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SYNTHESIS, SPECTRAL, *IN-VITRO* ANTIOXIDANT AND BIOLOGICAL ACTIVITIES OF NEWLY SYNTHESIZED Cr(III) AND Mn(II) COMPLEXES OF BIDENTATE SCHIFF BASE BY GREEN ROUTE METHOD

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ABSTRACT

First row transition metal complexes of Cr(III) & Mn(II) with bidentate schiff base have been synthesized and characterized by spectral, analytical and biological characterization. Molecular formula and metal ligand ratio of metal complexes illustrated by analytical data (elemental analysis and metal estimation), the binuclear and octahedral geometry around the Cr(III) and Mn(II) ions were predict base on the results of magnetic moment and ultraviolet visible spectral method. Based on the results of stretching frequencies of functional group present in the metal chelates were confirmed by IR and Far-IR spectral studies. *In-vitro* biological activities of schiff base and its metal complexes were predicted and compared with the standards (bacterial and fungal) using the strain *viz., E.coli* & *A. niger*. The complexes show enhanced bio-potential activities than the schiff base. *In-vitro* antioxidant activity of Cr(III) and Mn(II) complexes was carried out free radical DPPH scavenging method. The IC50 values show the complexes are higher antioxidant activities.

Keywords: schiff base, spectral studies, octahedral, Bio-potential activity, scavenging activity, Antioxidant

INTRODUCTION

Schiff base is an organic ligand having good binding nature and geometry. The metal complexes of schiff bases are important in the biological, medicinal and bio-inorganic chemistry. Isoniazid was the bio active compound having primary, secondary amino and ketone group which were effect to the biological activities such as tuberculosis, antibacterial, antioxidant, anti-inflammatory and anticarcinogenic effect **[1-2]**. Schiff base also used effectively in organic synthesis, pigment, dyes and polymer stabilizers. They are also have variety of biological activities such as antidiabetic, antimalarial, anti-inflammatory, antibacterial, antiasthamatic, ect., **[3]** schiff base also possesses structural similarities with naturally occurring biological compounds which were synthetically flexible, selective and sensitive for the metal ions because they have azomethine group **[4-5]**. Oxygen, nitrogen, sulphur are the donor site in schiff base chelation of synthesized metal complexes have bio-potential activities **[6-7]**. Due to the lot interesting future in schiff base to the coordination chemistry, in the present work elaborately discussed the synthesis of Chromium & Manganese complexes with schiff base under green route synthetic method using water as green solvent and characterized based on the analytical spectral and biological methods.

EXPERIMENTALS

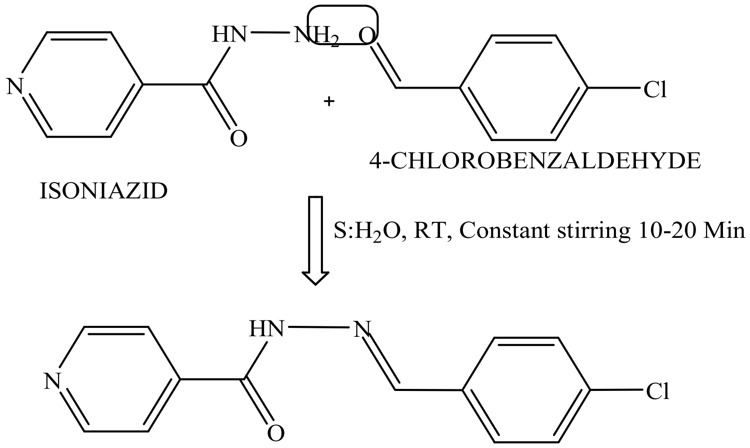
Materials: metal salts and ligands: chromium nitrate, manganese nitrate, Isoniazid and 4-cholorobenz-aldehyde was purchased from Alfa Aesar Company, solvents and reagents were of AnalaR grade (99% pure) used as such without further purification.

Synthesis of schiff base: The schiff base were synthesized by the addition of Isoniazid 0.528g in 10 ml water: methanol (1:1) and 0.541 g of 4-cholorobenzaldehyde in 5 ml of ethanol and add 15 ml water as green solvent and the mixture was stirred on 15-20 min at room temperature the precipitated white powder washed with water and dried in a desicator.

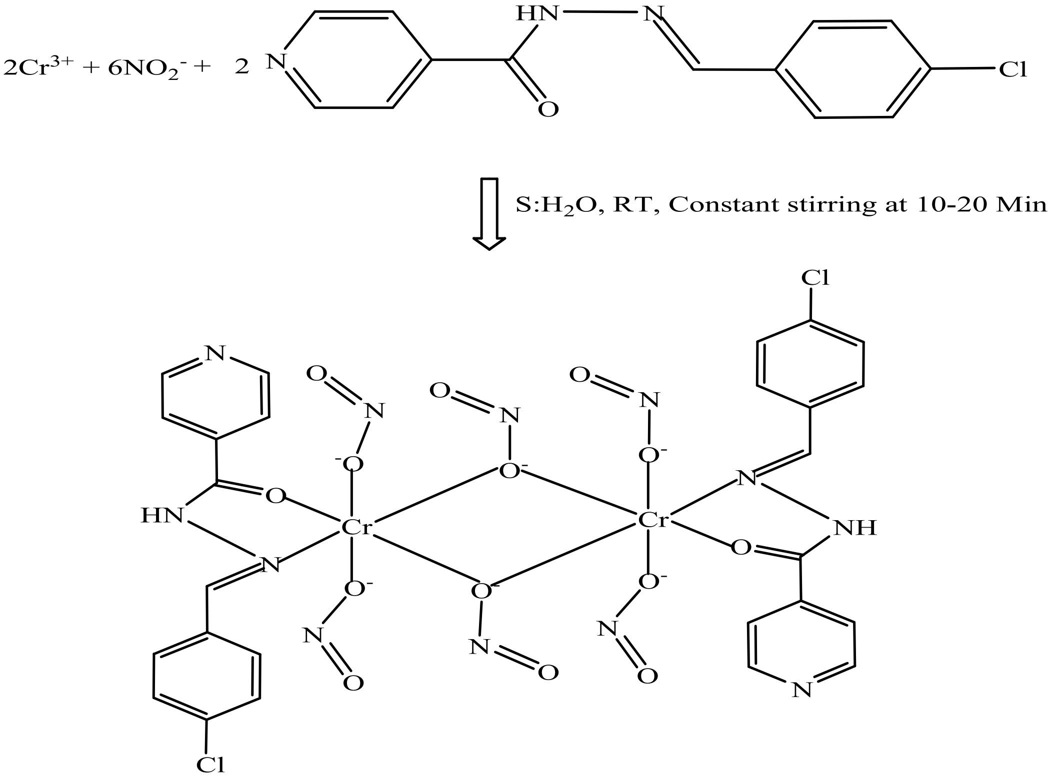
Synthesis of Cr(III) complex: The binuclear Cr(III) complex were prepared by mixing schiff base 1.298g 20 ml of methanol and sodium nitrite 1.034 g in 20 ml water to 1 g of chromiumnitrite in 15 ml of methanol and 10 ml of water added to the mixture used as a green solvent, the mixture was stirred at 15-20 mins at room temperature, the precipitated green color complex was filtered, washed with ethanol and dried in a desicator and kept in an air-tight glass container. The complex is stable under ordinary conditions.

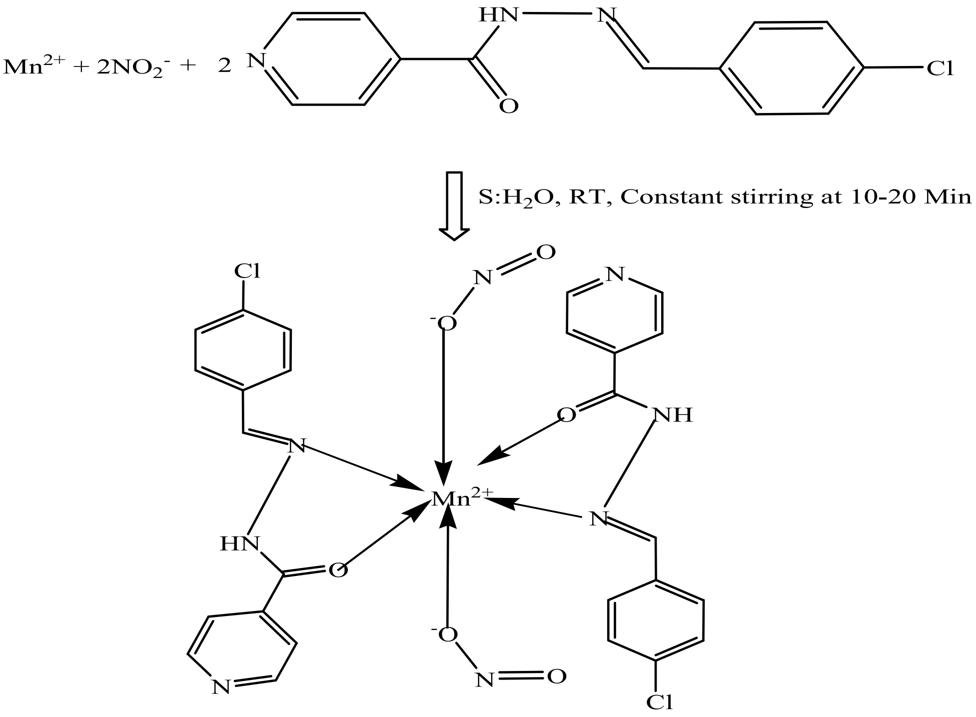
Synthesis of Mn(II) complex: The Mn(III) complex were prepared by mixing schiff base 2.069g 20 ml of methanol and sodium nitrite 0.549 g in 10 ml water to 1 g of manganese nitrate in 15 ml of methanol and 10 ml of water added to the mixture used as a green solvent, the mixture was stirred at 15-20 mins at room temperature, the precipitated colorless complex was filtered, washed with ethanol and dried in a desicator and kept in an air-tight glass container. The complex is stable under ordinary conditions.

Methods: Using elemental Vario make EL-III model instrument elemental analysis was carried out at 950-1200°C temperature. The metal ions were estimated volumetric method. Molar conductivity of metal complexes in acetonitrile solution was measured using Systronic Conductivity Bridge at 10^{-3}M concentration. The magnetic moment of Cr(III) and Mn(II) complexes were measured using a Lake Shore 7410 Vibrating Sample Magnetometer (VSM) at room temperature. The solid state diffused reflectance spectral (DRS) methods of electronic spectra of the complexes were recorded by using Varian make, CARY-5000 model, UV-VIS-NIR Spectrophotometer. Using Schimadzu, FT-IR, 8400 S Model IR spectrometer, IR spectra of schiff and synthesized complexes were recorded. The Far IR spectra of the complex were recorded in a Bruker, Germany make, 3000 Hyperion Microscope with Vertex 80 FTIR system model instruments.



(*E*)-*N*'-(4-chlorobenzylidene)isonicotinohydrazide


2Cr3+ + 6NO2- + 2
HN
N
N
O
Cl
S:H2O, RT, Constant stirring at 10-20 Min
Cr
Cr
O-
NH
HN


Mn2+ + 2NO2- + 2
HN
N
N
O
Cl
S:H2O, RT, Constant stirring at 10-20 Min
Mn2+
-O
NH
HN

RESULTS AND DISCUSSION

The synthesized complexes are stable; they are colored, soluble in organic solvent but insoluble in water. The stability was predicted by its melting point. The molecular weight and molecular formulae of schiff base and its complexes were illustrated by the micro analytical data. The low molar conductivity of metal complexes in DMSO are confirmed by its non-electrolytic, neutral nature **[8] (Table 1)**.

Electronic spectra: The schiff base shows strong band at 32,258 cm^{-1}, 39,206 cm^{-1} are assigned from $n\rightarrow\pi^*$ and $\pi\rightarrow\pi^*$ transitions. The transitions were experimentally confirmed by the presence of azomethine C=N and C=O chromophore in the schiff base. The electronic absorption spectra of Cr(III) complex exhibit three bands at 19,880 cm^{-1}, 25,773 cm^{-1} and 40,816 cm^{-1} corresponds to ${}^4A_{2g}\rightarrow{}^4T_{2g,}$ ${}^4A_{2g}\rightarrow{}^4T_{1g}$ (F) and ${}^4A_{2g}\rightarrow{}^4T_{1g}$(P) transitions. These assignments are confirming the octahedral geometry around Cr(III) metal ion which is further supported by the magnetic moment of 3.82 BM **[9]**. The Mn(II) complex shows two absorption band at 32,362 cm^{-1} and 39,062 cm^{-1} corresponds to the ${}^6A_{1g}\rightarrow{}^4E_g$ (G), ${}^6A_{1g}\rightarrow{}^4E_g$ (D) with the energy of 10B+5C and 17B+5C respectively indicating the octahedral geometry around the metal ion and further confirmed by the magnetic moment at 5.10 BM **[10]**.

IR and Far-IR spectra: The stretching frequencies of schiff base from IR spectra shows bands at 3456 cm^{-1}, 1667 cm^{-1} and 1592 cm^{-1} corresponds to the ν(N-H), ν(N=CH) and ν(C=O) groups respectively present in the schiff base, these are shifted to higher frequencies in the complexes after coordination of to the metal ions through nitrogen and oxygen atoms of imine & carbonyl group *via.,* bidentate mode. The pyridine ring shows two stretching frequencies of C-N group by symmetric and asymmetric at 1552 cm^{-1} and 1357 cm^{-1} on complexation these are shifted to higher frequencies **[11-12]**. Two aromatic rings in the schiff base at 2854 cm^{-1} & 3016 cm^{-1} of Isoniazid and 4-chlorobenzaldehyde which are also shifted to lower/higher frequencies upon coordination of metal chelates. The anionic mixed ligand nitrite ion gives frequencies at lower region 1400 cm^{-1}, 1250-1320 cm^{-1} and 1050-1090 cm^{-1} attributed to the symmetric O-N=O, asymmetric O-N=O and N-O respectively in which the symmetric stretching frequency changed very little upon coordination while asymmetric very large **[13]**. The schiff base coordinate to the metal ion through nitrogen atom of imine and oxygen atom of ketone by M-N & M-O stretching mode confirm by the stretching frequency at 516 cm^{-1} & 493 cm^{-1} in Cr(III) and 515cm^{-1} & 492 cm^{-1} in Mn(II) complex. The additional anionic ambidentate nitrite ion (ligand-2) can also coordinate to the metal ion through its oxygen atom by M-O mode was confirm by the frequency at 363 cm^{-1} and 365 cm^{-1} for both complexes respectively indicating the metal chelates group and also confirm the complexing ability of schiff base to the metal complexes **[14] (Table 2, Figure 1, 2)**.

Bio-potential activities: Antibiogram of synthetic compounds was done by disc diffusion method. Petri plates were prepared by pouring 30 ml of nutrient agar (NA)/potatoes dextrose agar (PDA) medium. The test organism was poured on solidified agar plate with the help of micropipette and dry for 10 min. The surfaces of media were inoculated with bacteria/fungi from a broth culture. A sterile cotton swab is dipped into a standardized microbes test suspension and used to evenly inoculate the entire surface of the Nutrient agar /PDA plates. Using sterile forceps, the sterile filter papers (6 mm diameter) containing each 100µl of sample and 100µl Standard solution were laid down on the surface of inoculated agar plate. The plates were incubated at 37 ºC for 24 hour for the bacteria and 48 hours for fungal strain. Each sample was tested in triplicates. The zones of inhibition of the tested microorganisms by the samples were measured using a millimeter scale. Metal complexes show enhanced biological activities due to its chelates nature, polar and non-polar nature. The cell permeation is also penetrate the metal complexes into cells and the chelation enhances the lipophilicity which favor the biological activities due to conjugation of π electrons delocalization of whole chelates rings **[15-16] (Figure 3)**.

In-vitro Antioxidant activity: The amount of sample needed to inhibit free radicals concentration by 50%, IC_{50}, was graphically determined by a linear regression method using Ms-Windows based graph pad Instat (version-3) software. Results were expressed as graphically/ mean ± standard deviation. The antioxidant activity of schiff base and its Cr(III) and Mn(II) complexes compared with standard ascorbic acid the results indicating that the metal complexes shows enhances activity against free radical scavenging activity the IC50 values of schiff base is higher than that of standard and metal complexes. The %cell death is 83% and 84% for metal complexes which is also higher than that of schiff base confirmed its potential antioxidant activities **[17-18] (Table 3, Figure 4-6)**.

Table 1: Micro analysis and conductivity of schiff base metal complexes

S. No.	Compound	MW (g/mol)	MP (°C)	Elemental analysis						Molar conductance (Ohm^{-1}cm^{2}mol^{-1})
				%C	%H	%N	%O	%Cl	%M	
1	Schiff base	259.70	180-185	60.06 (48.01)	3.85 (3.90)	16.17 (16.10)	6.16 (6.10)	13.47 (13.19)	-	20.00
2	$[Cr_2(SB)_2(NO_2)_6]$	899.48	190	34.68 (34.01)	2.22 (2.90)	18.67 (18.10)	24.90 (24.80)	07.78 (07.80)	11.56 (11.10)	24.00
3	$[Mn(SB)_2(NO_2)_2$	666.38	195	46.82 (46.90)	3.00 (3.60)	16.80 (16.60)	14.40 (14.90)	10.50 (10.90)	08.24 (08.40)	12.00

Table 2: IR stretching frequencies of schiff base and metal complexes (cm^{-1})

S. No.	Compound	ν(C=O)	ν (H-C=N)	Sy(C=N)	Asy(C=N)	Sy (O-N=O)	Asy (O-N=O)	ν (N-O)
1	Schiff base	3456	1667	1552	1357	-	-	-
2	Cr(III) complex	3457	1669	1551	1364	1402	1300	1086
3	Mn(II) complex	3458	1668	1553	1368	1406	1301	1083

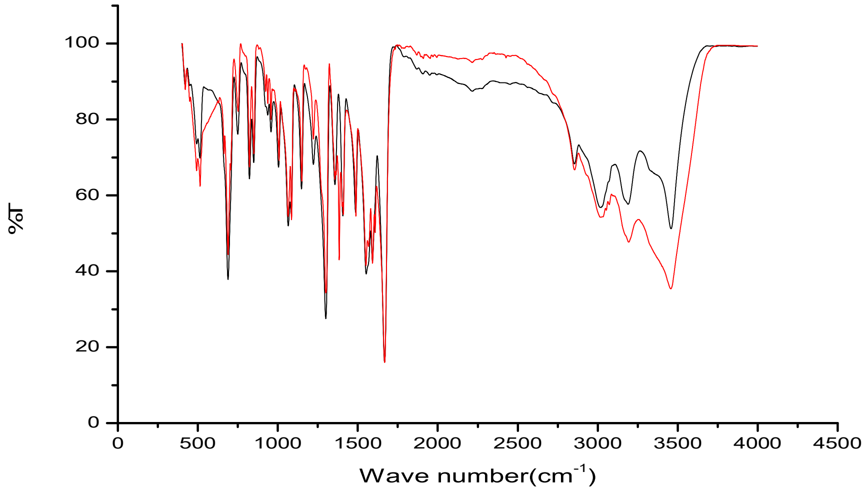


Figure 1: IR spectra of schiff base and binuclear Cr(III) complex

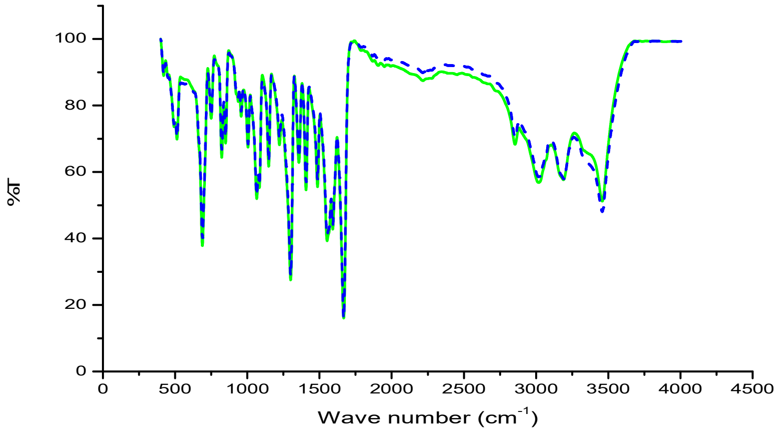


Figure 2: IR spectra of schiff base and mononuclear Mn(II) complex

Table 3: Antioxidant activity and IC50 values of schiff base and its complexes

Compound	% of inhibitions				IC_{50} value (µg/ml)
	20 (µg/ml)	40 (µg/ml)	60 (µg/ml)	80 (µg/ml)	
Schiff base	**19.54±1.36**	**40.90±2.86**	**65.01±4.55**	**82.72±5.79**	**48.08**
Cr(III) complex	**20.91±1.46**	**45.90±3.21**	**72.73±5.09**	**83.18±5.82**	**44.68**
Mn(II) complex	**23.18±1.62**	**47.72±3.34**	**74.09±5.18**	**84.01±5.88**	**43.05**
Std. (Ascorbic acid)	**25.45±1.78**	**49.54±3.46**	**77.73±5.44**	**95.45±6.68**	**39.88**

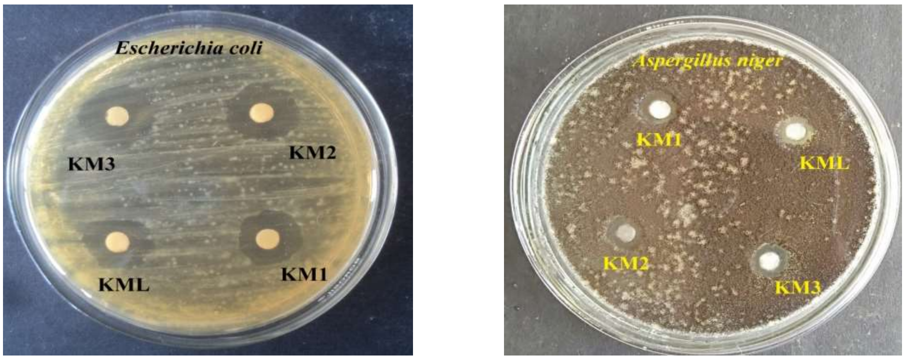


Figure 3: Bio-potential activities of schiff base and complexes

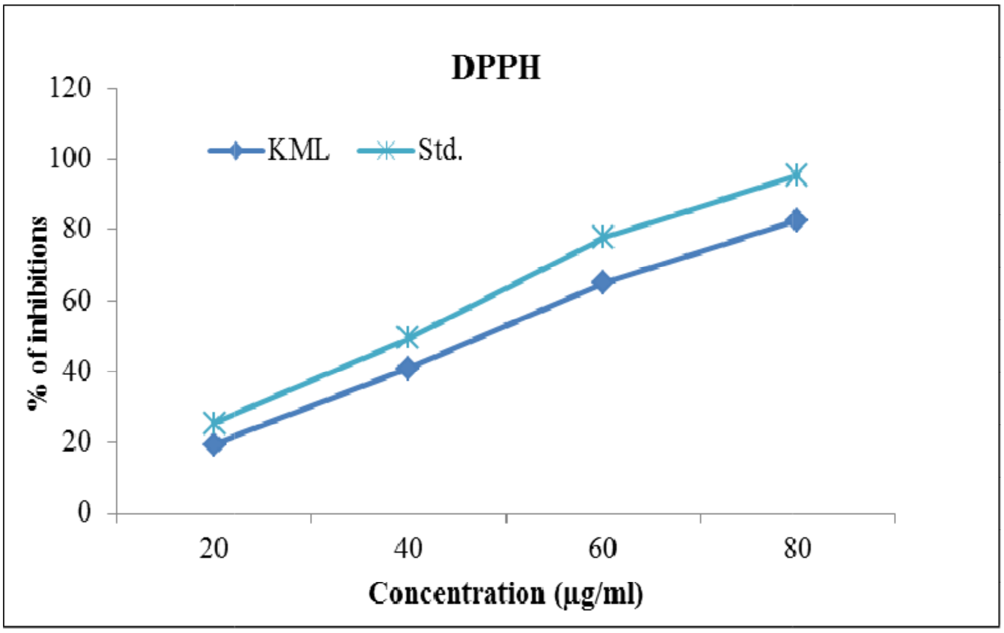


Figure 4: DPPH activity of schiff base and Standard

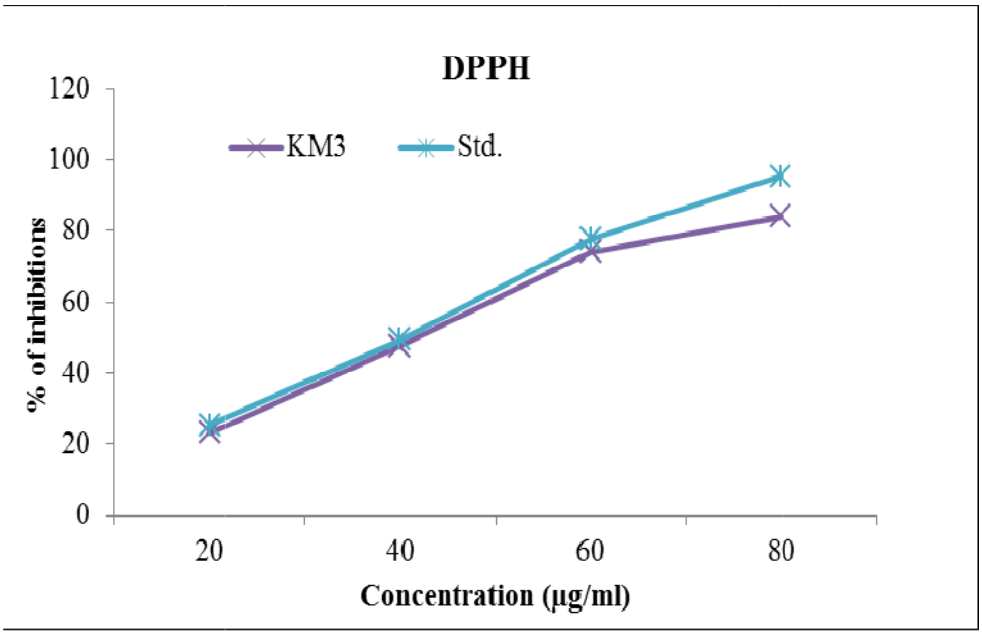


Figure 5: DPPH activity of Cr(III) complex and Standard

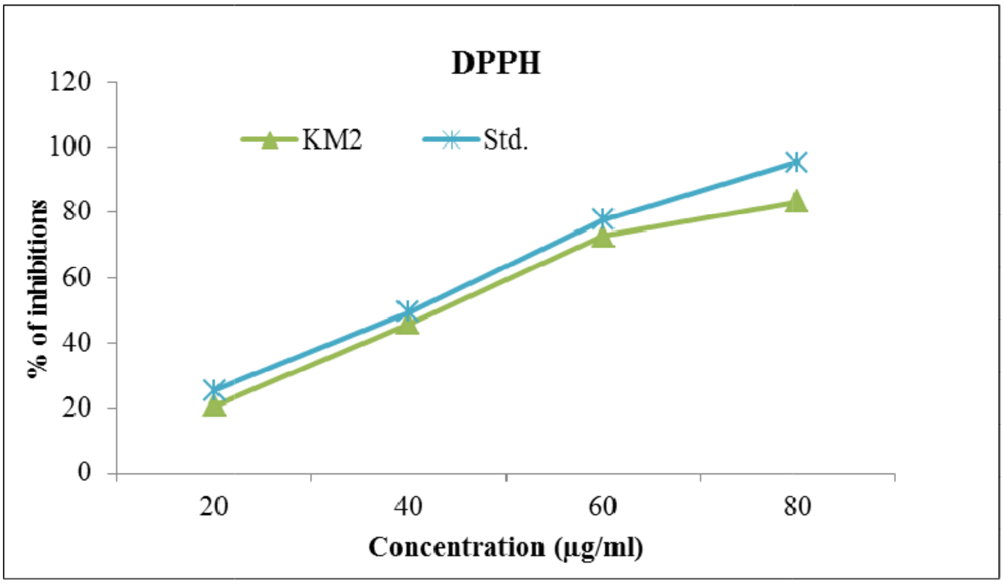


Figure 6: DPPH activity of KM3 sample and Standard

CONCLUSION

The present study conclude the green route synthesis and physico-chemical biological characterization of Cr(III) and Mn(II) complexes of bidentate schiff base (E)-N-(4-chlorobenzylidene) isonicotinohydrazide) derived from bio active Isoniazid and 4-chlorobenzaldehyde. Binuclear bridged octahedral Cr(III) complex and mononuclear octahedral Mn(II) complexes confirmed by the UV-visible, IR and Far-IR spectral data. The complexes are non-electrolyte and they are stable under ordinary condition. All the complexes are biologically active against tested microorganisms and they shows antioxidant activity by DPPH free radical scavenging method.

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