New 3- hydrazonoindolin-2-one Cd(II) complexes with amino pyridine ligands, Synthesis, Characterization and biological activity evaluation

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ABSTRACT

This research includes synthesis and characterization of some of Cd(II) complexes with (3-hydrazonoindolin-2-one)(HZI) ligand and amino pyridine ligands. Treatment equalmolar of CdCl₂.2.5H₂O and (HZI) ligand with two moles of n-aminopyridine (n-amp) (n:2,3,4) ligands afford a tetrahedral complexes of the type [Cd(HZI)(n-amp)₂]Cl₂, where (HZI) ligand behaves as a bidentate chelating fashion through the N atom of azomethine group and O atom of carbonyl group. Whereas the (n-amp):(n: 2,3,4) was bonded monodentate mode through the N atom of heterocyclic ring.

The prepared complexes have been characterized by molar conductivity, elemental analysis, infrared spectra and ¹H-NMR and ¹³C-NMR spectra. Also the evaluation of biological activity of the prepared complexes against two types of gram positive bacteria (Staphylococcus Epidermidis and Staphylococcus aureus) and (Citrobacter Freundii) and gram negative, all prepared complexes showed activity against Staphylococcus aureus more than amikacin, while the [Cd(HZI)(3-amp)]Cl₂ complex showed high activity against Staphylococcus Epidermidis and Citrobacter freundii more than another prepared complexes.

Introduction

Isatin or Tribulin is a derivative of indole from heterocyclic compounds, and its systemic name (1H-indole-2,3-dione), which was obtained by the scientists Erdman and Laurent in 1840 [1] as a product of the oxidation of Indigo (It is a distinctive blue dye) by nitric acid and chronic acid [2]. The isatin is present inside the human body in the brain and many body tissues and fluids. It also has many biological activities such as causing activities, Antispasmodics, analgesics, anti-convulsions and as a potent against of the receptors atrial peptide in vitro [3,4], antibacterial [5,6], anti-HIV activities [7,8] , as well as liver metabolites, are found in nature in plants such as mushrooms [9].

An Isatin use as ligand alone in preparation of many complexes or it was prepared a new isatin derivatives such as shiff base, Hydrazine-derived isatins were found to be active against sarcoma, antibacterial and antifungal [10,11]. Similarly, acetone- and ketone-derived isatins exhibited anticonvulsant activity [12]. Therefore in this study, a new Cd(II) with (3-hydrazonoindolin-2-one) (HZI) with n-aminopyridine as co-ligand was synthesized and characterized and studied the biological properties.

Experimental

Materials and methods

All chemical materials and solvents were supplied and used without purification. C.H.N analysis was recorded on an Elementar vario EL III C.H.N elemental analyzer. The Nuclear magnetic resonance was measured on a Bruker 400 MHz spectrometer in DMSO-d⁶ as a solvent. The melting point of the ligands and prepared complexes was recorded on Automatic (SMP30) melting point apparatus. The infrared spectra of compounds were recorded with KBr using a Shimadzu FT-IR 8400S spectrophotometer in the 400-4000 cm⁻¹ range. The molar conductivity of 10⁻⁵ M Freshly DMSO solution of prepared complexes was measured by using (Starter 3100c) digital conductivity meter.

Preparation of 3-hydrazonoindolin-2-one (HZI)

A solution of 98% hydrazine (0.055g, 1.1mmol) in (10ml) of absolute ethanol was added to a solution of isatin (0.161g, 1mmol) in (10ml) of absolute ethanol
ethanol with a few drops from glacial acetic acid. The mixture was refluxed for an hour, and then cooled to room temperature, where a yellow precipitate was separated. The yellow ppt. produced was filtered and washed with cold ethanol and dried under vacuum and recrystallized from a mixture of EtOH / DMF [13].

**Preparation of the [Cd(2-amp)_2Cl_2] complex**

A solution of CdCl_2·2.5H_2O (0.342 g, 0.0015 mol) in EtOH (10 ml) was added to a suspension of 2-aminopyridine (2-amp) (0.282 g, 0.003 mol) in (5 ml), the mixture was stirred at room temperature for an hour, then a white ppt. was formed. The white product was filtered off, and dried under vacuum in oven (0.700 g; 75.5%).

The [Cd(3-amp)_2Cl_2] and [Cd(4-amp)_2Cl_2] complexes were prepared and isolated in similar method.

**Synthesis of [Cd(HZI)(2-amp)] complex**

This complex was prepared by two different methods:

**First:**

A solution of the HZI ligand (0.080 g, 0.005 mol) in EtOH (10 ml) was added to a suspension of [Cd(2-amp)Cl_2] (0.138 g, 0.005 mol) in EtOH (10 ml). The mixture was stirred for 2 hours at a room temperature. The light yellow precipitate was formed, then filtered and dried in the oven under vacuum (0.5130 g, 66.7%).

The following complexes [Cd(HZI)(3-amp)]Cl_2 and [Cd(HZI)(4-amp)]Cl_2 were prepared and isolated in the similar method.

**Second 2nd method:**

A solution of CdCl_2·2.5H_2O (0.342 g, 0.0015 mol) (10 ml) was added to a solution of 2-aminopyridine (2-amp) (0.282 g, 0.003 mol) in EtOH (5 ml), the mixture was stirred for an hour at room temperature where the white suspension was formed, then a solution of (HZI) (0.0015 mol, 0.241 g) in EtOH (10 ml) of was added to the white suspension, the mixture was stirred gradually for 2 hours at room temperature where the yellow precipitate was formed, filtered and dried in the oven under vacuum (0.6152 g; 77.8%).

**Results and discussion**

**Molar electrical conductivity**

The results of the molar electrical conductivity of the (10^{-3} M) freshly solution of the (25°C) showed that. All the prepared complexes are electrical were in a molar ratio of (1: 2) positive ion: negative ion.

| Seq | Compound | Color          | M.P. | W.t G | Yield % | Λ (ohm cm^2 mol^{-1}) | Found(cal) % |
|-----|----------|----------------|------|-------|---------|----------------------|--------------|
| 1   | HZI      | Yellow         | 240-242 | 2   | 92      | 59.62 (59.35)        | 26.09 (26.00) |
| 2   | Cl_2Cd(HZI)(2-amp)_2 | Yellowish white | 236-239 | 0.19 | 71      | 40.58 (40.32)        | 13.41 (13.33) |
| 3   | Cl_2Cd(HZI)(3-amp)_2 | Yellowish white | 233-235 | 0.20 | 75      | 73.76 (3.47)         | 13.41 (13.35) |
| 4   | Cl_2Cd(HZI)(4-amp)_2 | Yellowish white | 243-246 | 0.17 | 79      | 80.74 (3.45)         | 13.41 (13.35) |

**Infrared spectra**

The infrared spectrum of (HZI) ligand showed a new stretch band of the azomethine group υ(C=N) at (1589 cm^{-1}) after the disappearance of the stretch band of υ(C=O) carbonyl group in the free isatin. The υ(C=O) carbonyl amide group showed at (1685 cm^{-1}), while the υ(NH) group showed at (3153 cm^{-1}) and the symmetrical and asymmetric stretching of the υ(NH) group displayed at (3193, 3353 cm^{-1}) respectively [13].

The spectra of the prepared complexes showed the υ(C=O) carbonyl amide group bands within the (1685-1683 cm^{-1}) range, the azomethine υ(C=N) group bands displayed within the (1606-1587 cm^{-1}) range, while the υ(NH) group bands showed at 3157 cm^{-1}, either symmetric and asymmetric υ(NH) bands displayed within the (3207-3197 cm^{-1}) and (3362-3353 cm^{-1}) range respectively. The υ(C=N) group in aminopyridine ligands were displayed within the (1552-1550 cm^{-1}) range [14,15].
Fig. 1: IR spectrum of (HZI) ligand

Fig. 2: IR spectrum of [Cd(HZI)(2-amp)]Cl₂ complex

Table 2: Selected IR stretching vibration bands (cm⁻¹) of the ligand and ids complexes

| Compounds            | HZI      | Amine ligand |
|----------------------|----------|--------------|
|                      | νC=O     | νC=N         | νNH | νNH₂ | νN=C | νNH₂ |
| HZI                  | 1685s    | 1589s        | 3153s | 3193s | 3355s | -   | -   |
| Cl₂Cd(HZI)(2-amp)₂f  | 1685s    | 1587s        | 3157s | 3207s | 3353m | 3014w | 1550m | 3353m |
| Cl₂Cd(HZI)(3-amp)₂f  | 1683s    | 1606s        | 3157m | 3197s | 3362m | 3070w | 1552m | 3352m |
| Cl₂Cd(HZI)(4-amp)₂f  | 1685s    | 1587s        | 3157s | 3197m | 3360m | 3055w | 1552m | 3353m |

s = strong, m= medium, w= weak , Ar. = Aromatic

NMR Spectra

¹H-NMR of (HZI) ligand

The ¹H-NMR spectrum of (HZI) ligand in DMSO-d₆ showed the protons Hₐ and H₄ as doublet of doublets at δ=7.36ppm and δ=6.87ppm with coupling constant (J₃H₄=8.03Hz) and (J₄H₄=7.87Hz) respectively. Whereas the proton in position H₅ and H₆ appeared as doublet of triplets at δ=6.98ppm and δ=7.16ppm with coupling constant (J₃H₅=7.78 Hz) and the spectrum showed two doublet at δ=9.53ppm and δ=10.54ppm with coupling constant (J₃H₄=13.94 Hz) respectively attributed to each of (NH₂) proton [13]. and showed a single signal at δ=10.67ppm attributed to the (NH) proton for isatin.
The $^{13}$C-NMR spectrum of the (HZI) ligand in DMSO-$d_6$ showed a signal at $\delta C = 136.48$ ppm which was attributed to the carbon (C=N) group, as well as a signal at $\delta C = 140.48$ ppm assigned to the carbon of benzene ring which was bonded to N pentagonal ring. The carbonyl group appeared at $\delta C = 162.91$ ppm, while another peaks of the carbon atoms showed within $\delta C = 111.35-129.54$ ppm range[13].

The spectrum of $[\text{Cd(HZI)(2-amp)}_2]\text{Cl}_2$ complex showed a doublet signal at $\delta H = 6.86$ ppm with coupling constant ($^3J_{Hd-Hc} = 7.74$ Hz) due to the H_d proton, and a triplet of doublets at $\delta H = 6.97$ ppm with coupling constant ($^3J_{Hb-Hc} = 7.50$ Hz), ($^4J_{Hb-Hd} = 1.02$ Hz) attributed to proton H_b proton, another signal showed a triplet of doublets at $\delta H = 7.15$ ppm with coupling constant ($^3J_{Hc-Hb} = 7.61$ Hz), ($^4J_{Hc-Ha} = 1.31$ Hz) attributed to the H_c proton, the spectrum showed a doublet at $\delta H = 7.36$ ppm attributed to the H_a proton, with coupling constant ($^3J_{Ha-Hb} = 7.56$ Hz), the spectrum also showed two doublets at $\delta H = 9.53$ ppm and $\delta H = 10.54$ ppm with coupling constant ($^3J_{H2-H1} = 14.22$ Hz) and ($^3J_{H3-H1} = 14.12$ Hz) respectively attributed to each of (NH$_2$) protons[13], and showed a single signal at $\delta H = 10.68$ ppm attributed to the (NH) proton for isatin.

The spectrum showed the signals of protons of the 2-amp as a broad singlet at $\delta H = 5.99$ ppm attributed to the (NH$_2$) where the integration value confirms the presence of 4 protons of the two (NH$_2$) groups, and the protons of H4 and H2 showed a multiple at $\delta H = 6.48$ ppm, and the H3 appeared a triplets of doublet at $\delta H = 7.90$ ppm due to the H1 proton with coupling constant ($^3J_{H1-H2} = 5.1$ Hz), ($^3J_{H1-H3} = 1.08$ Hz).

**Fig. 3:** $^1$H-NMR spectrum of (HZI) ligand in DMSO-$d_6$

**Fig. 4:** $^{13}$C-NMR spectrum of (HZI) Ligand in DMSO-$d_6$
\[ \text{Fig. 5: } ^{1}H\text{-NMR spectrum of [Cd(HZI)(2-amp)]Cl\textsubscript{2} complex in DMSO-d\textsubscript{6} } \]

\[ ^{13}\text{C}\{-^{1}H\}\text{NMR of [Cd(HZI)(2-amp)]Cl\textsubscript{2} complex} \]

The \(^{13}\text{C}\{-^{1}H\}\text{NMR spectrum of complex in DMSO-d\textsubscript{6} showed a signal at } \delta \text{C}=139.39\text{ppm due to the carbon of (N}=C\text{) group, and the } \delta \text{C}=149.39\text{ppm carbon in position 5 in 2-amp and at } \delta \text{C}=159.79\text{ppm to the carbon position 1 in 2-amp, a signal at } \delta \text{C}=163.51\text{ppm attributed to the carbon of (C}=O\text{) group, while the another signals of the carbon atoms showed within } \delta \text{C}=137.63\text{-}109.95\text{ppm range.} \]

\[ \text{Fig. 6: } ^{13}\text{C-NMR spectrum of [Cd(HZI)(2-amp)]Cl\textsubscript{2} complex in DMSO-d\textsubscript{6} } \]

\[ ^{1}H\text{-NMR of [Cd(HZI)(3-amp)]Cl\textsubscript{2} complex} \]

The spectrum of complex showed a doublet of doublets at \( \delta \text{H}=6.86\text{ppm with coupling constant (}^{3}\text{J}_{\text{Hd-Hc}}=7.83\text{Hz), (}^{4}\text{J}_{\text{Hd-Hc}}=2.53\text{Hz)} \) due to the H\textsubscript{d} proton, and a triplet of doublets at \( \delta \text{H}=6.97\text{ppm with coupling constant (}^{3}\text{J}_{\text{Hb-Hc}}=7.54\text{Hz), (}^{4}\text{J}_{\text{Hb-Hd}}=2.72\text{Hz)} \) attributed to proton H\textsubscript{b} proton, another signal showed as a triplet at \( \delta \text{H}=7.16\text{ppm with coupling constant (}^{3}\text{J}_{\text{Hc-Hb}}=7.63\text{Hz), attributed to the Hc proton, the spectrum showed a doublet at } \delta \text{H}=7.36\text{ppm with coupling constant (}^{3}\text{J}_{\text{H1-H2}}=8.51\text{Hz), respectively attributed to each of (NH\textsubscript{2}) proton}\textsubscript{S}[13], and showed a single signal at } \delta \text{H}=10.68\text{ppm attributed to the (NH) proton for isatin.} \]

The spectrum showed signals of 3-amp as a broad singlet at \( \delta \text{H}=5.13\text{ppm attributed to the (NH\textsubscript{2}) where the integration value confirms the presence of 4 protons of the two (NH\textsubscript{2}) groups, and showed a doublet at } \delta \text{H}=6.44\text{ppm attributed to the H3 protons with coupling constant (}^{3}\text{J}_{\text{H3-H1}}=9.26\text{Hz), (}^{4}\text{J}_{\text{H3-H1}}=2.33\text{Hz), and a triplet at } \delta \text{H}=6.57\text{ppm attributed to proton H2 with coupling constant (}^{3}\text{J}_{\text{H2-H1}}=8.13\text{Hz), and a doublet at } \delta \text{H}=7.90\text{ppm attributed to the H4 protons with coupling constant (}^{3}\text{J}_{\text{H4-H1}}=4.16\text{Hz)[16].} \]
The spectrum of complex showed a signal at $\delta C=139.13$ ppm attributed to the carbon of benzene ring which was bonded to N pentagonal ring, the spectrum showed a signal at $\delta C=149.39$ ppm attributed to the carbon Position 5 in 3-amp, a signal at $\delta C=160.17$ ppm attributed to the carbon Position 5 in (C=O) group, while the another signals of the carbon atoms showed within $\delta C=108.66$-127.51 ppm range[16].

The spectrum of complex showed a doublet at $\delta H=6.86$ ppm with coupling constant ($^{3}J_{Hd-Hc}=7.66$ Hz) due to the H$_d$ proton, and a triplet at $\delta H=6.97$ ppm with coupling constant ($^{3}J_{Hb-Hc}=7.56$ Hz) attributed to proton H$_b$ proton, another signal showed a triplet of doublets at $\delta H=7.14$ ppm with coupling constant ($^{3}J_{Hc-Ha}=7.61$ Hz) ($^{4}J_{Hc-Hb}=1.49$ Hz), attributed to the H$_c$ proton, the spectrum showed a doublet at $\delta H=7.36$ ppm attributed to the H$_{a}$ with coupling constant ($^{3}J_{Ha-Hb}=6.88$ Hz), the spectrum also showed two doublets at $\delta H=9.53$ ppm and $\delta H=10.54$ ppm with coupling constant ($^{3}J_{Hc-Ha}=13.95$ Hz) and ($^{3}J_{Hc-Hb}=10.00$ Hz) respectively attributed to each of (NH$_2$) protons[13], and showed a single signal at $\delta H=10.68$ ppm attributed to the (NH) proton for isatin. The spectrum showed signals of 4-amp as a broad singlet at $\delta H=5.98$ ppm attributed to the (NH$_2$) where the integration value confirms the presence of 4 protons of the two (NH$_2$) groups, and showed a doublet of doublets at $\delta H=6.45$ ppm attributed to the H$_{2}$ protons with coupling constant ($^{4}J_{Hc-Hb}=7.94$) ($^{3}J_{Hc-Ha}=3.91$ Hz), and showed a doublet of doublets at $\delta H=6.58$ ppm attributed to the H$_1$ protons with coupling constant ($^{4}J_{Hc-Hb}=8.80$ Hz) ($^{3}J_{Hc-Ha}=3.99$).
Fig. 9: $^1$H-NMR spectrum of [Cd(HZI)(4-amp)$_2$]Cl$_2$ complex in DMSO-d$_6$

$^{13}$C-$^1$H-NMR Spectrum of [Cd(HZI)(4-amp)$_2$]Cl$_2$ complex

The spectrum showed a signal at $\delta$C = 110.16 ppm due to the carbon of position 2 in 4-amp and a signal at $\delta$C = 136.51 ppm due to the carbon of (C=N) group, and a signal at $\delta$C = 139.39 ppm attributed to the carbon of benzene ring which was bonded to N pentagonal ring, the spectrum showed a signal at $\delta$C = 149.47 ppm attributed to the carbon of position 1 in 4-amp and a signal at $\delta$C = 153.97 ppm due to the carbon of position 3 in 4-amp, a signal at $\delta$C = 163.51 ppm attributed to the carbon of (C=O) group, while the another signals of the carbon atoms showed within $\delta$C = 112.01-129.64 ppm range.

Fig. 10: $^{13}$C-NMR spectrum of [Cd(HZI)(4-amp)$_2$]Cl$_2$ complex in DMSO-d$_6$

Biological activity study of the prepared compounds

The evaluation of biological activity of the prepared complexes against two bacterial types Staphylococcus Epidermidis and Staphylococcus aureus (gram positive) and Citrobacter freundii (gram negative) by hole method in $(10^{-3},10^{-4},10^{-5}$ M) of solution of the prepend complexes in DMSO-d$_6$ [17-19] compared with Amikacin as standard antibiotic, All complexes showed high activity against Staphylococcus aureus more than amikacin, while the [Cd(HZI)(3-amp)$_2$]Cl$_2$ complex showed high activity against Staphylococcus Epidermidis and Citrobacter freundii more than another complexes.
Scheme (2) The biological activity of the prepared complexes against three types of bacteria species.

Conclusions
A new tetrahedral complexes of the type [Cd(HZI)(n-amp)_2]Cl_2 (if n=2,3,4) when prepared by the reaction equal molar of CdCl_2.2.5H_2O and HZI ligand with two moles of n-aminopyridine (n=2,3,4) The HZI ligand behaves as a bidentate chelating ligand thought the N atom of the azomethine group and O atom of carbonyl group, whereas the n-aminopyridine ligands bonded as a monodentate through the N atom of heterocyclic ring.

And the prepared complexes showed a high biological activity against the Staphylococcus aureus mor than amikacin, while the [Cd(HZI)(3-amp)_2]Cl_2 complex showed activity against Staphylococcus Epidermidis and Citrobacter freundii compared with free ligand and Amikacin.

Table 3: Dimler inhibition zone (in mm) of the prependicular complexes in DMSO (DIZ) in (mm)

| Compounds          | Concentration | Staphylococcus aureus | Staphylococcus epidermidis | Citrobacter freundii |
|--------------------|---------------|-----------------------|---------------------------|---------------------|
| Amikacin (HZI)     | 1*10^-5       | 15                    | 16                        | 17                  |
|                    | 1*10^-3       | 40                    | 20                        | 10                  |
|                    | 1*10^-4       | 36                    | 10                        | 10                  |
|                    | 1*10^-5       | 36                    | 30                        | 10                  |
| [Cd(HZI)(2-amp)_2]Cl_2 | 1*10^-3      | 38                    | 8                         | 9                   |
|                    | 1*10^-4       | 37                    | 8                         | 9                   |
|                    | 1*10^-5       | 37                    | 8                         | 9                   |
| [Cd(HZI)(3-amp)_2]Cl_2 | 1*10^-3      | 36                    | 10                        | 10                  |
|                    | 1*10^-4       | 36                    | 10                        | 10                  |
|                    | 1*10^-5       | 40                    | 10                        | 10                  |
| [Cd(HZI)(4-amp)_2]Cl_2 | 1*10^-3      | 38                    | 9                         | 8                   |
|                    | 1*10^-4       | 38                    | 9                         | 8                   |
|                    | 1*10^-5       | 38                    | 9                         | 8                   |

References
[1] Candido-Bacani PD, Reis BD, Serpeloni JM, Calvo TR, Vilegas W, Varanda EA, Colus IMD. Mutagenicity and genotoxicity of isatin in mammalian cells in vivo.(2011), Mutation Research/Genetic Toxicology and Environmental Mutagenesis, 719: 47-51.
[2] Erdmann. O.L., (1340). "Untersuchungen über den Indigo", Journal für Praktische Chemie. 19 (1): 321–362. doi:10.1002/prac.13400190161.
[3] Pandeya, S. N., Smitha, S., Jyoti, M., & Sridhar, S. K.(2005), Biological activities of isatin and its derivatives. Acta Pharmaceutica Sinica B ,55(1), 27-46.
[4] Cane, A., Tournaire, M. C., Barritault, D., & Crumeyrolle - Arias, M. (2000). The endogenous oxindoles 5-hydroxyoxindole and isatin are antiproliferative and proapoptotic. Biochemical and biophysical research communications, 276(1), 379-384.
[5] Sridhar, S. K., Saravanan, M., & Ramesh, A. (2001), Synthesis and antibacterial screening of hydrazones, Schiff and Mannich bases of isatin derivatives. European Journal of Medicinal Chemistry, 36(7-8), 615-625.
[6] Daisley, R. W., & Shah, V. K. (1984), Synthesis and antibacterial activity of some 5-nitro-3-phenylminoindol-2 (3H)-ones and their N-mannich bases. Journal of pharmaceutical sciences, 73(3), 407-408.
[7] Srim, D., Clercq, E. D., Pannecouque, C., & Witvrouw,(1998), M. Anti-HIV activity of some Mannich bases of isatin derivatives. Indian Journal of Pharmaceutical Sciences, 60(4), 207.
[8] Sridhar, S. K., Pandeya, S. N., & De, E. C. (2001). Synthesis and anti-HIV activity of some isatin derivatives. Bollettino chimico farmaceutico, 140(5), 302-305.
[9] Cerchiaro, G., & Ferreira, A. M. D. C. (2006), Oxindoles and copper complexes with oxindole-derivatives as potential pharmacological agents. Journal of the Brazilian Chemical Society, 17(8), 1473-1485.
[10] Sekularac, G., Nikolic, J. B., Petrovic, P., Bugarski, B., Durovic, B., & Drmanic, S. Z. (2014).
Synthesis, antimicrobial and antioxidantive activity of some new isatin derivatives. *Journal of the Serbian Chemical Society*, 79(11), 1347-1354.

[11] Zahid H. C., Humayun P., Rauf A., Khalid M. K. & Claudiu T. S. (2004). Isatin-derived Antibacterial and Antifungal Compounds and their Transition Metal Complexes, *Journal of Enzyme Inhibition and Medicinal Chemistry*, 2004 Vol. 19 (5), pp. 417–423.

[12] Popp, F. D., Parson, R., & Donigan, B. E. (1980). Synthesis of potential anticonvulsants: condensation of isatins with acetone and related ketones. *Journal of pharmaceutical sciences*, 69(10), 1235-1237.

[13] Hassan, T. A. F. M., Kadi, A. A., & Abdel-Aziz, H. A. K. (2013). *U.S. Patent No. 8,497,296*. Washington, DC: U.S. Patent and Trademark Office.

[14] Albertin, G., Antoniutti, S., & Castro, J. (2009). Preparation of Cyanoguanidine and Ethylcyanamide Complexes of Ruthenium (II) and Osmium (II). *European Journal of Inorganic Chemistry*, 2009(35), 5352-5357.

[15] Ahmed A. Irzoqi, Ahmed S. M. Al-Janabi, Hayla M. Jirjes, (2017), Synthesis and Characterization of Phthalimide - benzothiazole Mercury(II) Complexes with Diphosphine and Diamines, *Diyala Journal for pure sciences* 13 (1), 1-11.

[16] Silverstein, R. M., Webster, F. X., & Kiemle, D. J. (2005). Proton NMR spectrometry. *Spectrometric Identification of Organic Compounds*, 7th ed.; John Wiley & Sons Inc.: New York, NY, USA, 142.

[17] Raman, N., & Sobha, S. (2010). Synthesis, characterization, DNA interaction and antimicrobial screening of isatin-based polyppyridyl mixed-ligand Cu (II) and Zn (II) complexes. *Journal of the Serbian Chemical Society*, 75(6), 773-788.

[18] Kumar, K., Kamboj, M., Jain, K., & Singh, D. P. (2014). Spectroscopic and antibacterial studies of new octaaazamacrocyclic complexes derived from carboxylazide and isatin. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 128, 243-247.

[19] Khan, A., Jasinski, J. P., Smoleaski, V. A., Paul, K., Singh, G., & Sharma, R. (2016). Synthesis, structure and cytotoxicity evaluation of complexes of N1-substituted-isatin-3-thiosemicarbazone with copper (I) halides. *Inorganica Chimica Acta*, 449, 119-126.

3-هيدرازونودولين-2-يون والأمينات

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المستخرج

تتضمن هذا البحث تحضير وتشخيص عدد من معقدات الكادميوم (II) مع ليكانت (II) 3-hydrazoneindolin-2-one (HZI) (3-هيدرازونودولين-2-يون) وعد وعدد من أمينو بيريدين .

عند تفاعل مول واحد من معقدات HZI (محمولة من Ammonium) مع مول من CuCl2.2.5H2O وصيا طرف ذرة نتروجين مجموعة HZI في مكان ذرة كادميوم نم (n:2,3,4) (n-amp) النتائج تقدم في الجدول التالي:

| المعقد | الاسم | مقدمة ذرة كادميوم | فصيلة | نوعية | الفعالية |
|-------|------|-------------------|-------|-------|---------|
| CdCl2 | كادميوم عادي | كادميوم كاسبي | كادميوم مصورة | متضمنة | 
| CdCl2 | كادميوم مصورة | كادميوم كاسبي | كادميوم مصورة | متضمنة | 
| CdCl2 | كادميوم كاسبي | كادميوم كاسبي | كادميوم مصورة | متضمنة | 

*Staphylococcus aureus* و *Staphylococcus aureus* درست الفعالية البيولوجية للمعدات المحضرة ضد نوعين من البكتيريا الموجبة لصبغة كرام .

*Staphylococcus aureus* و *Staphylococcus aureus* فعالية عالية انتهج *Citrobacter Freundii* و *Epidermidis* في بعض المعاد تأثير أكبر على النوعين *Citrobacter Freundii* .

*Staphylococcus* *Epidermidis* و *Citrobacter Freundii* 46