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Study of Some New Pt(II) Complex Involving Quercetin, Naringen, and Apigenin: Synthesis, Characterization, Antimicrobial and Antioxidant Activities

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Abstract

A Pt(II) complex including quercetin, naringinin, and apigenin was made in the current study, and its structural characteristics were determined utilizing spectrum techniques. The Pt(II) complexes have been investigated for their ability to combat microorganisms and breast cancer. According to the findings of the investigation into the complex's antibacterial action, Staphylococcus aureus, Escherichia coli, Candida alblicans, and Aspergillus niger were all considerably impacted. Using the 2,2-Diphenyl-1-picrylhydrazylradical scavenging activity assay (DPPH), it was examined whether the Pt(II) complexes have antioxidant qualities and may be useful in the treatment of disorders caused by free radicals. These novel complexes may be exploited for these therapeutic purposes, according to this study's findings.

Keywords: Platinum(II); Structural analysis; Antimicrobial activity; Anticancer activity.

Introduction

Most transition metal ions can easily form stable complexes with multidentate ligands. These compounds could be used in inorganic, biological, pharmaceutical, and environmental chemistry [1]. Flavonoids and their derivatives, which are found in

natural products, have been demonstrated to have a notable ability to reduce tumor growth and cancer cell division. There are several polyphenolic flavonoids, including apigenin (4′,5,7-trihydroxyflavone), quercetin (3, 3′, 4′, 5, 7-pentahydroxyflavonone), and naringin (a flavanone glycoside produced from the flavanone naringenin) [2]. These antioxidant flavonoids, which are present in a variety of plants and foods, influence the activities of antioxidant enzymes, control ROS levels through various cellular signal transduction pathways, and have anti-inflammatory effects that may help with swelling reduction, the death of cancer cells, blood sugar regulation, and heart disease prevention [3,4]. This research aims to evaluate certain newly synthesized platinum (II) complexes including quercetin, naringinin, and apigenin's antibacterial, antifungal, and anti-oxidant properties.

Materials and Methods

All chemicals were purchased from various firms and used as supplied.

Synthesis of Pt(II) complex

Synthesis of Chloro-Flavonoid Platinum(II) Complexes

An ethanolic solution (15 mL) of flavonoids (apigenin, naringinin, or quercetin) (1mmole, 0.27 g) was added to an aqueous solution (15 mL) of K_2PtCl_4 (1mmole, 0.41g) at pH= 8, stirred for 24 hours at 25 ^oC and then neutralized with 10% HCl to give a green precipitate. Recrystallization of the product by ethanol : chloroform (5:1) gave a light green solid for ($K[PtApiCl_2]$ in 88 % yield, m.p = 186- 188 ^oC), (brown crystals for $K[PtNarCl_2]$ in 85 % yield, m.p = 169- 171 ^oC) or ($K[PtQueCl_2]$ as light brown crystals in 81% yield, m.p. 229-231 ^oC) [5].

Synthesis of dicarboxylato-Flavonoid Platinum(II) Complexes

The reaction mixture (Ag_2SO_4; 1.00 mmole, 0.31 g), 20 mL methanol and flavonoids ($K[PtApiI_2]$, $K[PtNarI_2]$ or $K[PtQueI_2]$) (1.00 mmole, 0.75 g) in methanol (20 mL)) was stirred for 6 hours at 25 ^oC in the dark. The precipitate (AgI) and barium oxalate (1.00 mmole, 0,22 g) in 20 mL of 1 x 10^{3-} M H_2SO_4, stirred for 3 hours at 25 ^oC. A white solid of $BaSO_4$ was formed was neutralized with 10% solution of potassium carbonate then to 5 mL, treated with excess of acetone and dried at 25 ^oC. Recrystallized by a distilled water and acetone (1:4) to afford the complexes ($K[PtApiOx]$ as brown crystals in 85% yield, m.p. 134-136 ^oC), ($K[PtNarOx]$ as dark brown crystals in 91 % yield, m.p. 112-114^oC) or ($K[PtQueOx]$ as dark brown crystals in 83 % yield, m.p. 110- 112 ^oC) [6].

Antimicrobial Activity

The activity of pt(II) complexes were evaluated against S. aureus, E. coli, C. alblicans, and A. niger, on Mueller Hinton Agar (MHA) plates using well diffusion assay. The tested compounds were dissolved in DMSO with concentrations (25 mg/mL) for each compound. 100 µL from tested compounds added to every well (7 mm diameter holes cut within the agar gel, 20 mm aside from one another). The plates were incubated for twenty-four h at 36ºC ± 1ºC, the zone of inhibition was measured [7].

Antioxidant Activity

The DPPH solution was prepared according to the procedure stock solution, prepared daily, was used at a 0.1 mM final concentration: 2mg of DPPH reagent (Sigma-Aldrich,USA) were weighed (Analytical Balance Gibertini Elettronica E505,sensitivity 0.01 mg) and suspended in 50ml of ethanol (EtOH) 96%. The mixture was vigorously shaken for 30min under magnetic stirrer agitation (ARE Heating Magnetic Stirrer;Velp Scientfica, Usmate, Italy) and kept at room temperature in the dark. Experimental data were acquired on a spectrophotometer (Varian Cary 50 Bio UV-Vis; Varian Inc.,Palo Alto, CA, USA),set at 517nm under dim light, by solution). The DPPH radical scavenging effect results in decolorization and is calaculated in terms of percentage reduction of DPPH according to the following equation [8]:

$$\textbf{DPPH reduction (\%)} = [A^0 - As / A^0] \times 100$$

Where A° represents the absorbance of control and A_S is the absorbance of the samples. The % DPPH reduction values were normalized per sampled air volume (m^3; % DPPHv) or per PM mass amount (mg ;% DPPHm).

Results and Discussion

FTIR Spectra

The FTIR spectra of all prepared compounds La1, La2, La3, La7, La8, La9 show all the important vibrational bands in certain regions, especially in the fingerprint and other regions. Table 1 shows the important functional groups vibration bands while all representations FTIR spectra of complexes La1, La2, La3, La7, La8, La9 are shown in Figures (1, 2, 3, 4, 5, 6), respectively. Generally, the FTIR spectra confirm the presence of all possible functional groups in the suggested structures of these compounds. The FTIR spectrum of complexes La1, La2, La3, La7, La8, La9 show a strong stretching vibration band at the range of 1612- 1660 cm^{-1} due to carbonyl

group ν(C=O). In comparison with the carbonyl stretching bands of free apigenin, narginin and quercetin ligand and the complexes La1, La2, La3, La7, La8, La9 it was found a shift towards low frequencies (about 31-49 cm^{-1}) which can be attributed as an evidence to the coordination this group with platinum ion. The FTIR spectra of complexes La1, La2, La3, La7, La8, La9 show appearance of a broadly strong band due to the stretching bands for hydroxyl groups ν(O-H) at 3325 and 3460 cm^{-1} [2, 3, 9]. Unfortunately, the disappearance of this is not clear due to the presence of other hydroxylated group in the complex structures. Generally, the IR spectra of all compounds La1, La2, La3, La7, La8, La9 showed the following bands: weak bands in the range 3001 - 3096 cm^{-1} can be attributed to the stretching vibration of the aromatic C-H while the bending vibrations of aromatic C-H within the range 721 - 879 cm^{-1} appeared as medium bands. Strong to medium bands in the range 1408 - 1516 cm^{-1} can be assigned to the aromatic C=C stretching vibration. The IR spectra of compounds La1,La2,La3,La7,La8,La9 show a strong band at 1111-1180 cm^{-1} can be assigned to ν(C-O) [10, 11, 12].

Table (1). Important infrared vibration bands of complexes.

Com No.	ᵛ(Oh)	ᵛ(C-H) Arom. Stretch.	ᵛ(C=O)	ᵛ(C=C)	ᵛ(C-O)	ᵛ(C-H) Arom. Binding	ᵛ(Pt-O)	ᵛ(Others)
La1	3444 Br, S	3050 W	1654 S	1478 S	1165 S	840 M 736 M	437 W	-
La2	3452 Br, S	3058 W	1635 S	1511 M	1160 S	833 M 750 M	428 W	-
La3	3440 Br, S	3042 W	1635 S	1504 M	1172 S	800 W 740 W	439 W	-
La7	3425 Br, S	3055 W	1635 S	1408 M	1114 S	775 S 721 M	420 W	-
La8	3421 Br, S	3001 W	1639 S	1450 M	1114 S	817 S 735	513 W	-
La9	3336 Br, S	3060 W	1654	1498 M	1111 S	829 S 748 M	425 W	-

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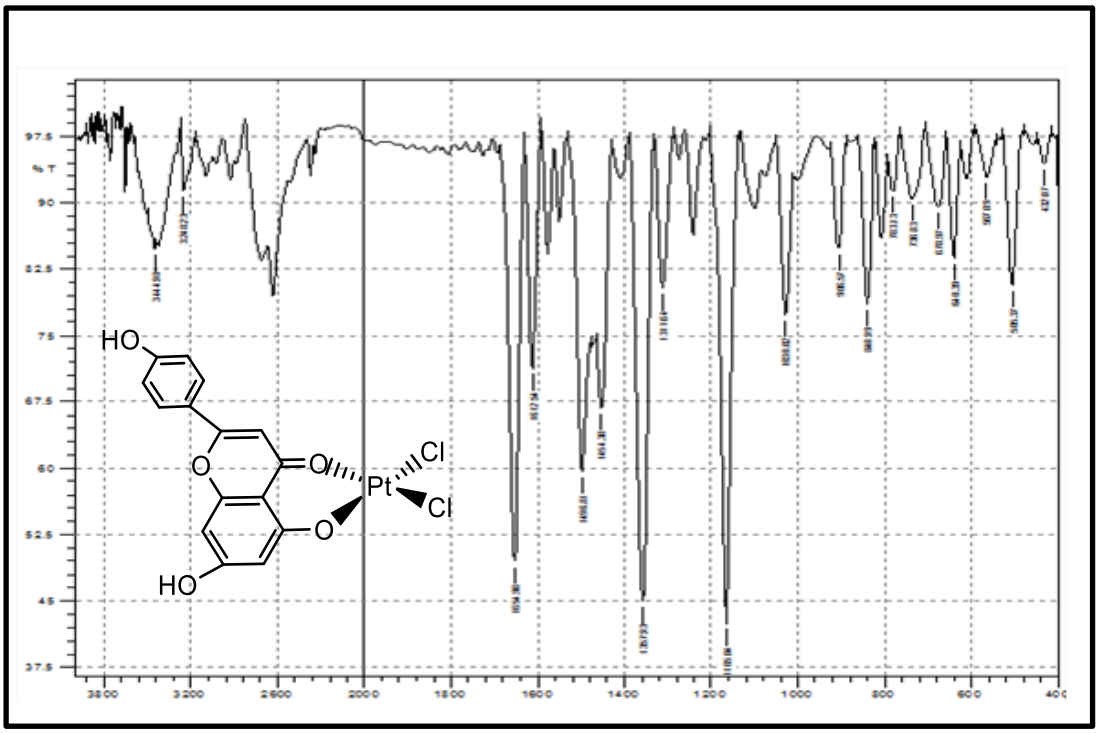
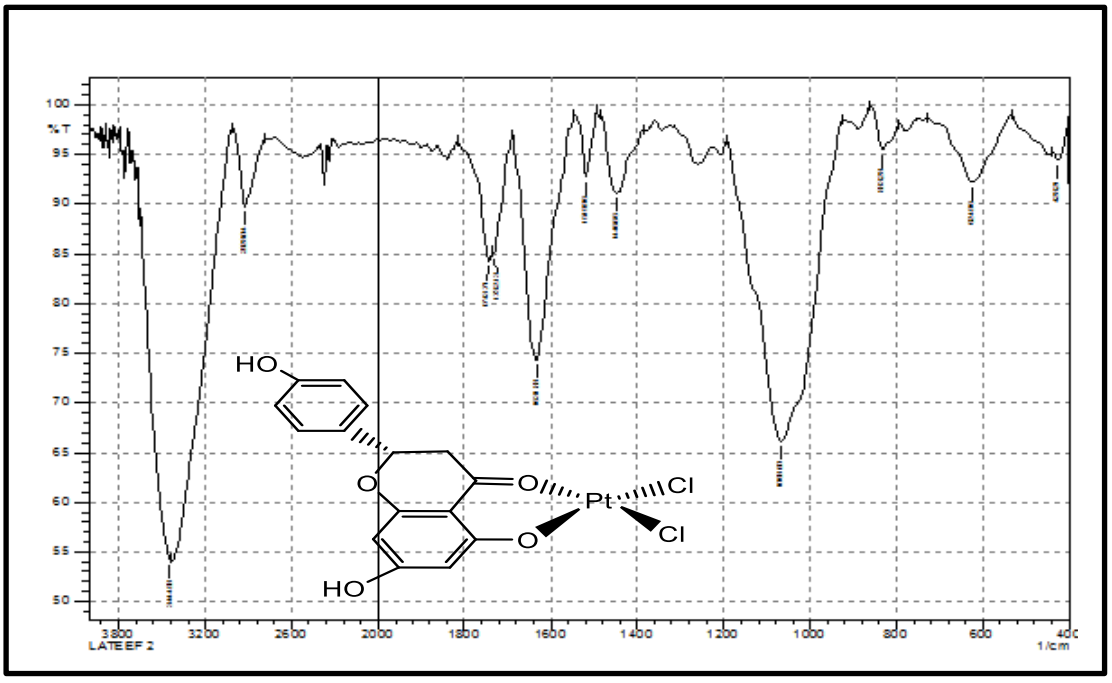
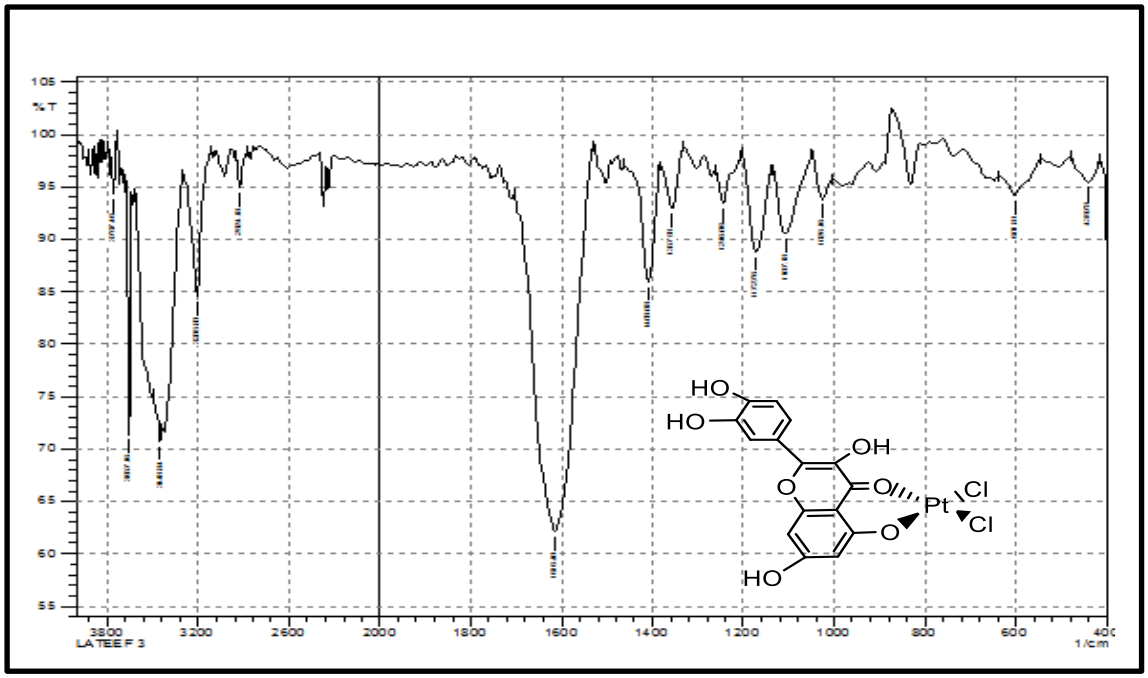


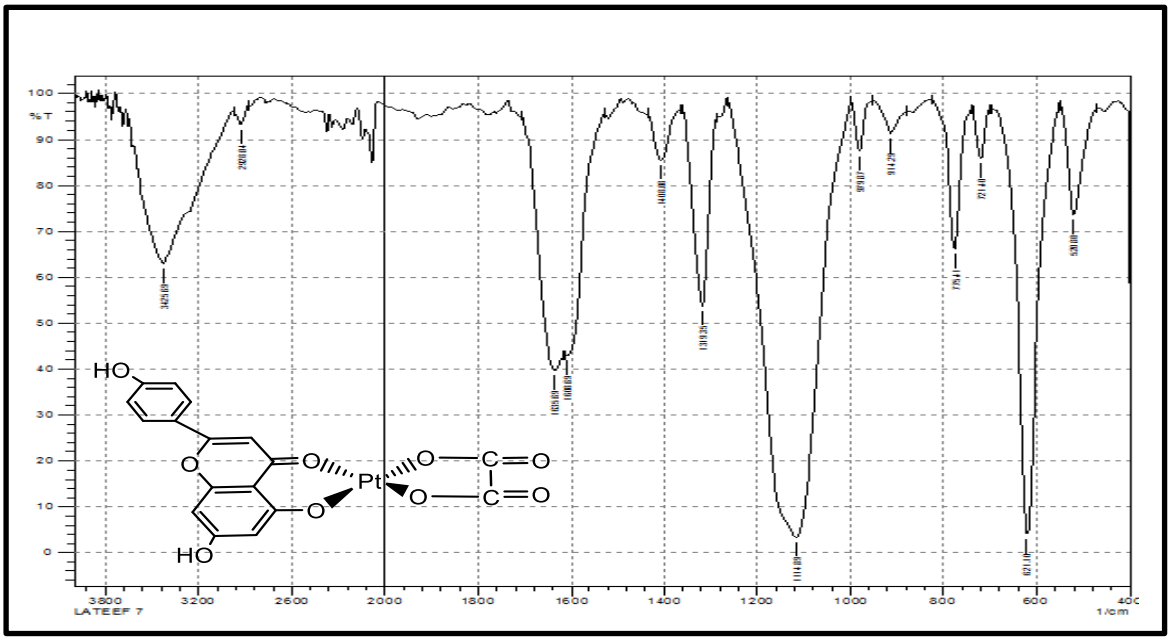
Figure(1). FTIR spectrum of complex La1



Figure(2). FTIR spectrum of complex La2



Figure(3).. FTIR spectrum of complex La3



Figure(4).. FTIR spectrum of complex La7

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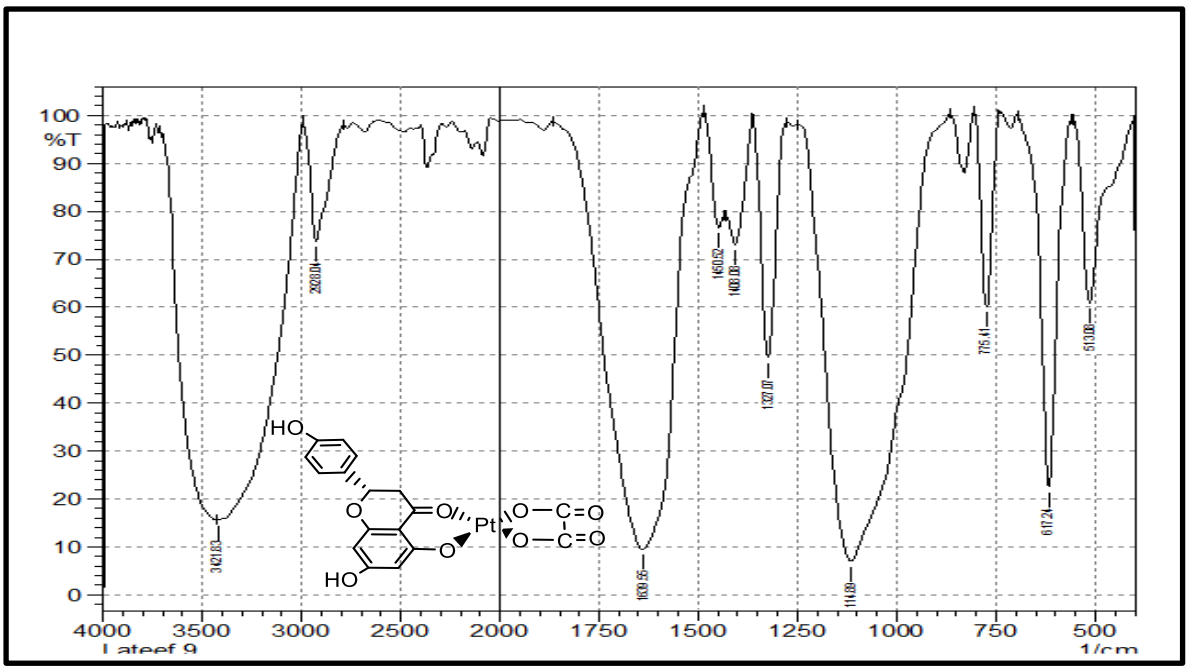
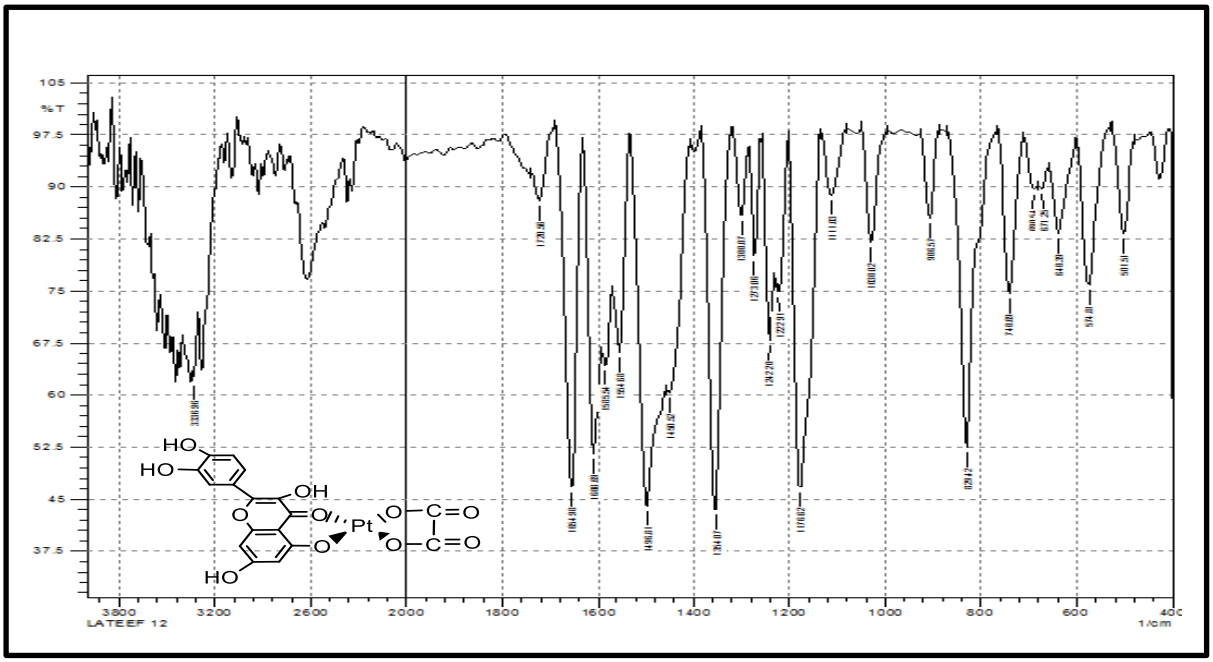


Figure(5). FTIR spectrum of complex La8



Figure(6).. FTIR spectrum of complex La9

^{1}H NMR Spectra

^{1}H NMR spectra of La1, La2, La3, La7, La8, La9 were carried out in DMSO-d_6 solutions. These compounds appeared for the expected characteristic signals of all protons in these compounds, which are in good agreement with their suggested molecular formulas. Figures 3.16 -3.30 represent ^{1}H NMR spectra of these new compounds La1, La2, La3, La7, La8, La9 respectively and all these data were summarized in Table2. The signal at 2.5 ppm in the spectra is due to methyl protons of DMSO solvent and the signal at 3.5 ppm can be assigned to water protons. ^{1}H NMR spectra of platinum (II) complexes which contain apigenin ligand La1, La7 show two singlet signals at the ranges of 12.81 – 13.30 and 10.93- 13.02 ppm can be assigned to protons of hydroxyl group OH and OH*, respectively [11, 12, 13]. In comparison these complexes with the free apigenin, the disappearance of the third OH signal at 16.40 ppm can be considered as an evidence for coordination this hydroxyl group with the platinum(II) ion [13, 14]. On the other hand, the ^{1}H NMR spectra of complexes La1, La7 appear a doublet signal at the range of 8.06 -8.08 ppm attributed to magnetically equivalent protons for H_1 and H_4 while the second doublet signal at region between 7.58 and 7.89 ppm assigned to magnetically equivalent protons for H_2 and H_3. From this observation can we concluded that these aromatic protons in the same magnetic environments. Three singlet signals at the ranges of 6.97- 7.18 , 6.53-6.76 and 6.22-7.37 ppm can be attributed to H_5, H_7 and H_6, respectively [14, 15]. ^{1}H NMR spectra of platinum (II) complexes which contain narginin ligand La2 , La 8 show two singlet signals at the ranges of 12.00 – 12.81 and 9.61- 11.16 ppm can be assigned to protons of hydroxyl group OH and OH*, respectively. In comparison these complexes with the free narginin, the disappearance of the third OH signal at 12.06 ppm can be considered as an evidence for coordination this hydroxyl group with the platinum(II) ion [13, 15]. Also, the ^{1}H NMR spectra of complexes ligand La 2, La 8 appear two doublet signals at the ranges of 7.12 – 8.06 and 6.83-7.58 ppm can be assigned to (H_1 and H_4) and (H_2 and H_3), respectively. Two singlet signals in the region between 6.71-7.18 and 6.06- 6.37 ppm due to H_5 andH_6, respectively [14]. On the other hand, a triplet signal at range of 4.55- 5.13 ppm can attributed to the aliphatic proton H_9. Two doublet signals at the ranges of 2.75- 3.80 and 2.75- 3.37 ppm can be attributed to aliphatic protons H_8 and H_7. Although H_8 and H_7 lie in the same carbon atom, but their signal in different chemical shifts. This observation can be confirmed that these protons lie in different magnetic environments. ^{1}H NMR spectra of platinum (II) complexes which contain quercetin La3, La9 appeared three signals at ranges of 12.84-13.40, 10.36-13.13 and 9.56-13.05 ppm attributed to protons of hydroxyl groups OH, OH* and OH**, respectively [7]. The disappearance of the fourth OH signal in complexes containing quercetin can be assigned to coordinate this ligand with platinum(II) ion. Also, ^{1}H NMR spectra of complexes La3, La9 appear two doublet signals at the ranges of 7.43-7.92 and 6.73- 7.59 ppm due to

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H_1 and H_2. Three singlet signals located at the region between 6.32 and 6.77; 6.02 and 6.49; and, 6.02 and 6.46 ppm can be assigned to aromatic protons H_4, H_5 and H_6, respectively [15]. ^{1}H NMR spectra of compounds La1, La2, La3, La7, La8, La9 show a doublet signals in the range of 6.55- 6.96 and 8.15- 8.23 ppm can be attributed to H_1 (and $H_{1'}$) and H_2 (and H_2) protons, respectively while the singlet signals that ranged at 7.81- 8.11ppm attributed to H_3 (and H_3) proton. ^{1}H NMR spectra of compounds La2, La3, La7, La8, La9 show three singlet signals in the ranges of (7.40-7.55) ; (6.44- 6.83) and (7.93- 7.95) ppm can be assigned to H_4 (and $H_{4'}$); H_5 (and $H_{5'}$) and H_6 (and $H_{6'}$), respectively. ^{1}H NMR spectra of compounds La3, La7, La8, La9 appear a doublet signal in the range 8.82-8.83 ppm due to protons of H_7 (and $H_{7'}$) and H_{10} (and $H_{10'}$) while the doublet signal in the range 8.48-8.80 ppm can be assigned to H_8 (and $H8_{'}$) and H_9 (and $H_{9'}$). On the other hand, ^{1}H NMR spectra of La2, La3, La7, La8, La9 exhibit a low-field singlet signal at the range of 8.84- 8.97 ppm due to proton of phenolic group. This signal attain high chemical shift can be explained that for the bond of that proton with oxygen atom which has high electronegative trend [13,14,15].

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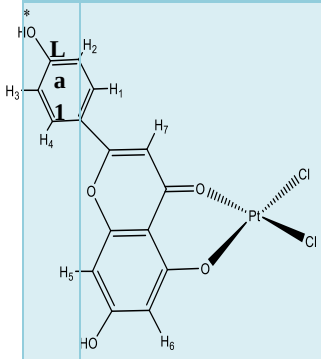
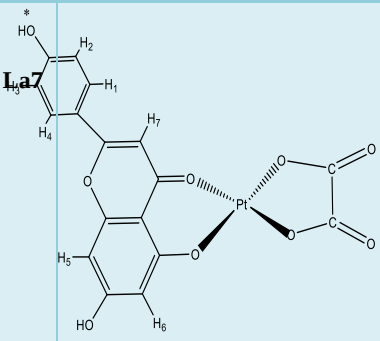
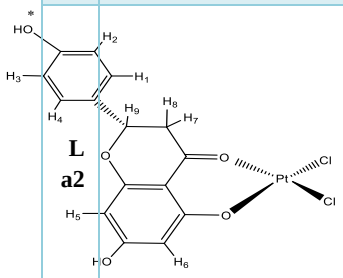
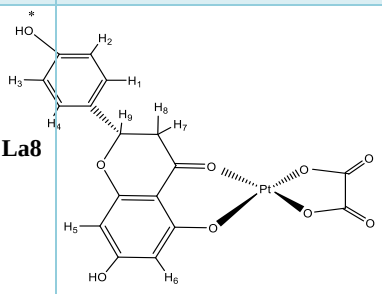
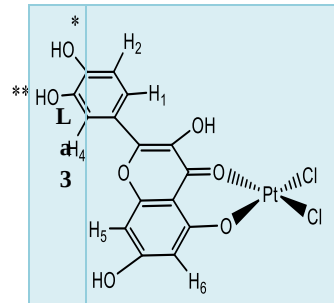
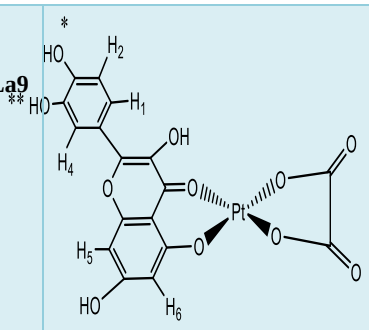
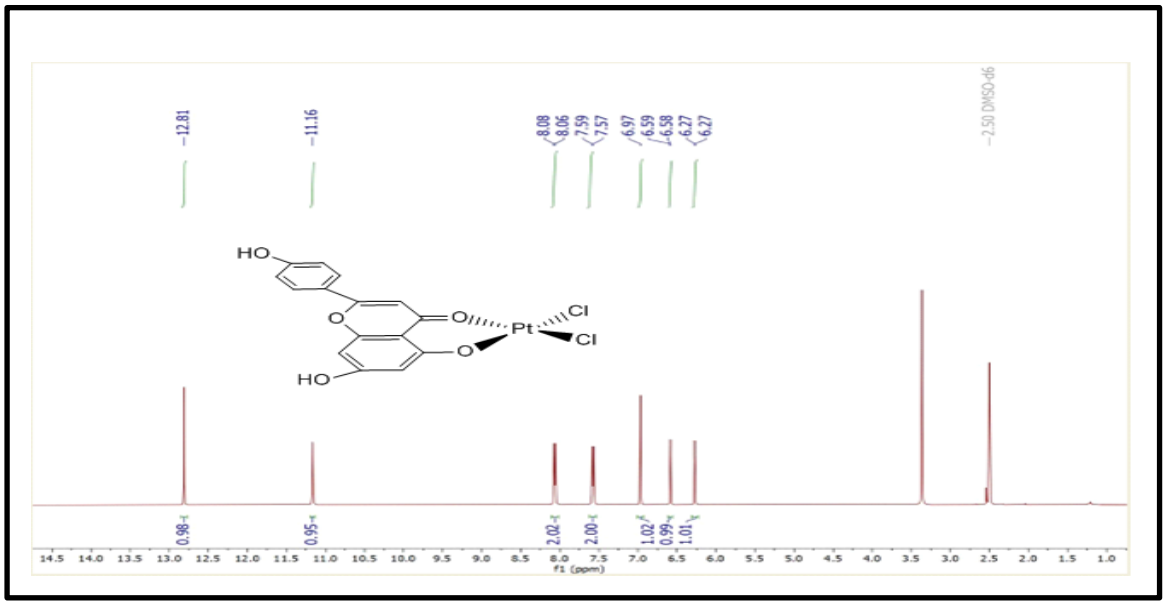
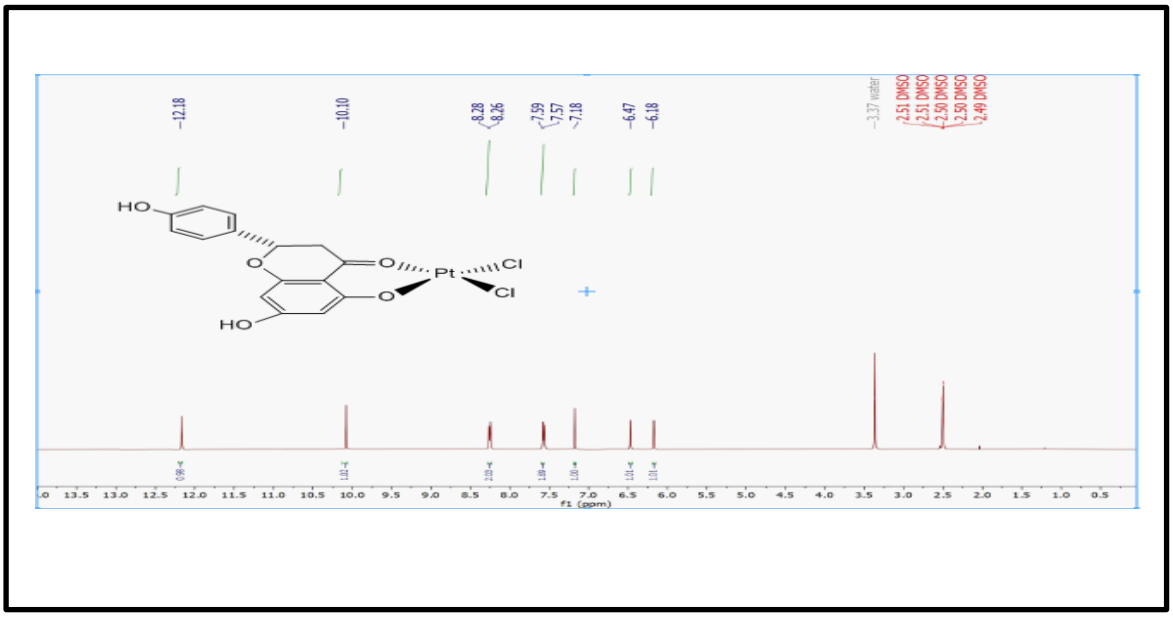
Table (2). ^{1}H NMR data of the synthesized complexes.

Com. No.	Structure	Chemical Shift Δ (Ppm) TMS = 0 Ppm	Com No	Structure	Chemical Shift Δ (Ppm) TMS = 0 Ppm
La1		12.81 (S, 1H, OH) 11.16 (S, 1H, OH*) 8. 07 (D, 2H, H_1 &H_4) 7.58 (D, 2H, H_2 & H_3) 6.97 (S, 1H, H_5) 6.58 (S, 1H, H_7) 6.27 (S, 1H, H_6)	La7		12.83 (S, 1H, OH) 10.98 (S, 1H, OH*) 8. 08 (D, 2H, H_1 &H_4) 7.59 (D, 2H, H_2 &H_3) 6.99 (S, 1H, H_5) 6.54 (S, 1H, H_7) 6.23 (S, 1H, H_6)
La2		12.04 (S, 1H, OH) 9.71 (S, 1H, OH*) 7. 32 (D, 2H, H_1 &H_4) 6.91 (D, 2H, H_2 & H_3) 6.80 (S, 1H, H_5) 6.06 (S, 1H, H_6) 5.12 (T, 1H, H_9) 3.80 (D, 1H, H_8) 3.37 (D, 1H, H_7)	La8		12.00 (S, 1H, OH) 9.61 (S, 1H, OH*) 7. 12 (D, 2H, H_1 &H_4) 6.83 (D, 2H, H_2 & H_3) 6.71 (S, 1H, H_5) 6.06 (S, 1H, H_6) 5.13 (T, 1H, H_9) 3.80 (D, 1H, H_8) 3.36 (D, 1H, H_7)

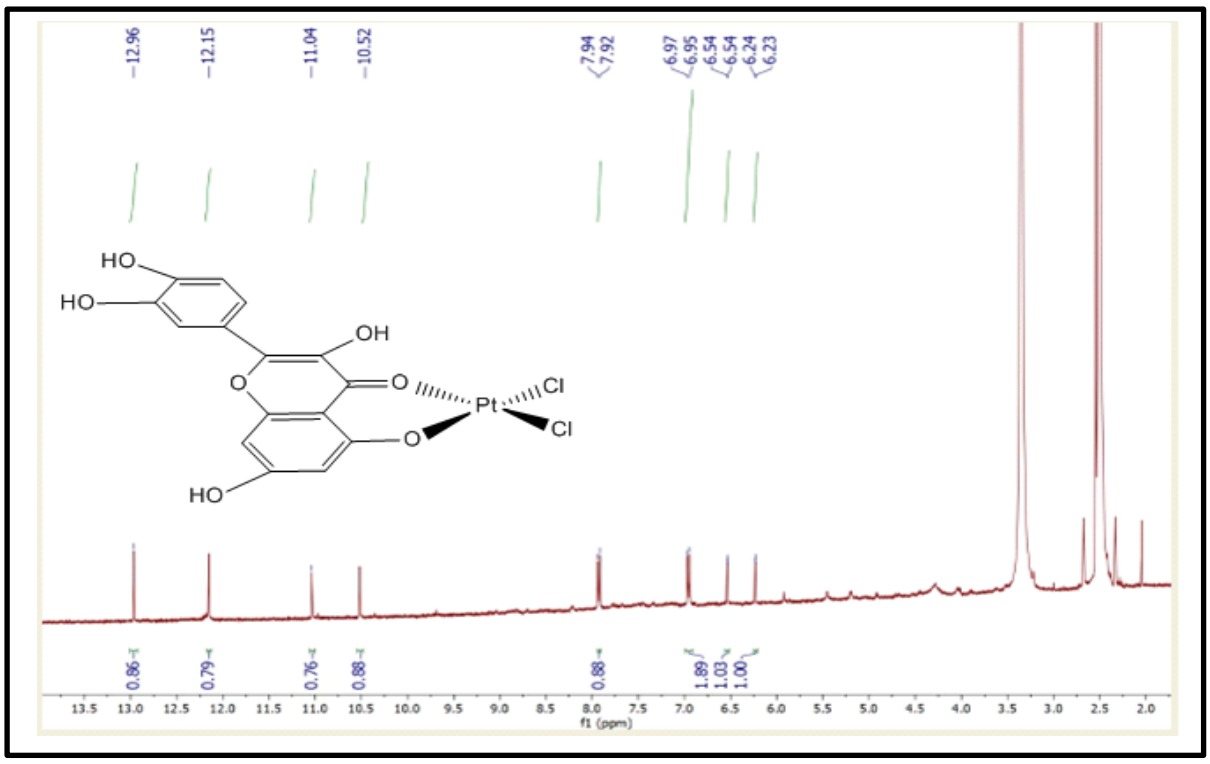
L a 3		12.96 (S, 1H, OH) 11.04 (S, 1H, OH*) 10.32(S, 1H, OH**) 7. 43 (D, 1H, H_1) 6.96 (S, 1H, H_2) 6.53 (S, 1H, H_4) 6.23 (S, 2H, H_5) 6.27 (S, 1H, H_6	La9		12.96(S, 1H, OH) 10.88 (S, 1H, OH*) 10.39 (S, 1H, OH**) 7. 92 (D, 1H, H_1) 6.92 (D, 1H, H_2) 6.77 (S, 1H, H_4) 6.48 (S, 2H, H_5) 6.18 (S, 1H, H_6



Figure(7). ^{1}HNMR spectrum of complex La 1



Figure(8). ^{1}HNMR spectrum of complex La 2



Figure(9). ^{1}HNMR spectrum of complex La3

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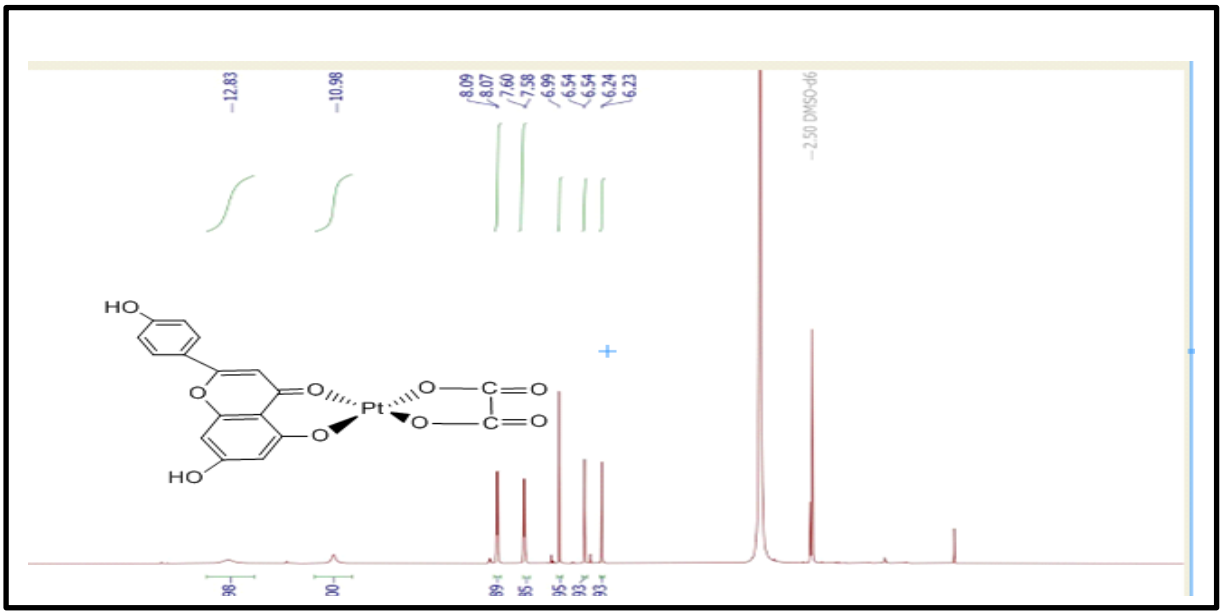
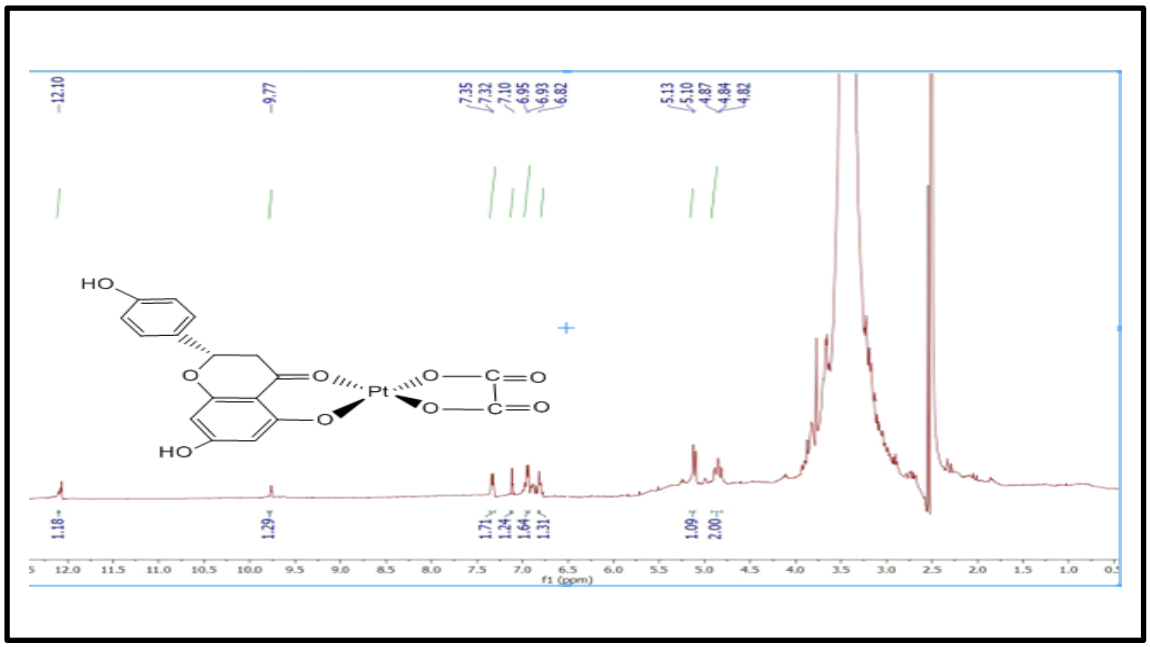
ISSN (Print):1992-9218



Figure(10). ^{1}HNMR spectrum of complex La 7



Figure(11). ^{1}HNMR spectrum of complex La 8

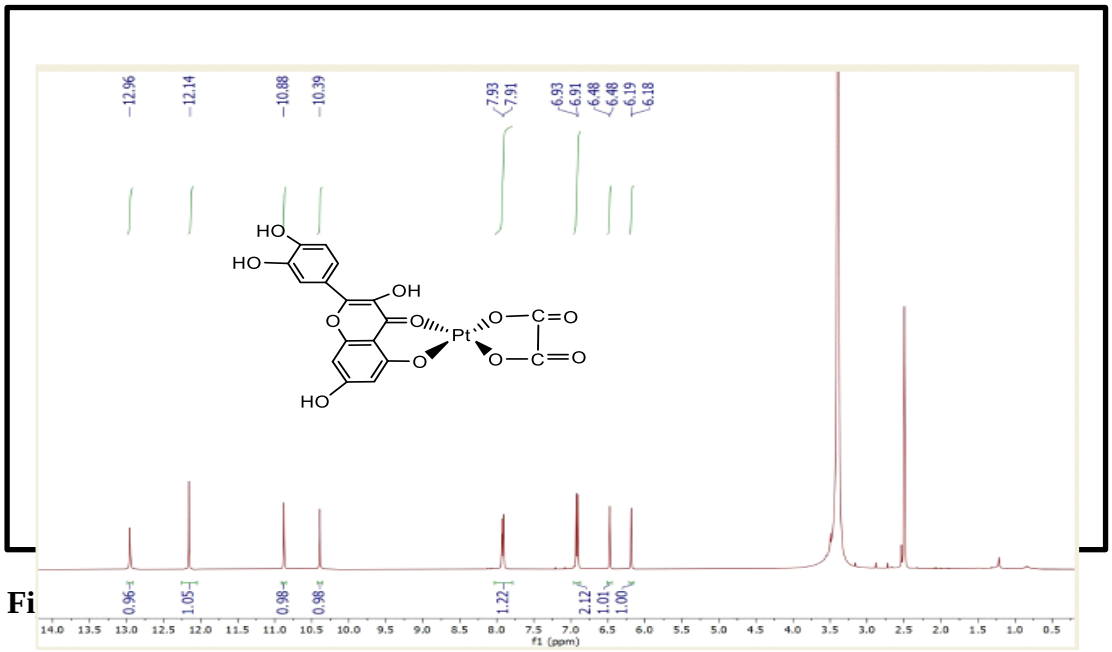


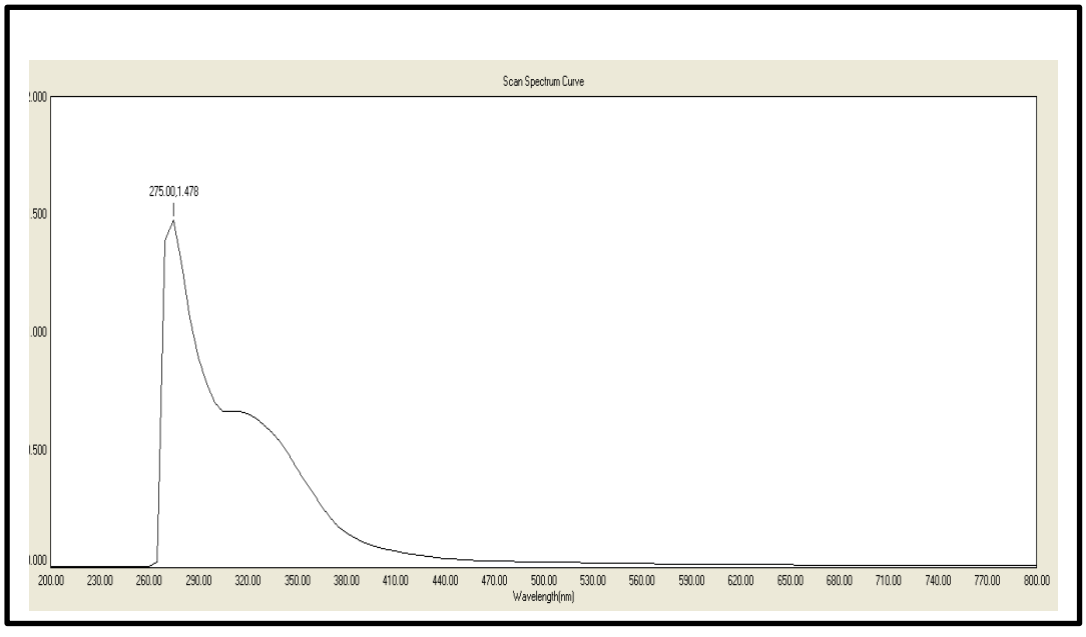
Fig 12. [1]HNMR spectrum of complex **La 9**

Ultraviolet- Visible Spectra

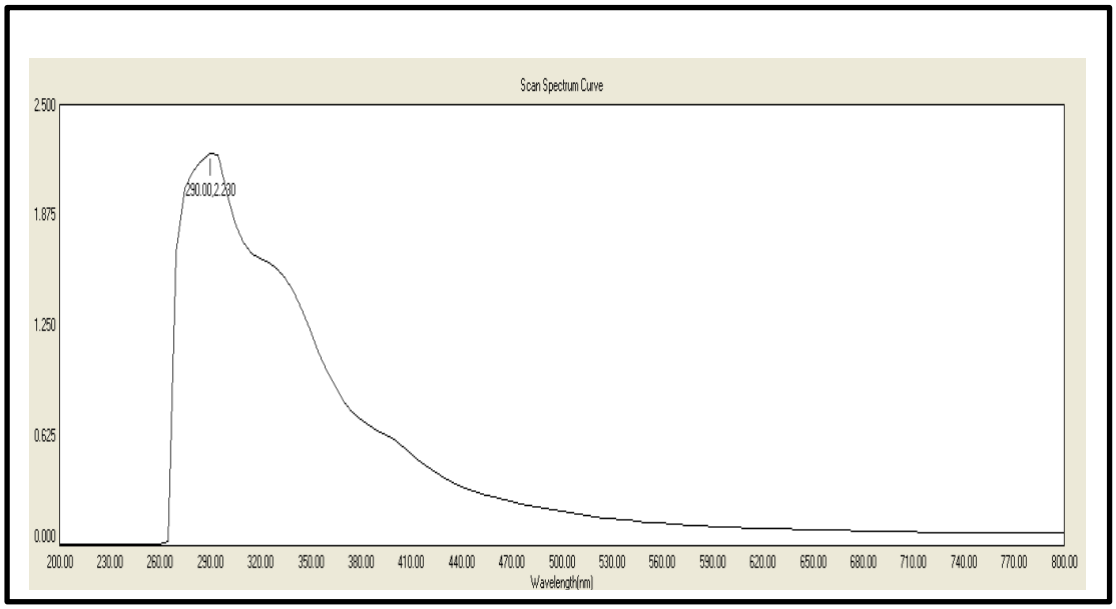
The electronic spectra of all synthetic compounds La1, La2, La3, La7, La8, La9 were measured at 1 x 10^{-4} M using dimethyl formamide as a solvent in the region 200-800 nm. Figures 13-18 represent the UV- Vis. Spectra of complexes La1,La2,La3,La7,La8,La9, respectively while the electronic transition data are summarized in Table 3. Generally, the UV.-Vis, spectra of complexes La1, La2, La3, La7, La8, La9 are similar to the electronic spectra of corresponding ligands. Therefore, the observed bands in complexes are mainly ligand based bands. The UV-Vis. spectra for compounds La1,La2,La3,La7,La8,La9 show an absorption peak in the region of 255- 295 nm due to π- π * transition of aromatic rings. This band is in good agreement with previous work [15]. These transitions have high intensities because the high permittivity of electron transitions between the energy levels of the aromatic rings. Also, the UV-Vis. spectra for compounds La1,La2,La3,La7,La8,La9 show second absorption peak as a shoulder in the region of 320- 334 nm can be assigned to n→ π* transitions. All UV-Vis. spectra for compounds La1, La2, La3, La7, La8, La9 was not clearly observed the d- d transitions for platinum (II) ion. The reason for their disappearance may be due to the fact that they were blocked and masked by π→π* transitions of aromatic rings [7].

Table (3). UV-Visible data of the synthesized complexes.

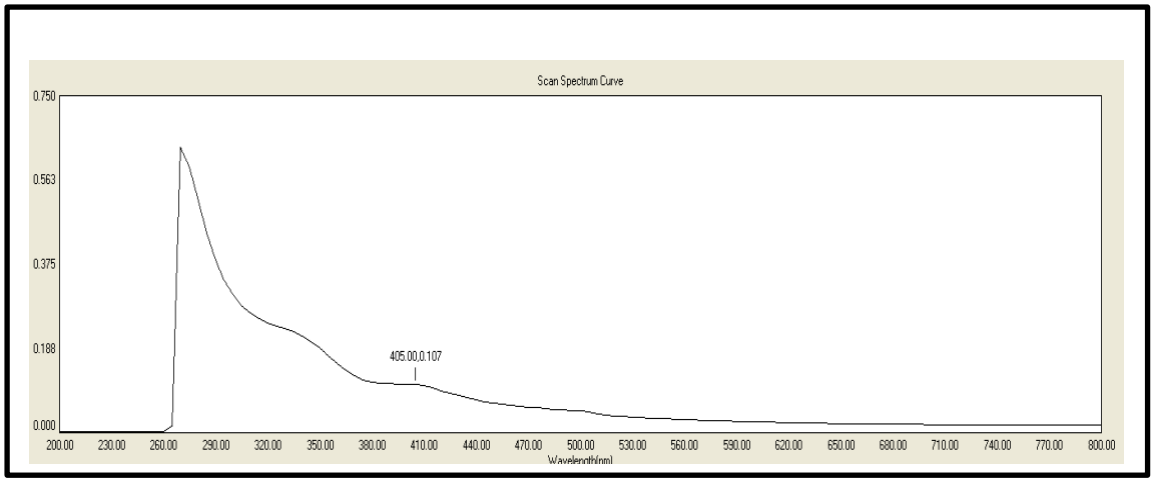
Comp. No.	Wavelength (Nm)	Transition Type
La1	275 320	Π → Π* N → Π*
La2	295 330	Π → Π* N → Π*
La3	275 320	Π → Π* N → Π*
La7	269 327	Π → Π* N → Π*
La7	269 327	Π → Π* N → Π*
La8	282 320	Π → Π* N → Π*
La9	275 339	Π → Π* N → Π*



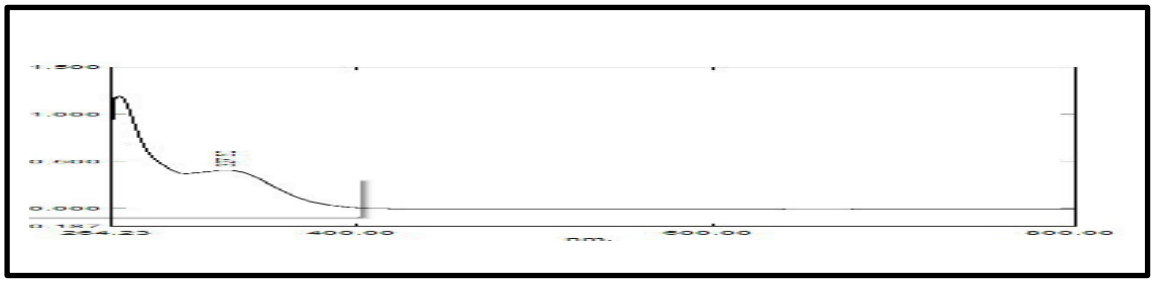
Figure(13). UV-Visible spectrum of complex La1



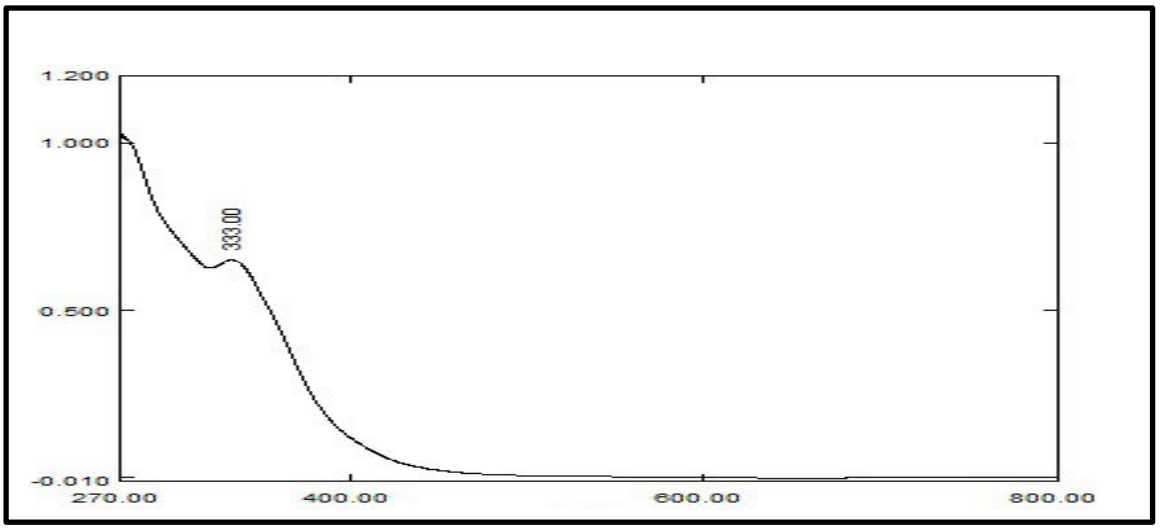
Figure(14). UV-Visible spectrum of complex La2



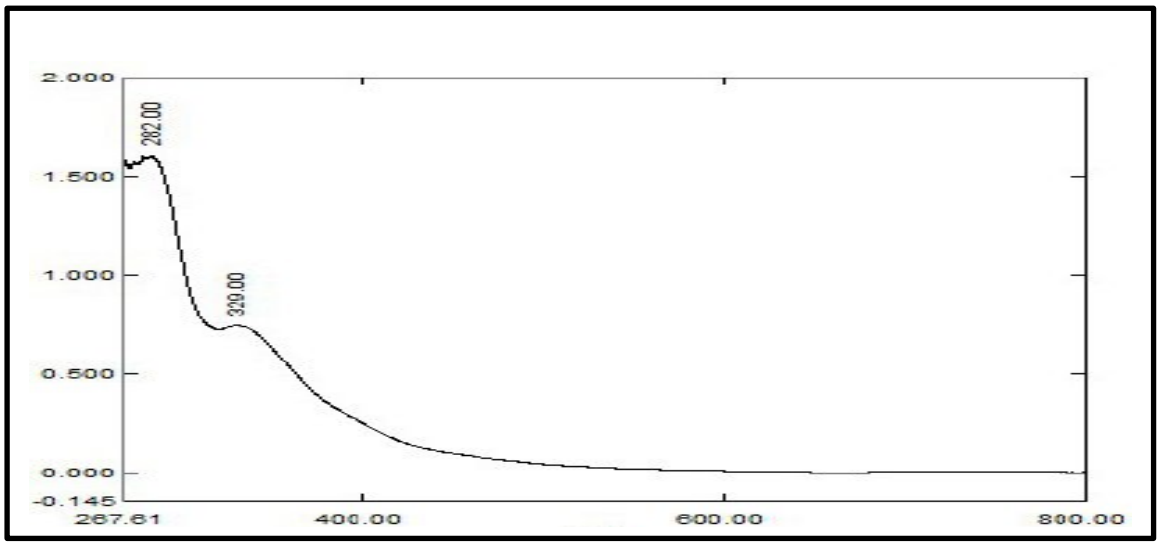
Figure(15). UV-Visible spectrum of complex La3



Figure(16). UV-Visible spectrum of complex La7



Figure(17). UV-Visible spectrum of complex La8



Figure(18). UV-Visible spectrum of complex La9

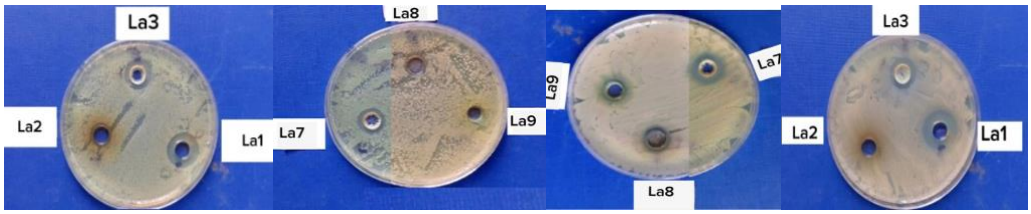
Antimicrobial Activity

The primary foundation for treating bacterial and fungal illnesses is provided by antimicrobials. However, due to their enormous genetic variety, bacteria can easily evolve antibiotic resistance and dodge the effects of antibiotics. Major clinical issues have arisen in the management of infectious diseases as a result of the development of multi-drug resistance in pathogenic bacteria and parasites. The hunt for new antimicrobial chemicals and medications was sparked by these and other issues, such as the toxicity of some antimicrobial treatments on the host tissue [14]. In the present

study, antibacterial activity in the concentration (25mg/ml) against Gram-positive bacteria (Staphylococcus aureus) of the complexes was found to range in the order of La3 (IZ= 20 mm)> La 1= La7 (IZ= 16 mm) > La8= La9 (IZ= 12 mm), respectively, as shown in Table (4) and Figures [15]. Also, the activity of synthesized complexes against Gram-negative bacteria (Escherichia coli) was La3 (IZ= 20 mm) > La1(IZ= 16 mm) > La7 (IZ= 14 mm) > La2 (IZ= 13 mm), respectively. Same Table 4 and Figures 1 and 2 showed that the platinum (II) phenolic-ligand complexes (25mg/ml) give a good antifungal activity against Gram-positive fungal (Candida alblicans) in the order of La3 (IZ= 24 mm) > La1= La2 (IZ= 20 mm) > La7 (IZ= 17 mm) > La8= La9 (IZ= 15 mm), respectively. The antifungal activity against Gram-negative fungal (Aspergillus niger) was ranged in the order of La7 (IZ= 15 mm) > La8 (IZ= 14 mm) > L 9 (IZ= 12 mm) respectively. Our data pointed out that the complexes La1,La2,La3, had no activity against Gm-Ve fungal (Aspergillus niger) On the other hand, the complex La3 showed good antibacterial activity against Gm+Ve (Staphylococcus aureus), Gm-Ve (Escherichia coli), possessed the highest antifungal activity against Gm+Ve (Candida alblicans) and did not exhibit any activity against Gm-Ve (Aspergillus niger). This outcome may be due to the fact that gram-negative bacteria and fungi have an outer membrane made of lipopolysaccharides. As a result, the synthesized platinum (II) phenolic-ligand complexes can combine with the lipophilic layer to increase the membrane's permeability to Gram-negative bacteria. Due to the significance of this wall for bacterial and fungal survival, the antibacterial action of the produced complexes may also be linked to the structure of bacterial cell walls. Therefore, the gram-positive microbial species' blockage of a stage in peptidoglycan synthesis may be the cause of the capacity of antibiotics to kill or slow the growth of bacterial and fungal organisms [16]. Platinum complexes are of interest to many synthetic organic chemists due to their significant pharmacological and biological characteristics in addition to their catalytic activity. They are significant complexes in the field of pharmaceutical chemistry, primarily showing exceptional antimicrobial action [17]. The synthesized Pt (II) phenolic complexes in this study showed a wide range of antimicrobial activity in their antibacterial and antifungal properties which may be a result of the polarity of the metal and the alteration in the structure of these complexes may be to blame for the complex's significant activity. Some reports showed that the type of ligand that is attached to the metal core can be changed to increase the interaction with microorganisms. In the current study for synthetic platinum II complexes containing phenolic ligands that displayed intriguing biological traits like antibacterial and antifungal activity. Additionally, because many chemicals exhibit synergistic effects, the presence of phenolic rings is essential [18,19].

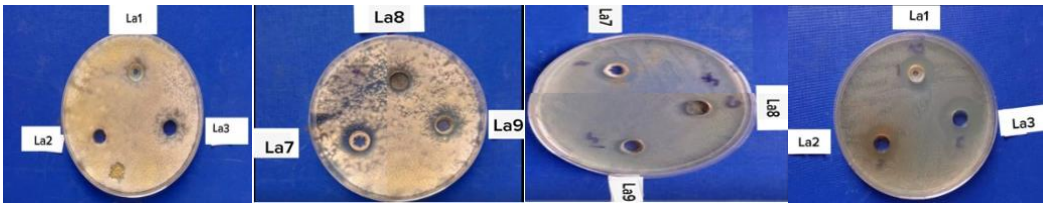
Table(4):The Inhibition Zone (mm) against selected bacterial and fungi.

Compounds	Diameter Of Inhibition Zone(Mm)			
	Antibacterial Activity		Antifungal Activity	
	Staphylococcs Aurens	Escherichia Coli	Candida Albicans	Aspergillus Niger
La 1	16	16	20	----
La 2	----	13	20	----
La 3	20	20	24	----
La7	16	14	17	15
La8	12	----	15	14
La 9	12	----	15	12



(A) **(B)**

Figuer (19). Inhibition zone of complexes against S. aureus (A) and E. coli (B) at conc. (25mg/ml)



(A) **(B)**

Figure(20). Inhibition zone of complexes against C. albicans (A) and A. niger (B) at conc. (25mg/ml)

Antioxidant activity

An antioxidant assay based on electron transfer that generates a violet solution in ethanol is the DPPH (2,2-diphenyl-1-picrylhydrazylhydrate) free radical method. In the presence of an antioxidant molecule, this free radical, which is stable at room temperature, is reduced, producing an ethanol solution that is colorless. Based on the evaluation of antioxidants' ability to scavenge it, the assay is conducted. By obtaining a hydrogen atom from antioxidants, the odd electron of a nitrogen atom in DPPH is reduced, resulting in the corresponding hydrazine [20, 21]. The results in Table (3-7) and Figures (3-50) indicated that synthesized complexes exhibited variable DPPH radical scavenging and a decrease in the antioxidant activity of the synthetic platinum phenolic complexes in the order of 2 > 1 > 8 = 9 > 3 > 7 > 6 > 4 with corresponding percentage values of (79.28 > 76.52 > 76.4 = 76.4 > 67.53 > 65.36 > 57.32 > 47.12 %), respectively. It is also discovered that the 2 complex has greater antioxidant power than the 4 complex, which has lower activity. The phenolic ligands, which operate as antioxidants by interacting with a variety of free radicals, may be one explanation for the greater antioxidant activity of these complexes. The transfer of a hydrogen atom, a single electron, sequential proton loss electron transfer, or the chelation of transition metals were the mechanisms by which antioxidant effects were carried out [22, 23, 24]. The structure-function relationship shows that the ligand type, position of the substituent, electronic and steric effects, and the enzyme inhibitory activities of the platinum complexes are influenced. However, it appears that electronic variables are more significant than other aspects [22, 25, 26].

Table(5). Antioxidant activity of synthesized compounds.

Compounds	Concentration(µg/Ml)						Ic50 (µg/Ml)
	6	12	18	36	75	100	
1	37.47468	44.22687	41.25591	40.85078	45.03714	87.85	76.52
2	37.74477	36.79946	36.52937	43.14652	37.33964	82.35	79.28
3	40.58069	43.01148	43.41661	39.90547	47.46793	89.55	67.53
4	40.85078	43.01148	43.6867	48.81837	87.17083	89.95	47.12
6	28.32241	30.59324	35.45326	37.21113	41.84372	72.87	57.32
7	38.82512	43.551655	34.233625	61.10736	84.74004	150.75	65.36
8	35.31398	41.39095	36.12424	62.18771	55.03038	149.6	76.4
9	33.01823	39.50034	40.17556	46.38758	53.40986	154.3	76.4

Conflicts of interest

It is made explicit by the authors that they have no conflicts of interest with this work.

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