www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 4148-4152

www.thepharmajournal.com
Received: 10-10-2022
Accepted: 12-11-2022

Vivek Kumar
Department of Chemistry, JV Jain (P.G.) College, Saharanpur, Uttar Pradesh, India

Raj Kumar
Professor and Head, Department of Chemistry, JV Jain (P.G.) College, Saharanpur, Uttar Pradesh, India

Corresponding Author:
Vivek Kumar
Department of Chemistry, JV Jain (P.G.) College, Saharanpur, Uttar Pradesh, India

Antimicrobial and antifungal activities of Co(II)-Potassium Propan-1,3-Diol Di Xanthate

Vivek Kumar and Raj Kumar

Abstract
Co(II)-complex of Potassium Propan-1,3-Diol Di Xanthate (PPDDX) was studied to examine its antimicrobial activities by using disc diffusion method. The radial growth *Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae* and *Staphylococcus aureus* was inhibited by this complex at higher concentration. The complex is highly toxic against common pathogenic fungi such as *Aspergillus niger, Aspergillus flavus* and *Candida albicans* at all the concentration. In this study, the disc diffusion method is used to examine the complex behavior.

Keywords: Antifungal activity, Disc diffusion method, Complex, Potassium Propan-1,3-Diol Di Xanthate

Introduction
Many essential biological chemicals are chelates. Chelates play important roles in oxygen transport and in photosynthesis. Furthermore, many biological catalysts (enzymes) are chelates. In addition to their significance in living organisms, chelates are also economically important, both as products in themselves and as agents in the production of other chemicals. The fast developing field of bioinorganic chemistry is mostly centered on the presence of coordination compounds in living system. Medicinal inorganic chemistry is a multidisciplinary field of growing significance in both therapeutic and diagnostic medicine [1]. The discovery and development of antitumor cisplatin compounds played a profound role in the fields of medicinal inorganic chemistry. The success of cisplatin has aroused great interest in the development of new metal complexes for diagnostic and treats diseases including diabetes, alzheimer and cancer. Although highly effective in treating a variety of cancers, the cure with cisplatin is still limited by dose-limiting side effects.
Transition metal (II) ions are the fundamental elements for healthy life of living organisms like human, plants and animals have applications in the area of bio–science, environmental, clinical, industrial, agricultural and pharmaceutical fields [2]. The four most frequently used transition metals in biological systems are iron, cobalt, copper and zinc. The antibiotic properties of Ni (II) xanthate complexes was studied by Qadir [3]. Li *et al.* [4] investigated the manufacture and biological evaluation of a new oxo complex containing metronidazole xanthate for imaging tumour hypoxia. Torshizi *et al.* [5]. Synthesized and analysed xanthate derivatives and their iron (II) complexes. Yanev *et al.* [6] investigated the metabolism of xanthate and its antimycobacterial action. Several xanthates have antiglaucoma properties and are potential carbonic anhydrase inhibitors.
Many additional metal containing compounds are now widely utilized in medicine, such as Cisplatin, cis-$(Nh_3)_2$, $PtCl_2$ which is successfully used as an anticancer medication all over the world. A significant inhibition activity was predicted with complexes against various bacterial inoculums typed as gram-positive bacteria (*S. Aureus, S. Pneumoniae, Stap. pneumoniae, B. subtilis*) and gram-negative bacteria (*S. Flexneri, S. typhi, K. Pneumoniae, H. Influenza*) and various fungal inoculums such as *A. Niger, C. albicans, C. Tropicalis, M. Campestris*. The chelating capacity of the Schiff base with Co(II) and Ni(II) ions led to the conclusion that complexes are effective antimicrobial agents [7]
The metal ions and ligand molecules in the complexes are close to the cell membrane of *Escherichia coli*, which has reached the goal of destroying the spatial structure of proteins in bacteria, leading to the decline of bacteria's reproductive capacity, thus inhibiting their growth and even death. Hirschfield surfaces analyses show that complexes of Co(II) are stable due to the interactions of intermolecular hydrogen bondings).

Finally, each molecule of the Co(II complex is linked to each other to form a three-dimensional supramolecular network structure, which has potential applications and deserves further study [8].

Metal complexes of Co(II), Ni(II) and Cu(II) with a new Schiff base were screened for in vitro antibacterial activity against *Staphylococcus aureus* as Gram+ve bacteria and *Escherichia coli* (*E. coli*) as Gram-ve bacteria using inhibition zone diameter. DNA binding and biological activity of the hydrazone (HL) and its Co(II), Ni(II) and Cu(II) complexes were found to be effective antibacterial [9]. When compared to a typical antibiotic, the antibacterial activity of the mixed ligand of Co(II) and Ni(II) complexes is moderate. The complexes have good anti-inflammatory properties, when compared to the standard medicine diclofenac sodium. The Co(II) and Ni(II) complexes showed a good percentage of inhibition [10]. The Co(III) complexes showed some activity against MRSA and the fungal strains. A detailed account on the physical properties and ligand substitution reactions of these complexes was recently studied [11].

Ahmed [12] investigated the broad range antifungal properties of Co(II)-chelates. Balapure [13] studied the sublimable xanthate-mediated solid-state synthesis of highly interspersed g-C_3N_4/Ag_2S nanocomposites exhibiting efficient bactericidal effects both under dark and light conditions. Khalil [14] synthesized the Single precursor-based transition metal sulfide nanoparticles and evaluation of their antimicrobial, antioxidant and cytotoxic potentials.

Materials and Methods

Culture Media

The following media were used in the study: nutrient agar (Himedia, M001), soyabean casein digest agar (Himedia, M290), nutrient broth (Himedia, M002), yeast malt agar (Himedia, M424), yeast malt broth (Himedia, M425), Sabouraud Chloramphenicol agar (Himedia, M1067) and Sabouraud dextrose broth (Himedia, M033). The media's composition is listed below.

Nutrient Agar (Himedia, M001)

Peptic digest of animal tissue	5.0 gm.
Yeast extract	1.5 gm.
Beef extract	1.5 gm.
Sodium chloride	5.0 gm.
Agar	15 gm.
D/w	1 ltr.
Final pH (at 25˚C)	7.4 ± 0.2

A total of 2.8 gram of nutrient agar (M001) was suspended in 1000 ml distilled water and autoclaved for 15 minutes at 15 lbs pressure (121 °C).

Soyabean Chloramphenicol Agar (Himedia M1067)

Peptic digest of animal tissue	5.0 gm.
Casein enzymatic hydrolysate	5.0 gm.
Dextrose	40.0 gm.
Chloramphenicol	0.05 gm.
Agar	15 gm.
D/w	1 ltr.
Final pH (at 25˚C)	5.6 ± 0.2

A total of 65.0 grams of medium (M1067) was suspended in 1000 ml distilled water and autoclaved for 15 minutes at 15 LBS pressure (121°C).

Sabouraud Dextrose Broth (Himedia M033)

Dextrose	20.0 gm.
Special peptone	10.0 gm.
D/w	1 ltr.
Final pH (at 25°C)	5.6 ± 0.2

A total of 30.0 grams of medium (M033) was suspended in 1000 ml distilled water and autoclaved for 15 minutes at 15 lbs pressure (121 °C).

Soyabean Chloramphenicol Agar (Himedia M1067)

Peptic digest of animal tissue	5.0 gm.
Casein enzymatic hydrolysate	5.0 gm.
Dextrose	40.0 gm.
Chloramphenicol	0.05 gm.
Agar	15 gm.
D/w	1 ltr.
Final pH (at 25˚C)	5.6 ± 0.2

A total of 65.0 grams of medium (M1067) was suspended in 1000 ml distilled water and autoclaved for 15 minutes at 15 lbs pressure (121 °C).

Yeast malt Broth (Himedia M426)

Peptic digest of animal tissue	5.0 gm.
Malt extract	3.0 gm.
Yeast extract	3.0 gm.
Dextrose	10.0 gm.
D/w	1 ltr.

A total of 21.0 grams of medium (M426) was suspended in 1000 ml distilled water and autoclaved for 15 minutes at 15 lbs pressure (121°C).

Sabouraud Dextrose Broth (Himedia M033)

Dextrose	20.0 gm.
Special peptone	10.0 gm.
D/w	1 ltr.
Final pH (at 25°C)	5.6 ± 0.2

A total of 30.0 grams of medium (M033) was suspended in 1000 ml distilled water and autoclaved for 15 minutes at 15 lbs pressure (121 °C).

Microorganism

From IMTech Chandigarh and kept for a long time, according to IMTech Chandigarh's instructions.

Pseudomonas aeruginosa	(MTCC No. 1680)
Klebsiella pneumoniae	(MTCC No. 109)
Aspergillus niger	(MTCC No. 1344)
Staphylococcus aureus	(MTCC No. 737)
Aspergillus flavus	(MTCC No. 871)
Escherichia coli	(MTCC No. 1687)
Candida albicans	(MTCC No. 227)

Co(II) complex of Potassium Propan-1,3-Diol Di Xanthate (PPDDX)

Disc-diffusion method

Vincet and Vincent used this approach in 1944. The organism (inoculum) was generated after culturing the organism by transferring a loop full of the relevant organism from the

stock culture into the sterile broth (at the same temperature and incubation period). The organisms were transferred using a 5 ml sterile broth loop. The microbial cultures were incubated according to the instructions below.

Fungus	26 °C for 72 hours
Bacterial	37 °C for 24 hours
Yeast like	26° C for 24 hours
C. albicans	

20 ml sterilized base agar was transferred directly to sterile Petri dishes and allowed to set equally. After that, each petri dish received 0.2 ml of old broth (fresh 5 ml). The chemical samples (various concentrations) were thoroughly moistened on sterile filter paper discs (whatman 44, dia 6 mm) and placed on seeded agar plates.

After an appropriate incubation period for each microorganism, the compounds inhibitory action was observed against the tested organisms. With the help of the disorder, the diameter of the zone of inhibition (mm) was measured accurately to the closest mm.

Tube dilution method for minimum inhibitory concentration (MIC) estimation.

To determine the MIC of the drugs against microorganisms, tube dilution method was used.

In vitro antibacterial testing:

On nutritional agar slant, the test bacteria *E. coli*, *S. aureus*, *Kb. pneumoniae*, and *P. aeruginosa* were kept. (Himedia M001).

After inoculation with a loop full of culture from the slants, nutrient broth (M002, Himedia) was used to investigate antibacterial activity of compounds. The broths were cultured at 37°C ± 1°C for 24 hours. 0.25 ml of 24 hour broth culture was seeded into a new 20 ml media. After dissolving the compounds in dimethyl sulphoxide (DMSO) to produce a 200 mg/ml stock solution, the first dilution was made by mixing 0.2 ml of the test material solution with 1.8 ml of seeded broth.

To make the second dilution, 1 ml of this has been diluted with 1 ml of seeded broth. As a control, a set of tubes containing mainly seeded broths was retained and a suitable solvent (DMSO) was used.

Result and Discussion

Co(II)-PPDDX complex antimicrobial and antifungal activity

At various concentrations, the Co(II)-PPDDX complex had less effect on bacterial radial growth. At 600 ppm, the Co(II)-PPDDX complex inhibited the growth of *S. aureus* (11.0 mm) and *P. aeruginosa* (10.1 mm) but *E.coli* and *Kb. Pneumoniae* are remain unaffected. Co(II)-PPDDX complex does not demonstrate increased toxicity at higher concentrations. The development of various bacteria was reduced at higher concentrations of Co(II)-PPDDX complex at 1000 ppm against *E. coli* (11.0 mm), *P. Aeruginosa* (13.0 mm), *S. aureus* (14.0 mm) and *Kb. pneumoniae* (11.0 mm) by disc diffusion method. At 600 ppm Co(II)-PPDDX complex exhibited good efficacy *against A. Flavus*, *A. Niger* and *Candida albicans*. The disc diffusion method revealed a zone of inhibition of more than 20.0 mm at 1000 ppm concentration of Co(II)-PPDDX complex.

Table 1: Effect of Co(II)-PPDDX complex on radial growth of various bacteria done by disc diffusion method.

Co(II)-PPDDX complex	**Zone of inhibition (mm)**			
Concentration (ppm)	***E. Coli***	***P. Aeruginosa***	***S. Aureus***	***Kb. Pneumoniae***
600	0.0	10.1	11.0	0.0
800	9.0	11.0	13.0	9.5
1000	11.0	13.0	14.0	11.0

Disc diameter = 6 mm

Table 2: Effect of Co(II)-PPDDX complex on radial growth of various fungi done by disc diffusion method.

Co(II)-PPDDX complex	**Zone of inhibition (mm)**		
Concentration (ppm)	***Aspergillus flavus***	***Aspergillus niger***	***Candida albicans***
600	11.0	11.0	16.0
800	17.0	16.0	21.0
1000	24.0	21.0	26.0

Disc diameter = 6 mm

Table 3: Minimum inhibitory concentration of complex of Fe(III) on growth of some fungi and bacteria by tube dilution method.

Organisms	***Escherichia coli***	***Staphylococcus aureus***	***Pseudomanas aeruginosa***	***Klebsiella pneumoniae***	***Aspergillus flavus***	***Aspergillus niger***	***Candida albicans***
MIC (mg/ml)	21.0	21.0	21.0	21.0	3.5	3.5	3.5

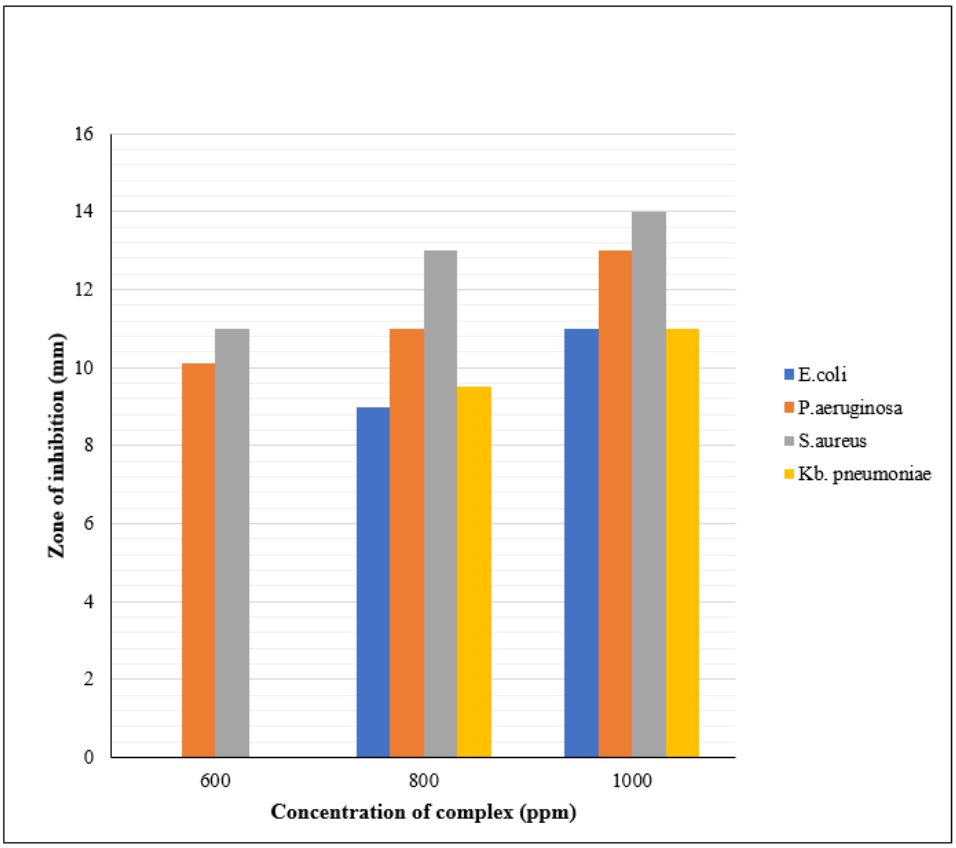

Fig 1: Effect of Co(II)-PPDDX complex on radial growth of various bacteria done by disc diffusion method.

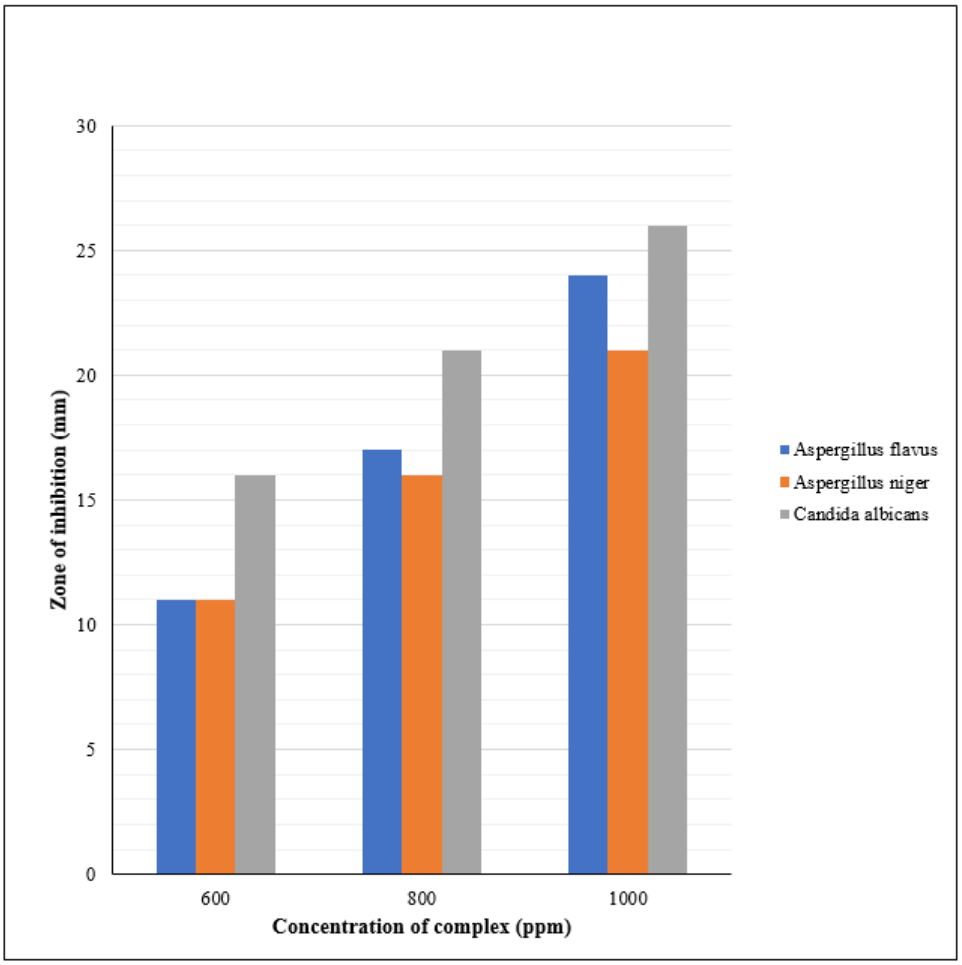

Fig 2: Effect of Co(II)-PPDDX complex on radial growth of various fungi done by disc diffusion method.

Conclusion

The study examines the complex Co(II)-Potassium Propan-1,3-Diol Di Xanthate's (PPDDX) antibacterial and antifungal activities. The complex is tested for four different forms of bacteria and three different types of fungi. The antifungal activities are shown to be more efficacious than the antibacterial activities at all the concentration of Co(II)-PPDDX complex.

References

1. Christen Y. Oxidative stress and Alzheimer disease. The American Journal of Clinical Nutrition. 2000 Feb 1;71(2):621-629.
2. Weder JE, Dillon CT, Hambley TW, Kennedy BJ, Lay PA, Biffin JR, *et al*. Copper Complexes of Non-Steroidal Anti-Inflammatory Drugs: An Opportunity Yet to Be Realized. Coordination Chemistry Reviews. 2002 Oct 1;232(1-2):95-126.
3. Qadir A. Synthesis, characterization and antibacterial activities of two nickel(II) complexes with xanthate derivatives and N,N,N′,N′-tetramethylethylenediamine as ligands. Transition Metal Chemistry. 2017 Feb;42(1):1-5.
4. Zhenxiang Li, Xiao L, Zhang J, Wang X, Zhonghui J, Weifang Z, *et al*. Kit formulation for preparation and biological evaluation of a novel 99mTc-oxo complex with metronidazole xanthate for imaging tumor hypoxia, Nuclear Medicine and Biology. 2016 Feb 1;43(2):165-170.
5. Torshizi HM, Jahromi SZ, Saeidifar M, Ghasemi A, Ghaemi H, Heydari A. Synthesis, Characterization and in Vitro Antimicrobial Screening of the Xanthate Derivatives and their Iron(II) Complexes. 2017 Oct 1;36(5):43-54.
6. Yanev S, Stoyanova T, Valcheva V, Montellano PO. Xanthates: Metabolism by Flavoprotein-Containing Monooxygenases and Antimycobacterial Activity. Drug Metabolism and Disposition. 2018;46(8):1091-1095.
7. Nagaraj R, Murugesan S, Jeyaraj DR, Arumugam S, Shunmugasundaram G, Radhakrishnan NA. Spectroscopic studies on DNA interaction and anticancer activities of pharmacologically active pyrimidine derivative mixed ligand Co(II) and Ni(II) complexes. Journal of Molecular Structure. 2022 Mar 15;1252:132079.
8. Pan YQ, Zhang Y, Yu M, Zhang Y, Wang L. Newly synthesized homomultinuclear Co(II) and Cu(II) bissalamo-like complexes: Structural characterizations, Hirshfeld analyses, fluorescence and antibacterial properties. Applied Organometallic Chemistry. 2020 Mar;34(3):e5441.
9. Gammal OA, Mohamed FS, Rezk GN, Bindary AA. Structural characterization and biological activity of a new metal complexes based of Schiff base. Journal of Molecular Liquids. 2021 May 15;330:115522.
10. Muthuppalani M, Otaibi AA, Balasubramaniyan S, Manikandan S, Manimaran P, Mathubala G, *et al*. Synthesis, Characterization and Bio-Potential Activities of Co(II) and Ni(II) Complexes with O and N Donor Mixed Ligands. Crystals. 2022 Feb 26;12(3):326.
11. King AP, Gellineau HA, MacMillan SN, Wilson JJ. Physical properties, ligand substitution reactions, and biological activity of Co(III)-Schiff base complexes. Dalton Trans. 2019;48(18):5987-6002.
12. Ahmed S, Yadav JNS. Infectious mercury resistance and co-transfer R-plasmid among *E. coli* strain. Indian J Exp. Biot. 1988;26(1):601-605.
13. Balapure A, Mude H, Tata P, Dutta JR, Ganesan R. Sublimable xanthate-mediated solid-state synthesis of highly interspersed g-C_3N_4/Ag_2S nanocomposites exhibiting efficient bactericidal effects both under dark and light conditions. J of Environ. Chemical Eng. 2021;9(5):106065.
14. Khalil AT, Khan MD, Razzaque S. Single precursor-based synthesis of transition metal sulfide nanoparticles and evaluation of their antimicrobial, antioxidant and cytotoxic potentials. Appl Nanosci. 2021 Sep;11(9):2489-2502.