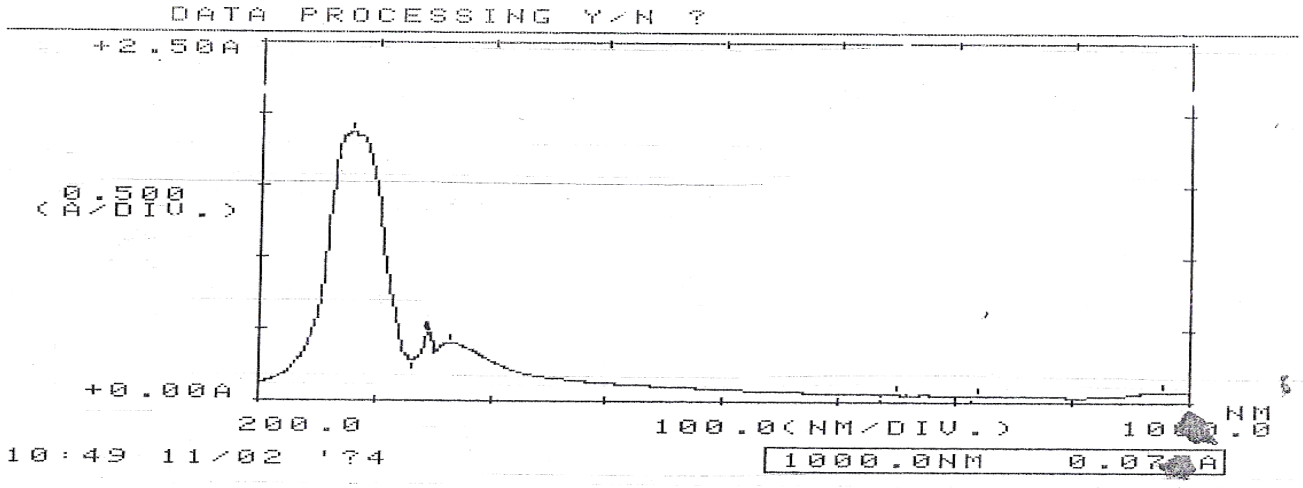


Fig. 3 : Electronic spectrum of complex-1: [Ag(SMZ)(NO_3)(H_2O)]. H_2O.