ACTA SCIENTIFIC MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 3 Issue 10 October 2019

Research Article

Studies on Antimicrobial and Antioxidant Potential of Metal Complexes and Synthetic Organic Compounds

Saira Zahoor* and Muhammad Sajid

Department of Biochemistry, Hazara University Mansehra, Pakistan

***Corresponding Author:** Saira Zahoor, Department of Biochemistry, Hazara University Mansehra, Pakistan.

E-mail: saira.zahoor.awaan@gmail.com

Received: May 23, 2019; **Published:** September 27, 2019

DOI: 10.31080/ASMS.2019.03.0422

Abstract

Organic compounds and metal complexes play important roles in biological system, and it has been recognized that many synthetic organic compounds and metal complexes used in manufacturing of medicines and are bio transformed by metal ions metabolism. Studies on metal compounds of Schiff bases and synthetic compounds have been of major significance due to their spectral properties and vast applications. The current study deals with the compounds and determination of their antibacterial and antioxidant activities and on the basis of results, three compounds at various concentrations give indicatively high scavenging capacity. In scavenging capacity, results of the three compounds which are metal complexes having codes are SH-4-9, SH-4-11 and SH-4-13 at different concentrations (10 ppm, 100 ppm, 1000 ppm) were statistically significant. Similarly, results of lower DPPH scavenging capacity were also significant in compounds having code KH-4-3. Out of twenty-three only four compound having codes SH-4-3, SH-4-4, SH-4-5 and SH-4-9 showed the encouraging results against four bacterial strains.

Keywords: Metal Complexes; Synthetic Organic Compounds; Antibacterial Activity Antioxidant Activity; Ascorbic Acid; Ceftriaxone Sodium

Introduction

Metal complexes are groups of atoms having chemical structure in which medial metal atom is encircle by metalloid atoms called ligands which are joined by chemical bonding [1]. Metals play avital role in the manufacturing of different drugs for years, ever since human being started to walk on the planet. Many metals are very essential for our body which our diets contain in varying quantities, although people have only recently realized importance of metals. It happened due to increased in knowledge education and awareness of people, personnel and family health. Metal complexes are used in current medical use in many classes of the pharmaceuticals [9]. Some metal complexes having strong antimicrobial activities which are already running in the market [2,3]. The compounds which do not occur naturally and prepared by the reaction of other compound are known as synthetic compounds. Herbal medicines are mostly used for the traditional treatment of health problems in developing countries [4]. New organic synthetic compounds synthesized in laboratory and used in the manufacturing of drugs [5]. Bacteria consist of a large domain of prokaryotic microorganisms. Bacteria consist of multiple shapes, like spheres to rods and spirals, a few micrometers in length. Bacteria were among the first life forms to appear on Earth. Its habitat is soil, water, acidic hot springs, radioactive waste [8] and the deep portions of Earth's crust. *Escherichia coli* are known as facultative anaerobic gram-negative bacteria [10]. It is rod like in structure which is normally found in the warm-blooded organisms [7]. *Staphylococcus aureus* is a gram-positive coccal bacterium. It is a member of the Firmicutes. *Klebsiella pneumoniae* is gram-negative, nonmotile, encapsulated, rod-shaped bacterium. They grow in clusters and have no flagella [12]. *Streptococcus pneumoniae* is a gram - positive bacteria. Metal complexes are the sunny reddish color which was firstly introduced in India and famous to old Egyptians [14]. Schiff base complexes and synthetic organic compounds have taken more attention recently in bioinorganic and biochemistry due to their antimicrobial and chemotherapy features [13]. To some extent metals having showed the antitumor efficacy like zinc and cadmium [15-17].

Materials and Methods

To investigate the antioxidant and antibacterial activity of the synthetic organic compounds and metal complexes were studied by methods discuss below.

Materials

The following chemicals and compounds were used.

Collection of synthetic organic compounds, metal complexes and chemicals

Samples of metal complexes and synthetic organic compounds were collected from the chemistry lab of Hazara University Mansehra. These compounds were already identified by using Fourier Transform Infrared (FT-IR) and Nuclear Magnetic Resonance (NMR) spectroscopies and their molecular weights were measured by Mass Spectrometry (MS). The compounds are listed below in table 1.

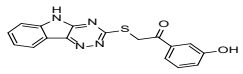
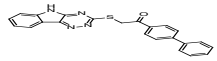
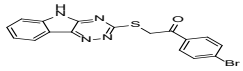
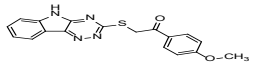
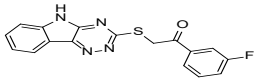
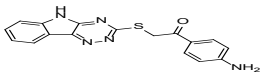
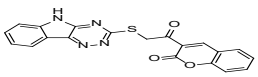
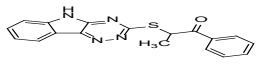
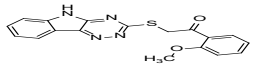
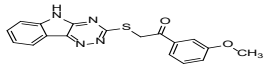
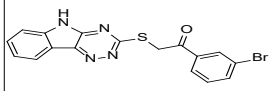
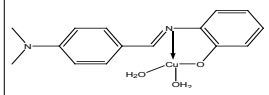
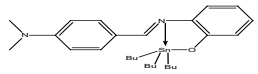
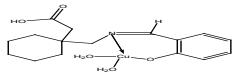
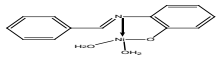
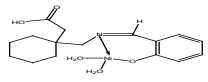
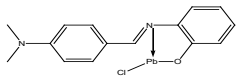
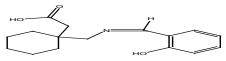
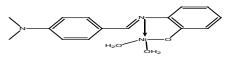
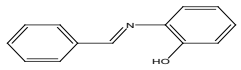
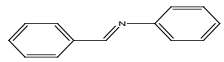
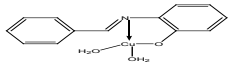
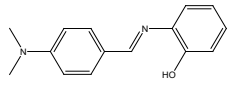
S. No	Codes	Structures	Molecular weights
01	KH-4-1		336
02	KH-4-2		396
03	KH-4-3		399
04	KH-4-4		350
05	KH-4-5		338
06	KH-4-6		335
07	KH-4-7		388
08	KH-4-8		334
09	KH-4-9		350
10	KH-4-10		350
11	SH-4-1		399
12	SH-4-2		338.87
13	SH-4-3		529.35
14	SH-4-5		373.0
15	SH-4-5		290.8
16	SH-4-6		369.33
17	SH-4-7		481.95
18	SH-4-8		275
19	SH-4-9		334.02
20	SH-4-10		197.23
21	SH-4-11		181.23
22	SH-4-12		295.80
23	SH-4-13		240.12

Table 1: Synthetic organic compounds and metal complexes.

Materials

2, 2-diphenyl-1-picrylhydrazyl (DPPH) (Sigma), Methanol (HPLC Grade), Ethanol (HPLC Grade) Ascorbic acid ($C_6H_8O_6$) (Sigma), Test samples (Chemistry lab of Hazara University Mansehra) UV spectrophotometer (UV/VIS China) and Micropipette (Accumax). Nutrient agar (Oxoid), Culture of bacterial strains (Biola-

bs Islamabad), Test samples (Chemistry lab of Hazara University Mansehra), Hot Incubator (Forma scientific), Cold Incubator (Forma scientific), Laminar Floor Hood (Galvano Scientific), Sodium Hydroxide (Sigma), Autoclave (Galvano Scientific), Hot plate magnetic stirrer (DHPS-1) Dry heat sterilizer (DHG9030A), Weighing balance (AUX220 shimadzu), Disinfectant Isopropyl Alcohol (I.P.A 70%) (Sigma), Micropipette (Accumax).

Microorganisms used

Four strains of bacteria were selected on the bases of their clinical importance which were already identified, and out of which two were gram negative i.e. *Klebsiella pneumoniae* and *E. coli* and two bacteria were gram positive *Streptococcus pneumoniae* and *Staphylococcus aureus*. These microorganisms were collected from Bio labs Islamabad were inoculated on nutrient agar media at 4°C temperature. The stock cultures were maintained at 4°C.

Methodology

Antioxidant and antibacterial activity of metal complexes and synthetic organic compounds were studied by the following methods.

Antioxidant activity

The antioxidant activities of all synthetic compounds and metal complexes were determined by DPPH scavenging activity.

DPPH scavenging activity

The method used to detect the antioxidant activity of all synthetic organic compounds and metal complexes was described by [6] modified by [11].

Preparation of stock solution

Bulk solution of DPPH was prepared by dissolving 32 mg DPPH reagent in 1000 ml of 80% methanol. Bulk solution of ascorbic acid (positive control) was prepared in water by dissolving 0.15 mg/mL,1.5 mg/mL, and 15 mg/mL in ethanol for 150 ppm, 1500 ppm and 15000 ppm respectively. The solution of all samples was prepared with strength of 0.15 mg/mL, 1.5 mg/mL, and 15 mg/mL in ethanol for 150 ppm, 1500 ppm and 15000 ppm.

Procedure

After preparation of stock solution 200 µL of the test sample and 3mL of DPPH solution were taken in test tube for each sample from stock solution. The final concentration of samples became 10ppm, 100 ppm, 1000 ppm by using formula M1V1=M2V2. Mixtures were shacked gently and kept in dark for one hour at room temperature. After one-hour samples were run on UV spectrophotometer along with standard ascorbic acid simutansiously by using 80% methanol was as a blank. Absorbance for all test samples and positive control i.e ascorbic acid were measured at 517 nm by using UV spectrophotometer. DPPH was used as a negative control whereas ascorbic acid was used as a positive control and methanol 80% was used as a blank. Test was performed in triplicate for each sample.

The final percentage inhibition was calculated by the following formula.

DPPH scavenging activity (Percentage inhibition) = [Ac – As / Ac] × 100

Ac =Absorbance of control

As = Absorbance of sample

The results were averages of triplicate for each sample.

Antibacterial activity

In this study antibacterial activity of metal complexes and synthetic organic compounds were observed by using well diffusion method against four different pathogenic bacterial strains i.e. *Staphylococcus aureus, Streptococcus pneumoniae, E. coli,* and *Klebsiella pneumoniae*. *Staphylococcus aureus* and *Streptococcus pneumoniae* were gram positive bacteria and *E. coli,* and *Klebsiella pneumoniae* were gram negative bacteria.

Standard drug dilutions

Ceftriaxone sodium salt was used as positive control by dissolving 62 mg standard drug of ceftriaxone in 625 µL of ethanol that the concentration becomes 62 mg/625 µL for 1:10 and 62 mg/1225 mL for 1:20 dilutions, and ethanol were used as negative control.

Sample preparation of synthetic organic compounds and metal complexes

Bulk solution of different compound was prepared by dissolving 62 mg/625 µL ethanol for 1:10 dilution and 62 mg/1250 mL of ethanol for 1:20 dilutions.

Sub culturing of bacterial strains and pour samples

Weared gloves and mask and mopped the hands with methanol. Mopped the laminar flow hood with disinfectant methanol. Took out the petri dishes from incubator and placed on the bench of laminar flow hood. Took petri dish and bacterial culture was seeded on media with the help of sterile swab stick. Well was made in the center of petri plates with the help of micropipette tip. Then filled whole well fill with 50 µL sample of test dilution, ethanol was used as a negative control. Plates were kept in hybridization oven at 37°C for 24 hours. Clear zones of inhibition of test samples were measured by using Vernier caliper after 24 hours. For each sample duplicate plates were prepared having two different dilutions (1:10 and 1:20). Ethanol was used as a negative control for against four bacterial strains (*Klebsiella pneumoniae, E. coli, Streptococcus pneumoniae* and *Staphylococcus aureus*).

Results and Discussion

Bacteria can cause different diseases in human, animals and plants. Several drugs are used against these bacteria due to heavy reliance on these drugs several strains developed resistance so there is need to search and develop new antibacterial agents. In present study we investigated the antimicrobial activity of synthetic compounds. In addition to this we evaluated the antioxidant activity of these compounds.

Antibacterial activity

The antimicrobial potency of the synthetic organic compounds and metal complexes were studied in different concentrations (62 mg/625 mL and 62 mg/1250 mL) for 1:10 and 1:20 dilutions respectively by well diffusion method against four pathogenic bacterial strains. Two were Gram-positive *Staphylococcus aureus* ATCC No 2592 and *Streptococcus pneumoniae* ATCC No 49619, and two were Gram-negative *Escherichia coli* ATCC No 25922 and *Klebsiella pneumoniae* ATCC No 10031. Based on their applications these bacterial strains have been selected and the purpose of further formulation study. Antibacterial activity of metal complexes and synthetic organic compounds were assessed in the form of zone of inhibition of bacterial growth. The results are shown in the following table 2 for 1:10 and 1:20 dilutions. Antibacterial activities of synthetic organic compounds and metal complexes were checked against four bacterial strains *Staphylococcus aureus*, *Streptococcus pneumoniae, Escherichia coli* and *Klebsiella pneumoniae.* The compounds having codes KH-4-1, KH-4-2, KH-4-3, KH-4-4, KH-4-5, KH-4-6, KH-4-9, KH-4-10 and SH-4-10 did not show any activity against above four bacterial strains on 1:10 and 1:20 dilutions. Compounds having code SH-4-4, SH-4-5, SH-4-7 and SH-4-9 were active against four bacterial strains *Staphylococcus aureus*, *Streptococcus pneumoniae, Escherichia coli* and *Klebsiella pneumoniae* and showed the encouraging results. In comparison of gram positive and gram-negative bacterial strains the code SH-4-2 and SH-4-3 showed much sensitivity to gram negative bacterial strain i.e. *Klebsiella pneumoniae* and showed encouraging zones of inhibitions on 1:10 and 1:20 dilutions. SH-4-12 showed the best antibacterial activity against *Klebsiella pneumoniae* and showed 12.6 mm and 12 mm zones of inhibition respectively. It did not show good activity against rest bacterial strains *Escherichia coli, Staphylococcus aureus* and *Streptococcus pneumoniae.* SH-4-3 showed 7 mm and 5.8 mm zone of inhibition against *Staphylococcus aureus* 7 mm and 6 mm zone of inhibition against *Streptococcus pneumoniae.* In case of gram-negative bacteria sample SH-4-12 showed the best antibacterial activity and gave 12.6 mm and 12 mm zones of inhibition against *Klebsiella pneumoniae.* In case of KH-4 series KH-4-7 showed the highest zone of inhibition against *Streptococcus pneumoniae* which is 3.3 mm, but it was much less as compare to standard drug ceftriaxone. In case of metal complexes, the sample having code SH-4-3 and SH-4-12 showed highest zones of inhibition among all the compounds against *Klebsiella pneumoniae* but rest were not much sensitive to this strain of bacteria. When we compare overall results then out of twenty-three only four compound having codes SH-4-3, SH-4-4, SH-4-5 and SH-4-9 showed the encouraging results against four bacterial strains. Ceftriaxone is a new third generation cephalosporin with excellent activity against many gram-negative and gram-positive microorganisms was used as standard drug. The values obtained are the mean of three independent replicate along with standard deviation because the activity was performed in triplicate. Results are shown in table 2 for 1:10 and 1:20 dilutions. In antibacterial activity when we compare the samples with standard the sample having code SH-4-3 and SH-4-12 showed the encouraging results and both having 12.6 mm and 12 mm zone of inhibition on *Klebsiella pneumoniae* on 1:10 and 1:20 dilutions. The both samples showed the best activity on 1:10 and 1:20 dilution as compared to standard drug ceftriaxone sodium which having 12.5 mm and 11 mm zone of inhibition on 1:10 and 1:20 dilutions.

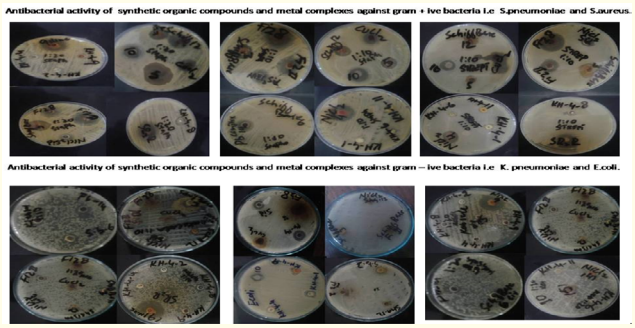


Figure 1: Antibacterial activity of synthetic organic compounds and metal complexes against four pathogenic strains.

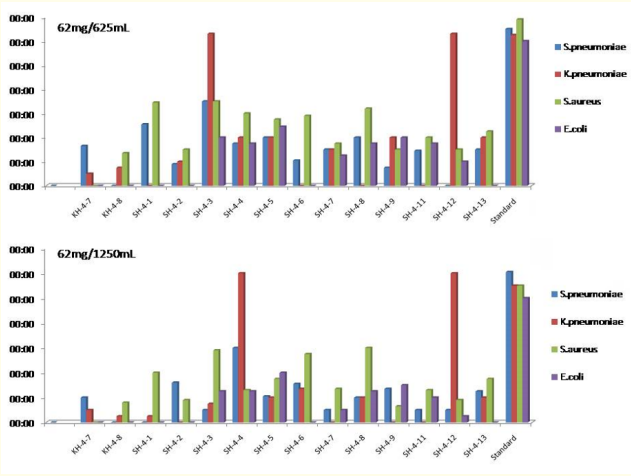


Figure 2: Antibacterial activity of synthetic organic compounds and metal complexes.

enging capacities as compared to their standard 10 ppm, 100 ppm and 1000 ppm dilutions.

We have performed antioxidant activity in twenty-three samples with different dilutions. SH-4-13 showed the highest antioxidant capacity which was 99% among all the compounds comparative to ascorbic acid which was reference standard which showed 98.1% potency. When we compared DPPH scavenging activities with standard ascorbic acid then we observed other compounds also showed satisfactory results which can be seen in table 2. In case of KH-4 series only KH-4-7 showed the best results and gave 75.3% potency which was considerable but less than from ascorbic acid and in SZ series SH-4-1, SH-4-6, SH-4-9, SH-4-11 showed the encouraging results among all the dilution. When we compare overall results the metal complexes showed the best results as compare to synthetic organic compounds are shown in figure 3.

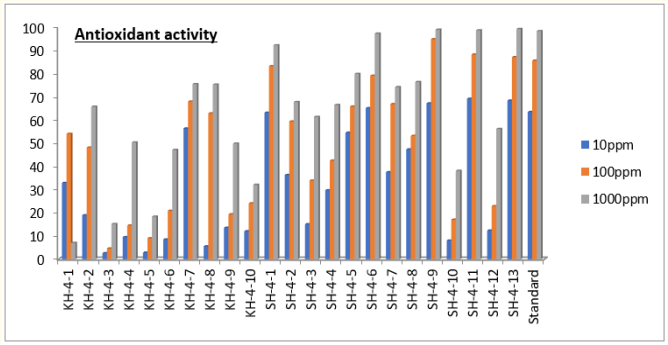


Figure 3: DPPH scavenging activity of synthetic organic compounds and metal complexes at 10 ppm, 100 ppm and 1000 ppm dilutions.

Antioxidant activity

Antioxidant activity of all compounds and metal complexes were checked in three different dilutions. All dilutions of synthetic organic compounds of KH-4 series showed decrease in DPPH percentage scavenging capacities as compared to their standard which is mentioned as positive control i.e. Ascorbic acid except KH-4-7 which showed highest scavenging capacities as compared to other compounds in 10 ppm, 100 ppm, and 1000 ppm dilutions. In case of metal complexes three samples having codes SH-4-11, SH-4-13 and SH-4-9 showed increase in DPPH percentage scav-

Conclusion and Future Strategies

The presence of important synthetic organic compounds as well as metal complexes suggested that these compounds possess varying degree of biological activities including antibacterial and antioxidants activities and can be further studied for the structure illumination and development of pharmacologically important medicinal chemistry of agents.

Metal complexes and synthetic organic compounds showed the best activity against different bacterial strains and can be used as

S.No	Samples code	DPPH Percentage scavenging activity		
		Percentage Inhibition		
		(10 ppm,100 ppm,1000 ppm) 0.00015 g/mL,0.0015 g/mL,0.0015 g/mL ± S. Dev		
		10ppm	100ppm	1000ppm
1	KH-4-1	32.8 ± 0	53.9 ± 0.0015	7 ± 0
2	KH-4-2	18.9 ± 0	48 ± 0.0015	65.6± 0.0005
3	KH-4-3	2.59 ± 0.005	4.59 ± 0.001	15.1 ± 0.0005
4	KH-4-4	9.5 ± 0.005	14.5 ± 0	50.2 ± 0.001
5	KH-4-5	2.8 ± 0.0005	9 ± 0.0015	18.3 ± 0
6	KH-4-6	8.49 ± 0.001	20.8 ± 0.001	47 ± 0
7	KH-4-7	56.2 ± 0.0005	67.8 ± 0.005	75.3 ± 0.001
8	KH-4-8	52.5 ± 0.001	62.7 ± 0.001	75.1 ± 0.0005
9	KH-4-9	13.5 ± 0.005	19.31± 0.005	49.7 ± 0
10	KH-4-11	12 ± 0.001	24 ± 0.005	32 ± 0.0005
11	SH-4-1	63 ± 0.005	83 ± 0.0005	92 ± 0.001
12	SH-4-2	36.2 ± 0	59.2 ± 0.005	67.6 ± 0.001
13	SH=4-3	15 ± 0.001	33.8 ± 0.0005	61.2 ± 0.0005
14	SH-4-4	29.64 ± 0.001	42.4 ± 0.001	66.3 ± 0
15	SH-4-5	54.4 ± 0.005	65.64 ± 0.0005	79.7 ± 0
16	SH-4-6	64.98 ± 0.005	78.9 ± 0.005	97 ± 0.0005
17	SH-4-7	37.4 ± 0.001	66.7 ± 0.005	74 ± 0.0005
18	SH-4-8	47.2 ± 0	53 ± 0.001	76.2 ± 0.005
19	SH-4-9	67 ± 0	94.6 ± 0.51	98.7 ± 0.051
20	SH-4-10	8 ± 0.001	17 ± 0.001	38 ± 0.005
21	SH-4-11	69 ± 0	88 ± 0	98.4 ± 0.0005
22	SH-4-12	12.3 ± 0.005	22.8 ± 0.001	56 ± 0
23	SH-4-13	68.2 ± 0	86.9 ± 0.005	99 ± 0.0005
24	Ascorbic acid	66.3 ±0.005	85.4 ±0.0005	98.1 ±0

Table 2: Antioxidant activity of synthetic organic compounds and metal complexes.

antibacterial agents to inhibit the bacterial growth or to kill the pathogenic microorganisms against different infectious diseases. Some metal complexes and synthetic organic compounds showed the best antioxidant activity can also be used as antioxidants to removal of oxygen.

Bibliography

1. Akter S., *et al.* "Solvent effects on antioxidant properties of persimmon (Diospyros kaki L. cv. Daebong) seeds". *International Journal of Food Science and Technology* 45 (2010): 2258-2264.

2. Barry AL. "The antimicrobic susceptibility test". *Principles and Practices* (1976): 95-99.

3. Lea and Febiger. Antimicrobial Agents and Chemotherapy. Copyright© American Society for Microbiology Printed in U.S.A 13.1 (1978): 61-69.

4. Bedir E., *et al.* "Biologically active steroidal glycosides from Tribulus terrestris". *Pharmazie* 57.1 (2002): 491-493.

5. Casewell M and Talsania HG. "Predominance of certain klebsiella capsular types in hospitals in the United Kingdom". *Journal of Infection* 1 (1979): 77-79.

6. Kulisic T., *et al.* "Use of different methods for testing antioxidative activity of oregano essential oil". *Food Chemistry* 85 (2004): 633-640.

7. Latif A and Shaker R. "The chemistry of mercapto- and thione-substituted 1, 2, 4-triazoles and their utility in heterocyclic synthesis". *Journal of Heterocyclic Chemistry* 26 (1989): 769.

8. Li H and Sun H. "Recent advances in bioinorganic chemistry of bismuth". *Current Opinion in Chemical Biology* 16.1-2 (2012): 74-83.

9. Lippert B and Cisplatin. "Chemistry and Biochemistry of a Leading Anticancer Drug". John Wiley and Sons: Amsterdam, The Netherlands, Molecules 20 (2015): 7955.

10. Mishra, N., *et al.* "An overview of biological aspects of Schiff base metal complexes". *International Journal of Advancements in Research and Technology* 2.8 (2013): 52-66.

11. Obeid HK., *et al.* "Bioactivity and analysis of biophenols recovered from olive mill waste". *Journal of Agricultural and Food Chemistry* 53.4 (2005): 823-837.

12. Peru and Bolivia. "Escherichia coli in children". *Journal of Emerging Infectious Diseases* 12.6 (2006): 375-379.

13. Pizarro AM and Sadler PJ. "Unusual DNA binding modes for metal anticancer complexes". *Biochimie* 91.10 (2009): 1198-1211.

14. Raman, N., *et al.* "Synthesis and spectral characterization of antifungal sensitive Schiff base transition metal complexes". *Mycobiology* 35.3 (2007): 150-153.

15. Rohaya A., *et al.* "Antioxidant, radical-scavenging, anti-inflammatory, cytotoxic and antibacterial activities of methanolic extracts of some Hedyotis species". *Life Sciences* 76.17 (2005): 1953-1964.

16. Rosenberg B., *et al.* "Platinum compounds: A new class of potent antitumour agents". *Nature* 222 (1969): 385-386.

17. Ryan KJ and Ray CG. "Sherris Medical Microbiology". *McGraw Hill* (2005).

Volume 3 Issue 10 October 2019