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Original Research Article

Chemical and Biological Study of Some Transition Metal Complexes with Guanine as Ligand

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ABSTRACT

DNA sequences rich in Guanine can come together to form G-quadruplexes, which are tetra-stranded structures. According to some theories, these secondary DNA structures may have a role in the control of several important biological processes. The telomere and the promoter regions of several oncogenes contain guanine-rich sequences that have the potential to create G-quadruplexes in the human genome. The aim of the work was to Prepare guanine complexes with metal ions (Cd(II), Fe(II), Cu(II), Zn(II), Cr(III), Fe(III), Pb(II), and Mn(II)). The complexes were characterised by physical chemical and spectroscopic techniques such as electrical conductivity, metal content, infrared, UV-visible and molar conductivity techniques. The molar ratio of Guanine to metal ion reaction is 1:2, which is determined by the molar ratio method. Dissociation constants for guanine ligands were determined spectrophotometrically. The effect of solvents on the electronic spectra of guanine ligands was studied using solvents of different polarities. The biological activity of guanine ligands and their metal complexes was tested *in vitro* against selected fungal and bacterial species. The results showed satisfactory spectra for the tested organisms.

Keywords: Guanine Complexes; Molar Ratio Method; Effect of Solvents; Biological Activity.

Introduction

Nucleic acids are biopolymers or small biomolecules. They are essential to all known forms of life. The term nucleic acid is an umbrella term for DNA and RNA. Complexes of transition metals with nucleic acids in proteins and peptides are used in many biological processes, such as oxygen transport, electron transfer, and oxidation. During these processes, particular enzymatic active centres form complexes with divalent metal ions [(1)]. Most transition metals chemically react with the N atom of a purine (No7) or the N atom of a pyrimidine (No3) and disrupt the double helix (2). The binding of transition metals, especially to the G-C sites of DNA, leads to its damage through H_2O_2 oxidation to form free radicals [(2)].

Reactions of transition metal complexes with polynucleotides generally fall into two categories: (i) redox reactions involving metal complexes that mediate nucleic acid oxidation; (ii) those involving coordination of metal centres to sugar-phosphate backbones to those that mediate the hydrolysis of polymers. Redox and hydrolysis reactions of metal complexes with nucleic acids have achieved great success in the development of molecular biology tools [(3)]. Facials using Japanese nightingale droppings, or guano, have been used in Japan and elsewhere, ostensibly because the Guanine in the droppings produces the clear, "light" complexion users desire. Guanine crystals are rhombohedral platelets composed of several transparent layers. However, they have a high index of refraction, which partially reflects and transmits light from one layer to another, resulting in a pearlescent sheen. It can be sprayed, brushed or dipped [(4)].

Transition metals are essential cofactors, and cells have evolved complex import and export systems to maintain the metal concentrations required for growth. Metals must be adequately supplied to their cognate proteins after importation. Too little or too much metal input leads to growth arrest: insufficient metal prevents activation of important metalloenzymes, while too much metal leads to toxicity through enzymatic mismetallation (5). Understanding how cells may metallate an enzyme and keep it in the optimal metallation state has been difficult because transition metals have comparable characteristics and have been demonstrated to substitute one another *in vitro* functionally. For instance, mononuclear enzymes include metals that dissociate rapidly *in vitro*[(6,7)]

Finding novel antimicrobial drugs is of tremendous interest due to the rising antimicrobial resistance. It is possible to assess the in-vitro antibacterial activity of putative antimicrobial agents using a variety of laboratory techniques[(8)]. The inhibitory effect of a new drug can be tested using agar disc diffusion; the method's main drawbacks are standardization and agent diffusion, but it is also an easy, affordable method. The antibacterial properties of plant extract were evaluated using the agar disc diffusion techniques[(9)].

Environment-friendly fungi, which are expected, can cause a wide variety of illnesses. Fungi can develop and infect people through the respiratory, digestive, and reproductive tracts, the vaginal area, and other physiological interfaces in warm, humid environments [(10)]. Novel palladium and platinum compounds with nitrogenous bases (guanine), which have the potential to be used in biomedicine and catalysis. In the article, wet chemical techniques are used to synthesize novel $[PdCl_2(HGua)_2]Cl_2H_2O$ and $[PtCl_5(HGua)]2H_2O$ compounds [(11)]

Whereas nucleic acids are crucial for biological processes. Many studies were carried out on the complexes prepared from nucleic acids. Different methods were used to identify the prepared

complexes in addition to using them for different calculations. Reactions of Zn^{2+}, Cd^{2+} and Hg^{2+} ions with Free Guanine were studied, and some of the analysis methods were used the fluorescence quenching, IR, Raman, ^{1}H-NMR, and potentiometric studies for the Zn^{2+}:guanine and the Cd^{2+}. I.R. and Raman spectra suggest that Zn^{2+} and Cd^{2+} interact with Guanine, but the interaction modes differed from metal to metal [(12)]. The difference in ionic radii causes the fluorescence spectra to show that the interaction involving Zn^{2+} is more favourable than that involving Cd^{2+}. There is evidence of stable metal ion Guanine complex formation in ^{1}H-NMR, potentiometry, and speciation diagrams. Potentiometric titrations of Hg^{2+}, the heavier group 12 metal, yield findings comparable to those of Zn^{2+} and Cd^{2+}. There were some variances between both (Zn^{2+} and Cd^{2+}) and Hg^{2+} in the ^{1}H-NMR tests. Fluorescence quenching by Guanine is the cause of[(12)]. It is significantly more significant for $[Pt(NH_3)_3]^{2+}$ to attach to the N atom (No 7) of the base than it is for hydrated Mg^{2+} or Zn^{2+} cations to connect to the inner shell. Even more significant alterations in the stability of platinated base pairs are implied by the electrical changes promoted by Pt coordination in the structure of nucleobases. [(13)]. The relationship between the strength of the G base pairs in the gas phase and the N atom (No 1) acidity of plastinated guanines has been discovered. While ionic-electrostatic forces predominantly affect the N atom (No 1) acidity with some additional polarization effects, they mainly affect the base pair, which polarisation effects enhance. [(13)].

Infrared multiphoton dissociation spectra of cis-$[Pt(NH_3)_2(G)Cl]^{+}$ and cis-$[Pt(NH_3)_2(A)Cl]^{+}$ ions, where A is adenine and G is guanine Ranges were performed in two spectra, namely 950-1900 cm^{-1} and 2900-3700 cm^{-1} [(14)].

Quantum chemical calculations yield the optimised geometries and I.R. spectra for the possible isomers of *cis*-$[Pt(NH_3)_2(G)Cl]^{+}$ and *cis*-$[Pt(NH_3)_2(A)Cl]^{+}$, where the cisplatin residue is attached to either the N atom (No 7), N atom (No 3) or to the carbonyl oxygen atom (No 6) of Guanine, and either to the N atom (No 7), N atom (No 3) or N atom (No 1) position of adenine, respectively. Consistent with the calculated results, the infrared characterization of cis-[Pt(NH3)2(G)Cl]+ revealed a covalent structure of Pt bound to the N atom (No. 7) of Guanine (15). In addition to the regular binding site for natural adenine, complexes with the N atom (#7)-H tautomer were also considered.

Crystallographic characterisation of the dinucleotide adduct *cis*-$[Pt(NH_3)_2\{d(PtGPtG)\}]$ revealed that platinisation was taking place in the guanine rings. Subsequent crystallographic characterisation of a site, specifically cisplatin patinated dodecahedra duplex DNA, bearing a 1,2-*cis* $\{Pt(NH_3)_2\}^{2+}$-d(GPtG) intrastrand adduct, revealed the significant kink that is introduced into DNA upon platination [(16)].

Many subsequent studies led to the characterization of the 1,3-cis-$[Pt(NH_3)_2]^{2+}$ d(GPtG) intrachain adduct structures derived from cisplatin and carboplatin, 1,2-cis-$[Pt(R, R\text{-}DACH)]^{2+}$-d(GPtG) intrachain adduct formed from oxaliplatin, 1,2-cis-$[Pt(NH_3)(NH_2C_6H_{11})]^{2+}$-d(GPtG) intrachain adduct formed by cis-$[Pt(NH_3)_2]^{2+}$-d(GPtG) interchain crosslinks formed by

satraplatin and cisplatin [(17)].

The reported structure of DNA carrying a 1,2-cis $[Pt(NH_3)_2]^{2+}$-d(GPtG) intrastrand cisplatin adduct in complex with the high mobility group box protein HMGB1 was solved by Platinized nucleosomal core particles composed of histone octameric proteins and double-stranded DNA

containing site-specific 1,3-cis-$[Pt(NH_3)_2]^{2+}$-d(GPtG) crosslinks carry.[18] Among post-transition metals, zinc stabilizes the ring domain in DNA-binding proteins. In order to find the specific interactions between Zn and Guanine monophosphate (GMP), the reaction depends on the concentration of the cation [19]. Another study observed that starting from a 1:1 ratio, metal ions bind to the N7 site and increase the [Zn]:[GMP] ratio to 4:1. [20]

The aims of this study use a modified and simple method to synthesise complexes of nucleic acids (ligands), including (Guanine) as a ligand with some metal (Cd^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+}, Cr^{3+}, Fe^{3+}, Pb^{+2} and Mn^{2+}), identification of the complexes by different analysis methods. The effect of different solvents (D. water, EtOH, MeOH, DMSO and DMF) was Studied at different pH media values on the absorbance and wavelength values. The antibacterial and anti-fungi activities of the synthesised complexes will be studied.

Experimental

Materials

All chemicals used in this investigation were laboratory grade; Guanine has used a ligand, the metal salt which uses to complexation with Guanine, including $CdCl_2$, $FeCl_2$, $CuCl_2$, $ZnCl_2$, $CrCl_3$, $FeCl_3$, $PbCl_2$ and $MnCl_2$, some solvents were used in this study including, distilled water, ethanol, methanol, DMSO and DMF. In addition to some acids, acetic acid (CH_3COOH), boric acid (H_3BO_3), Phosphoric acid (H_3PO_4), sodium hydroxide (NaOH), and nitric acid. The buffer solutions used in this study were of the universal type, prepared by 100 ml of an acid mixture containing 0.04 M of H_3BO_4, H_3PO_4 and CH_3COOH acids and adding the required volume of 0.2 N NaOH to adjust the desired pH values.

Synthesis of Guanine Complexes

0.2 mole of Guanine reflexed under vacuum in 50 ml ammonia was added to 0.1 moles of metal ions, and the mixture was left in a dark place until the complexes were prepared. The reaction takes about 3 –7 days. In the molar ratio method,[21] 10 volumetric flasks (10 ml) were cleaned, 2 ml of $3x10^{-3}$M of the ligand was transferred inside each flask, the flasks were numbered from 1 to 10, then 0.4 ml of $1x10^{-3}$M salt aqueous metal solution was added to the first flask, 0.8 ml to the second, 1.2 ml to the third, each flask has 0.4 ml of metal solution more than the previous one, and so on until 4.0 ml was added to the tenth flask. The volume in each flask was made up to the mark (10 ml). A series of [L]/[M] ratios were obtained using a UV spectrophotometer, and the absorption of each solution was measured at λ_{max} of the expected complex. Fluorescence quenching by Guanine is the cause of the [L]/[M] ratios plotted against the absorbance values. The result curves are straight lines with inflexion points; the complex's stoichiometry is indicated by the [L]/[M] ratio corresponding to the infection point. For each compound, this process was repeated, and all of the ligands under investigation were titrated with the metal ions (Cd^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+}, Cr^{3+}, Fe^{3+}, Pb^{2+} and Mn^{2+}).

Measurements

The conductivity of the solutions of the complexes was measured using conductometer type Nana. The melting point was measured using an electronic type (Melting point Apparatus SMP3) at the central chemical analysis laboratory, Faculty of Science, Omar Al-Mukhtar University. The absorbance was measured using a DU800 spectrophotometer covering the wavelength range from 190 to 450 nm; the spectra of the ligand solution at different pH values ranging from 2.3 to 11.9, and two cells of 1cm thickness were used. The infrared spectra of the ligands and their metal complexes were taken in potassium bromide discs using the I.R. spectrophotometer covering the range from 200 to 4000 cm^{-1} at the central laboratory of the Oceanography Institute of Alexandria University, Egypt**.**

Bacterial cultures

Bacteria were cultured on plates using McConkey agar selective and nutrition agar mediums. 23g of powder was dissolved in 1 litre of sterile, distilled water to create the medium. The medium was then sterilized by autoclaving it for 15 minutes at 121 °C. The bacteria were raised and kept at 37°C for 24 hours.

Antibacterial assay

The diffusion method was used to assess the antimicrobial tests. Gram-positive and Gram-negative bacteria (Escherichia coli and Streptococcus) were the strains used (8). All trains were kept apart from the medical students' patients. All of the strains' identities were verified. Before the medium solidified under aseptic conditions, a bacterial suspension was made and added to it. Different weights of guanine complexes, including Cd(II), Fe(II), Cu(II), Zn(II), Cr(III), Fe(III), Pb(II), and Mn(II), 0.1g from each complex in 0.9 ml were placed on the surface of the culture and incubated at 37 ^{0}C for 24 h. After incubation, the average of inhibition zones was recorded in a unit of (mm). The standard complex was prepared at 100 mg/0.9 ml, then diluted at 10 mg/0.9 ml and 1mg/0.9 ml.

Antifungal test

200 grams of potatoes were cut into cubes and added to 1000 ml of distilled water for half an hour, then filtered and placed in a graduated tester and added (20 g) of glucose in addition to (23 g) of agar and the inserted tester was filled with distilled water to 1000 ml. Then placed in a tightly sealed flask and put on flame for a quarter of an hour to half an hour, then sterilised after sterilisation, is poured into dishes [(9)]. The antifungal tests were assayed according to the (Longitudinal growth method and Dry weight). Fungal were obtained from the (Plant pathology laboratory, Department of Prevention, Faculty of Agriculture, Omar Al Mukhtar Al Bayda University, Libya). Isolated from cocoa seeds stored under non-ideal conditions, the fungus grew on the food medium at 25^{0}C. Using a tablet of the fungal diameter of 0.4 cm colony age 7 days and placed on the media, add the guanine complexes to different concentrations (100 mg/0.9 ml,10mg/0.9 ml,1 mg/0.9 ml) incubated at 25 ^{0}C. The longitudinal growth was calculated using the mycelium growth's orthogonal diameter and the average reading. The experiment was discontinued when the control covered the whole dish without treating the whole dish [(9)]. Germs

in each dish were counted using a slice count at a rate of 3 readings. The effect coefficient was calculated according to the equation:

$$Ration\ of\ effect\ treatment\ \% = \frac{\text{Diameter of the growth control} - \text{Diameter of the growth treatment}}{\text{Diameter of the growth control}} \times 100$$

Results and Discussion

Physical Properties of the prepared complexes

The physical properties of the prepared complexes (colours, conductivity and melting point) are given in Table (1). The electrical conductivity values in solutions were carried out to help characterise the structure of the complexes under investigation. The results were in the range of (0.23 -1.02 µS/cm), demonstrating the non-electrolyte character of these complexes. These values also showed no anions were present beyond the coordination sphere [22].

Depending on the type of metal, the ligand's colour was altered from its original state of being white to various other colours. This shift is mainly caused by the connection that forms when the ligand and the metal under study are attracted to one another. The colour of the complex depends on the number of electrons in the d orbital for the metal and the type of the ligand. As the strength of the ligand increases, the difference between the energy of the d electrons and the density of electrons in guanine increases. The magnetic frequency beam is proportional to the energy difference between the two states' energy in the atom; these electrons are in the d orbital, which is high and less energetic. The examined complexes' melting points varied between the complexes and the free ligand; this variation was mainly related to the binding between the metals and the ligand. The melting point values are often higher than 350 ^{0}C.

Infrared spectra studies

The infrared spectra of Guanine and its metal complexes were studied by changing the values of free ligand and complex. Specific band assignments, especially the NH_2 mode assignment at 1260–1020 cm^{-1}, vary from metal to metal. The NH_2 bands of Guanine at 1250 and 3158 cm^{-1} are slightly shifted on complexes in the studied. The δNH_2 pattern for free Guanine at 1668 cm^{-1} and the pattern corresponding to the N-bound complex of this ligand changed significantly. The NH_2 group (exocyclic NH_2 nitrogen) is thus coordinated with the metal ion of the complex. Guanine probably coordinates via the ring nitrogen, with pronounced shifts and occasional splitting of ν C=C, ν C=N and ring vibrations of the ligand (1605–1300 cm^{-1}).

The νNH region, 2900–2500 cm^{-1}, undergoes a significant change for Cd(II), Fe(II) and Cu(II) complexes, resulting in two weak maxima in this region. Guanine at 1250 cm^{-1} shifts to lower wavelengths upon complexation due to the ν C-NH_2 or δ N-H ring mode. The bands at 1045, 1048 and 1043 cm^{-1} in complexes of Cd (II), Fe (II) and Cu (II), respectively, are caused by νNH_2. This favours Guanine binding exclusively through the ring nitrogen. In the following, it is desired to know the nature of the complexes produced. This is done by comparing the infrared

spectra of the complexes and their ligands [23]. Comparing the infrared spectra of the ligands and their metal complexes yields a figure (1 – 9).

The bands at 1000 cm^{-1} in the free ligands could be assigned to the diametric structure; this band is shifted in the most prepared complexes. The produced compounds may coordinate with the investigated metals by M-O and M-N based on the IR data of the Fundamental groups (N-H, NH_2)[24]. The bands of the studied complexes are shown in Table (2).

Spectrophotometric studies

The solvent effects on the electronic absorption spectra are used to study the excited state's chemical properties and identify the electronic transitions in a molecule. The shift in the location of the maximum absorption, which is connected to the different characteristics of the solute and the use of solvents, is one of the most straightforward techniques for spotting such effects. Due to the stabilization of the excited state by the induced dipole interaction between the transition moment and the solvent molecule, the solvent polarizability tends to shift the maximum absorption towards lower energy. As well as, the frequency shift of the spectra bands from the vapour state to the solution could be related to the salvation stabilisation energy of the excited and ground states depending on the various types of intermolecular interaction. The Frank-Condon principle explains the spectral shift when solute molecules are excited, which does not require the most stable arrangement of solvent molecules in the ground state. The most stable arrangement in the excited state occurs when a solvent cage surrounds the exciting solute molecule. [25]

Functional groups with high bond moments are often involved in hydrogen bonding (26). In polar or hydrogen bonded solvents where the polar solute has a penetrating dipole moment, the λmax blue shift occurs with increasing solvent polarity in the presence of the "Frank Condon" phenomenon. If the excited state – dipole moment is less than that of the ground state, a blue shift of λmax occurs with increasing solvent polarity; this explains the shift of n—π* transition on hydrogen bonding relative to hydrocarbon solvents.

Non-polar solutes in non-polar solvents lead to roughly equal release energies of the ground state and excited state, which mainly depend on the refractive index of the solvent due to dispersion. A similar situation is found for non-polar solutes in polar solvents. However, with more solvent cage molecules and more H-bonded molecules, the behaviour of polar solutes in nonpolar or polar solvents depended on the solute's dipole moment (decrease or increase during excitation). [26].

In the first case, the reaction process results in a blue shift of the absorption maximum; in the second case, a redshift. Depending on many factors, an accumulation of hydrogen bonding forces is expected to occur in the presence of polar solvents. The magnitude of the charge in the dipole moment during electronic transitions, the value of the solvent dipole moment, and the size of the solvent and solute molecules. Several empirical single-solvent polarity parameters have been established with varying degrees of success, which correlate with solvent-dependent data. These are discussed in the review article. Nevertheless, little effort has been made to examine the interrelationships between the various parameters. Instead, the validity of the more widely

known parameters of solvent polarity in various solvent-related phenomena (spectroscopy, kinetics, and equilibrium) has been investigated. extensively studied) to most successfully measure the "polarity" of the solvent being tested. Because there is no single parameter that can effectively deal with various phenomena that vary with solvent[27], the absorption spectra of the Guanine In different solvents (H_2O, methanol, ethanol, DMF and DMSO) and the values of λ_{max} are collected in Table (3) and represented in Figures (10–14).

The absorption spectra of the (Guanine) in EtOH were shown in Figure (10), and the λ_{max} was shifted to 245nm. The absorption spectra of the (Guanine) in MeOH were shown in Figure (11), and the λ_{max} was shifted to 278 nm. While the absorption spectra of the (Guanine) in DMSO were shown in Figure (12), and the λ_{max} was shifted to 263 nm. The absorption spectra of the (Guanine) in DMF were shown in Figure (13), and the λ_{max} was shifted to 275nm. The absorption spectra of the (Guanine) in D.W was shown in Figure (14), and the λ_{max} was shifted to 250nm.

Determination of the stoichiometry

The molar ratio of metal ion to ligand was analyzed spectrophotometrically using the molar ratio method. UV absorbance can be used to determine the stoichiometry of complexes, and this method seems valuable for studying complexes with poor stability.

In this study, the concentration of metal ions was kept constant. The ligand concentration was varied to prepare a series of metal-ligand solutions with different [L]/[M] ratios. Measure the absorbance of these solutions at the λmax of the expected complex MLx using a UV spectrophotometer [28].

From this point, excess added ligand causes the line to bend because the absorbance value of the ligand at λ_{max} of the complex differs from that of the complex, corresponding to the [L]/[M] ratio at the inflexion point at the actual [L]/[M] ratios for the compounds studied are given in ABS - [L]/[M] curves, see Figures (15-66), it was found that of the studied complexes in this investigation can be stable in the form ML_2 and ML[28]. The results of the effect of pH on the absorbance values showed wide variations; for Guanine, the data showed that pH (11.5) was recorded at high basic media pH (8.1), while low absorbance was recorded at (2.1), Figure (22).

Antibacterial activities of Guanine complexes

Gram-positive bacteria (*Streptococcus*) and Gram-harmful bacteria were used to assess the antibacterial activity of the eight produced complexes (*Escherichia coli*). The products (0.1g) were dissolved in sterile D. water at a concentration of 0.9 ml, and 0.1 ml of each product was then removed from tube (1), transferred to the tube (2), and diluted further into three tubes of concentration. In the case of bacteria, the plates were incubated inverted at 37 ^oC for 24 hours and at 28 ^oC for 48 hours. The inhibition zones were measured in millimetres following incubation. A diameter of fewer than 10 mm means there is no impact. Gram-negative (*Escherichia coli*) bacteria were often more resistant to the studied products' antibacterial effects

than Gram-positive (*Streptococcus*) bacteria. *Escherichia coli* displayed greater susceptibility to the tested items than Gram-negative bacteria (MIC ranged between 12 – 20 mm). The products (Cd(II), (Fe(II), and (Fe(III)) are more effective against Gram-positive bacteria (*Streptococcus*) than Gram-negative bacteria (MIC level between 12 and 25 mm) (*Escherichia coli*). The results are displayed in Figures and Tables (4 and 5), respectively (23-35).

Antifungal activities of Guanine complexes

In biological systems, metal ions facilitate responses ranging from deficiency to toxicity. Some elements, such as iron and cadmium, are known to be in optimal absorption ranges for normal, healthy individuals. Metal ions in carefully designed molecules have been a boon to medical pharmacopoeias [(29)]. Toxicity thresholds can be low, whether necessary or not. One of the challenges in developing metal-based drugs is balancing the potential toxicity of active agents with the significant beneficial effects of these increasingly widely used therapeutic and diagnostic tools [(30)]. This fact served as the foundation for the hypothesis that zinc participates in the fungi's utilization of carbohydrates. The trials presented here demonstrate that *A. niger* was affected similarly by partial shortages of zinc, iron, and copper [(31)]. It would seem that zinc's influence on how carbohydrates are used has no discernible effect and says no more about the function of zinc than it does about the role of any other inorganic compound[(32)]. It is noted that the Guanine complexes significantly affected the growth of *Aspergillus niger fungi* compared to the control. The results of the effect of the studied complexes on antifungal activity are given in Figures 36-37. In *A. niger*, lead ($Mn^{2+)}$ had the largest metal accumulation, followed by Cd^{2+}, Fe^{3+}, Fe^{2+}, Zn^{2+}, Cr^{3+}, Pb^{2+}, and Cu^{2+}. Manganese concentrations are higher than those of hazardous metals like Cr^{3+}, Pb^{2+}, and Cu^{2+}, but excessive amounts start a process that prevents manganese from entering the cell. Although cadmium has clear metabolic significance in fungi, it is taken up by wall components through intracellular and extracellular chelating processes [(33)]. Thus, it is more bioavailable, although most fungi secrete siderophores to absorb iron (Fe^{3+}) in their environment [(34)]. As shown in the Figure (37), the effect of treatment on the growth of fungus when compared to the control where shows that all treatments have a high impact on the growth of the fungus by a ratio exceeding 70% for each (Cd^{2+}, Fe^{2+}, Fe^{3+}, and Mn^{2+}) while the effect treatments ranged (Zn^{2+}, Cr^{3+} and Pb^{2+}) 64% whereas the treatment on the growth of the fungi.

Percentages of treatment effect on bacteremia A.nger fungus

The results showed the effect of the tested Guanine complexes on the production of *A.niger fungi* of conidia germs. These complexes reduced the production germs by more than 90% for (Cd II, Fe II, Cu II, Zn II and Mn II). At the same time, the effect of (CrIII and FeIII) was less on bacterial fungi, while the (Pb II) was the most minor studied complexes on the growth of the fungus, eliminated by 16 %, Figure (38) and (39).

Experiments of dry weight

Toxic metals disrupt the structure of membranes and cause stress, which causes various reactions. Metal chloride complexes have imported inhibition of the fungal A.niger Figure (40). However, the secretion of mucilaginous binding molecules with a high affinity for these metal chloride complexes is a crucial feature of this reaction (Figures 41-44) and Table (6). [(35)] As shown in the Figure (41), the effect of treatment on the weight of the fungus when compared to

the control where shows that all treatments have a high impact on the weight of the fungus for each (Cd^{2+}, Fe^{2+}, Fe^{3+}, Mn^{2+}, Zn^{2+}, Cr^{3+} and Pb^{2+}). The results showed the effect of the tested Guanine complexes on the production of *A.niger fungi* of conidia germs. These complexes reduced the production germs by more than 90% for (Cd^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, Cr^{3+}, Fe^{3+} and Pb^{2+}).

Conclusion

According to the results obtained from this study which aimed to prepare new complexes by direct, simple and quick reaction between Guanine as ligand with some metal chlorides, the complexes gave significant antimicrobial effects on positive and negative grams of bacteria. The spectrophotometric studies showed the molar ratio of the reaction between guanine and metal ions are in the ratio 1:2. Also, the effect of some solvents showed a blue and red shift in the UV region depending on the polarity of the used solvents. Also, the prepared complexes by this modified reaction were characterised by some physical properties such as colour, M.p and conductivity. In general, the applied method in the study indicated that Guanine could be used as a free ligand to synthesise complexes by a simple reaction. The use of metal complexes as *in vivo* probes for Guanine structures is probably going to be a particularly active area in this field's future. Furthermore, given the dearth of *in vivo* uses for metal-containing Guanine DNA binders, future research is anticipated to examine these complexes' therapeutic uses.

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