Antimicrobial, Thermoanalytical and Viscometric Studies of Metal Based Schiff Base Polymer

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Summary: This study examines the synthesis, characterization, viscosity, thermal behavior and antimicrobial studies of copper(II) and nickel(II), complexes of a synthesized monomer 5,5-methylene bis(2'-pyridinecarboxaldehyde) (MBPC) and a Schiff base polymer poly-5,5-methylene bis (2-pyridinecarboxaldehyde) 1,3-propylenedimine (PMBPCPR). The monomer, polymeric ligand and poly metal complexes (PMBPCPRCu) and (PMBPCPRNi) were characterized by C.H.N analysis, FT-IR, UV –Vis spectroscopy, viscometery thermogravimetric (TGA) and differential thermogravimetry (DTA). The monomer MBPC was prepared by the reaction of 2-pyridinecarboxaldehyde with 1, 3, 5-trioxane in the presence of acetic acid and sulphuric acid. The polymeric ligand was prepared by polycondensation of monomer with 1,3-propylenediamine.The biological studies of compounds revealed that they possessed significant antibacterial and antifungal properties, against *Micrococcus flavus, Staphylococcus aureus, Bacillus Cirroflgellosus, Shigella flexneri, Escherichia Coli, Candida albicans, Aspergillus flavus,* and *A. Niger.*

Keywords: antimicrobial, viscosity, Schiff base, PMBPCPR, TGA.

Introduction

Distinct and evident attention had been engrossed on Schiff base polymers, due to their vast applications in many arenas especially in their biological features [1]. In recent years, the thermo analytical properties of Schiff base polymers have been enhanced after coordinating with a metal into polymeric backbone [2]. These polymers have attracted the attention of researchers towards their theoretical aspects and for their novel topologies and their vast applications in the fields of organic synthesis [3], waste water treatment, [4] hydrometallurgy, [5] and as biocidals. Several studies [6–11] have exposed a relationship between the metal ions and their metal complexes as antitumor [12–14] and antimicrobial mediators'. Schiff base metal complexes have been given excessive prominence, due to their vast applications in the fields of industrial and biological sciences, including in synthesis of drugs. The conjugated bonding and active hydroxyl groups in polymeric Schiff bases also have attracted attention of researchers worldwide due to their varied applications [15]. The polymeric metal complexes, possesses distinctive properties of sorption, for the recovery of trace metal elements and catalysis [16-19]. The present work examines the synthesis and characterization of the monomer, Schiff base polymer and its metal chelates by elemental analysis, FT-IR, UV-Vis, viscosity and thermo analytical studies. The work also examines antimicrobial characteristics of the polymer and its metal chelates.

Results and Discussion

The monomer, polymer and metal complexes were prepared following the synthetic procedures outlined in Scheme-1 (Fig 1). The monomer MBPC was synthesized according to the reported procedures for 5, 5'-methylene bis (salicylaldehyde) and 5, 5'-methylene bis (2-hydro-xyacetophenone) [21-23]. The polymer PMBPCPR was prepared by the polycondensation reaction between dialdehyde monomer MBPC and 1, 3-propylenediamine. The product was obtained in good yield. The polymetal chelates PMBPCPRCu and PMBPCPRNi were prepared by following the reported methods [24].

Elemental Microanalysis

The results of elemental micro-analysis for the compounds synthesized agreed with to the calculated values and supported the formation of the compound and also agreed with the structures assigned (Table-1).

Table-1: Analytical and physical data of monomer, Ligand and Polymer metal complex.

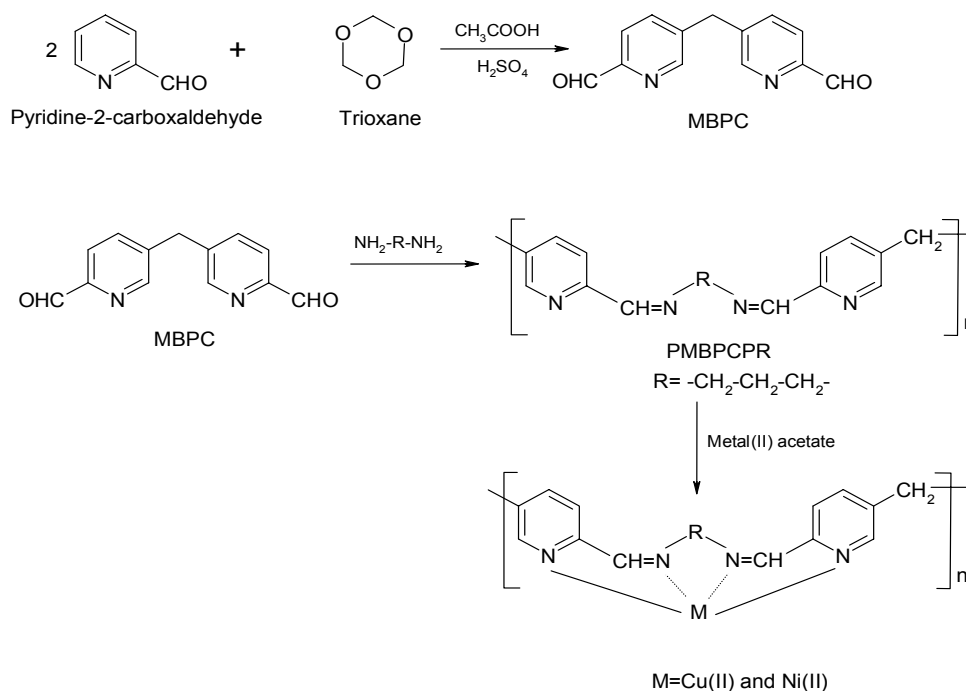| Compound	Yield (%)	Calculated (Found) %		
		C	H	N
MBPC	80	69.01(69.91)	4.45(3.84)	14.1 (13.2)
PMBPCPR	79	66.22(65.03)	5.23(4.77)	10.17(10.97)
PMBPCPRCu	81	58.61(59.00)	4.91(5.22)	17.08(16.30)
PMBPCPRNi	83	59.49(60.01)	4.99(5.00)	17.03(17.34)

Fig. 1:   Reaction scheme for the preparation of Polymetal complexes;PMBPCPRCu and PMBPCPRNi.

Table-2: Solubility [a,b] of monomer, ligands and Polymetal complexes in various solvents.

compound	Solubility in different solvents								
	H_2o	CH_3oH	C_2H_5OH	$CHCl_3$	Acetone	n-hexane	Ether	DMF	DMSO
MBPC	±	-	±	-	±	-	±	+	+
PMBPCPR	-	-	-	-	±	-	-	±	±
PMBPCPRCu	±	±	±	-	±	±	±	+	+
PMBPCPRNi	±	±	±	-	-	±	±	+	+

±partial soluble Insoluble
+ soluble

Solubility of Monomer, Ligand and Complexes

The monomer MBPC exhibits good solubility in polar aprotic solvents, dimethyl-formamide (DMF) and dimethylsulphoxide (DMSO). The polymer and its metal complexes, however showed poor solubility in most organic solvents, but were sufficiently soluble in DMF and DMSO to study their spectrophotometric characterizations (Table-2).

Vibrational Spectra

The FT-IR spectra of MBPC indicated strong bands at 1690 cm^{-1} and 1710 cm^{-1} due to ^{v}C=O stretching vibrations. The bands disappeared in Schiff base polymer PMBPCPR, while a new band at 1610 cm^{-1} corresponding to hydrogen bonded ^{v}(C=N) stretching vibration was observed,and differentiated the monomer from the polymer.. The monomer and polymer show varying bands of strong to medium intensity within 1460-1440 cm^{-1} and 1600-1500 cm^{-1} due to ^{v}(C=C) vibrations. Their nickel and copper poly chelates showed weak to medium intensity bands within 3100-2900 cm^{-1} due to ^{v}C-H aromatic and ^{v}C-H aliphatic stretching vibrations. A broad band at 3354cm^{-1} was observed in PMBPCPRNi due to adsorbed water molecule. The poly chelate PMBPCPRCu and PMBPCPRNi showed a sharp intense peaks at 1615 cm^{-1} and 1630 cm^{-1} due to ^{v}(C=N) azomethine stretch respectively in polymetal chelates with 5cm^{-1} to 20 cm^{-1} shift towards higher frequencies as compared to their respective ligand, attributing coordination of imine nitrogen to metal ions A number of bands of medium intensity were seen within 1520-1535cm^{-1} in PMBPCPRCu and PMBPCPRNi due to ^{v}(C=C) vibrations.

Electronic Spectra

The UV/Visible spectra of monomer, ligand and poly metal complexes were recorded in DMF (Table-3). The spectra were recorded in the range 190-700 nm. The monomer MBPC indicated three bands within 265-350 nm due to π - π* transition within pyridyl rings and conjugated C=O groups. The

synthesized ligand and poly metal complexes were calculated for 1% absorptivity. The Schiff base polymer PMBPCPR indicated absorption bands within 270-400 nm. The first and second bands for PMBPCPR appeared at 270 nm and 285 nm and third and fourth bands were at 343nm and 400nm.A bathochromic shift 5-7nm in the first, second and third absorption bands of the polymer PMBPCPR, as compared to the monomer MBPC was observed. The third band of polymer PMBPCPR at 343nm is the characteristic due to π- π^* transitions of azomethine group , its 1% absorptivity was (ε 1 % = 216 - 68 L g^{-1}cm^{-1}). The observation of the new absorption band in the Schiff base polymer, as compared to monomer may be due to conjugated (C=N) chromophore in the polymer due to polycondensation. The poly metal chelate PMBPCPRCu and PMBPCPRNi indicated absorption bands within 280-430 nm and 290-460nm with 1% absorptivity (ε 1 % = 134-55.7 L g^{-1}cm^{-1}), (ε 1 % =193.79 – 113.04 L g^{-1}cm^{-1})respectively due to π- π^* transitions in hetero aromatic rings and conjugated azomethine groups. A shift of 10-22 nm and 20-55nm in the absorption bands of polychelate as compared to the polymer, towards longer wavelengths is attributed to coordination with metal ion. The band observed in nickel chelate at 460 nm is assigned most to charge transfer band from the metal toward the ligand Fig. 2.

Table-3: Results of spectrophotometric studies in DMF as solvent.

Sr.No.	compound	λ nm	(ε L mol^{-1}cm^{-1})
1	MBPC	265	8596
		279	7918
		350	4524
		λnm (ε1%)	
2	PMBPCPR	270(216)	
		285(128)	
		343(80)	
		400(68)	
3	PMBPCPRCu	280(134)	
		283(180)	
		365(95)	
		430(55)	
4	PMBPCPRNi	290(193)	
		300(192)	
		398(159)	
		460(113)	

Thermal Analysis

Thermal analysis of monomer MBPC (Fig. 3a) indicated, initial weight loss of 2% between 50-100 °C due to loss of water in the sample. The material suffered rapid weight loss between 200 and 300^{0}Cwith rate of loss 0.6%/ °C at 295 °C (maximum rate of weight loss (T$_{max}$).The DTA of the monomer showed a sharp endotherm at 258 °C due to the melting of the monomer. The loss in weight for the polymer PMBPCPR started from 180 °C and loss of 18% occurred up to 485 °C. The DTA of polymer

PMBPCPR indicates two peaks first one is at 348°C and corresponds to melting of polymer, and second peak at 359°C due to decomposition of the compound. The TGA /DTA of PMBPCPRCu (Fig. 3b) indicated weight loss at 240 °C and initial weight loss of 34 % was observed up to 270 °C, followed by weight loss of 66 % up to 360°C due to the decomposition of poly metal chelate [25]. Between 340 and 420 °C the material suffered rapid weight loss with a loss rate 0.35% / °C at 400 °C, (T$_{max}$). A well-defined DTA curve at 390°C was observed due to the melting of poly metal chelate.
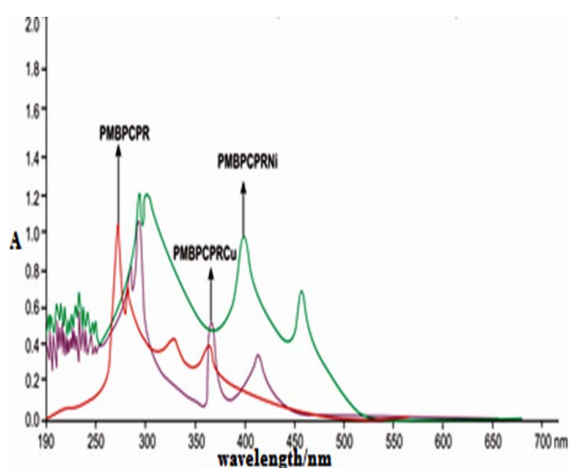

Fig 2: UV Visible spectrum of PMBPCPR, PMBPCPRCu (11) and PMBPCPRNi (11).

The TGA/DTA of PMBPCPRNi (Fig. 3c) indicated, 2 % weight loss up to 100^{0}C which was due to the loss of moisture followed by a weight loss of 26% up to 282 °C due to the decomposition. Between 300 and 360°C the material suffered rapid weight loss. The rate of loss was 0.5 % / °C at 330 °C, which is the temperature of maximum rate of weight loss (T$_{max}$). A well-defined DTA indicated endothermic at 390 °C may be due to melting of poly metal chelate. tThe Cu(II) and Ni(II) complexes exhibited enhancement in heat stability, as compared to polymeric ligand PMBPCPR.

Viscometric Analysis

The monomer MBPC indicated reduced viscosity (ηred) within 0.337-0.235 dl/g and (ηred) of polymeric ligand PMBPCPR was observed within 0.536-0.424dl/g and for PMBPCPRCu was within the range of 0.5291-0.4339 dl/g. The Ni (11) poly metal complex showed reduced viscosity 0.5207-0.4327 dl/g, and was higher than the parent monomer. The relationship between (η_{red}) and the concentration was

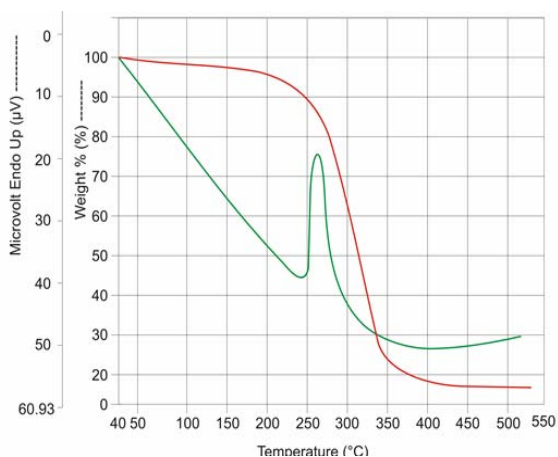linear, for monomer and polymer hence agreed with the Huggins equation.

Fig 3:   [a] TGA/DTA curves of MBPC.
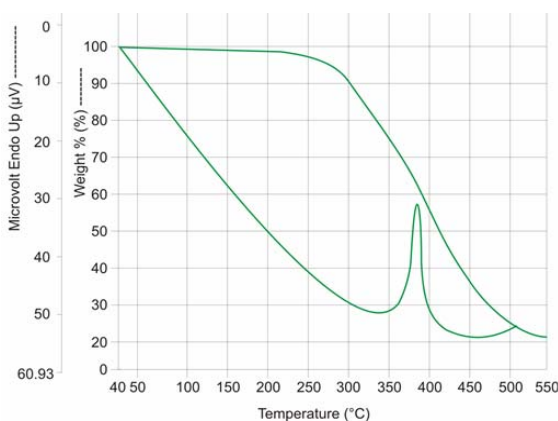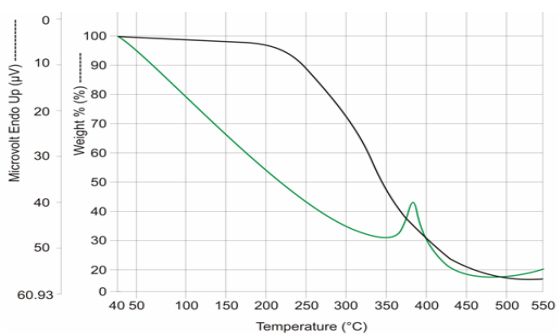

Fig. 3:   [b] TGA/DTA curves of PMBPCPRCu (11).

Fig. 3:   [c] TGA/DTA curves of PMBPCPRNi (11).

η $_{red}$ = [η] + K $_H$ [η] ^{2} C. The values of (η $_{red}$) increased with an increase in concentration, due to the rise of intermolecular forces of attraction between the molecules, and decreased with increase in temperature, due to the rise of vibrational frequency of molecules at higher temperatures. The

mobility of the molecules also increased with the increase in temperature, with the decrease of internal resistance to the flow, hence the viscosity decreased. The intrinsic viscosities for polymeric ligand and poly metal complexes, calculated from Huggins equation, describes that when a graph is plotted between reduced viscosity (η$_{red}$) and concentration (C), the intercept gives the intrinsic viscosity of the solution. The intrinsic viscosity increased with increase in molecular weight as shown in Table-4. The monomer indicated intrinsic viscosity within the range of 0.31–0.226 dl/g and for the polymeric ligand PMBPCPR was found to be within, 0.523-0.419 dl/g, higher than the parent monomer MBPC. The poly metal complex PMBPCPRCu showed the highest value of intrinsic viscosity 0.5324-0.4201 dl/g followed by PMBPCPRNi, 0.5243-0.4184 dl/g .This is in agreement with the fact that intrinsic viscosity depends upon the molecular weight of the compounds. [26]. The absolute viscosity (η $_{abs}$) for MBPC was in the range of 0.119–0.379 m N.S/m^2, for polymeric ligand PMBPCPR 0.275-0.526 m N.S/m^2, for PMBPCPRCu 0.609-0.383 m N.S/m^2 and for PMBPCPRNi 0.618-0.392 m.N.s/m^2 Fig. 4[a]. The values of η $_{abs}$ increased with concentration due to the rise in the density of solution and the possible formation of polymeric associates. As the temperature rose a sharp decrease in η abs was observed due to breaking up of the polymeric associations and increase in their mobility Fig. 4[b].The higher values of polymetal complexes as compared to polymeric ligands, may attribute to higher polymeric associations as a result of coordination.
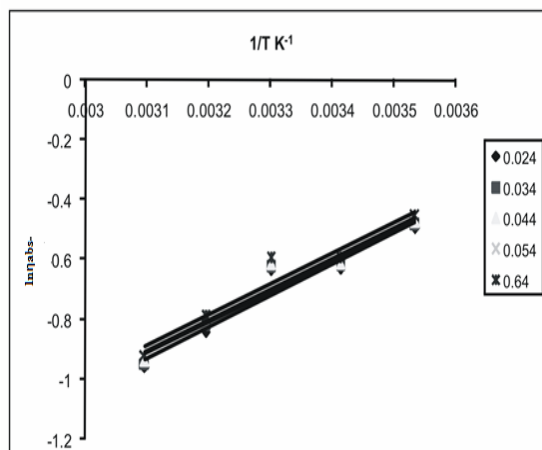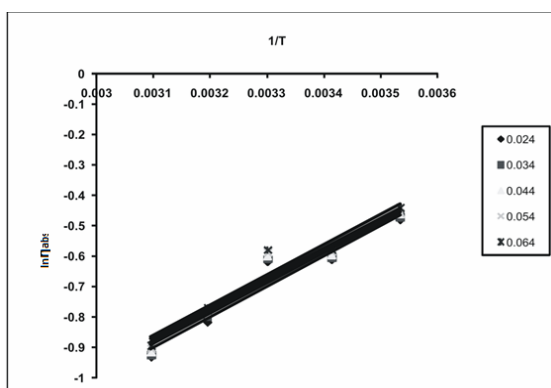

Fig 4:   [a] lnη vs 1/T of PMBPCPRCu (11).

Fig 4 [b]: lnη vs. 1/T of PMBPCPRNi (11).

Table-4: Intrinsic Viscosity values of monomer, Ligands and polymetal chelates (dl/g).

Compound	Temperature (K)				
	283	293	303	313	323
MBPC	0.3100	0.2900	0.2730	0.2440	0.2260
PMBPCPR	0.5233	0.4701	0.4701	0.4264	0.4188
PMBPCPRCu	0.5324	0.471	0.4511	0.4275	0.4201
PMBPCPRNi	0.5243	0.4699	0.4501	0.4272	0.4184

All thermodynamic parameters of polymeric ligand and poly metal complexes in dilute solutions of DMF were calculated. The values of ΔG_V for MBPC was 12.843 – 13.974 kj mol^{-1},and for polymeric ligand PMBPCPR 14.629 – 15.232 kJ mol^{-1}, for poly metal chelate PMBPCPRCu 15.090-16.085 kJ mol^{-1} and for PMBPCPRNi 15.125-16.146 kJ mol^{-1} calculated from the equation $\Delta G = 2.303 \ RT \ \log (\eta abs/10^{-3})$. The energy of activation increased with an increase in concentration and temperature in dilute solution. The increase of ΔGv with concentration indicates that in dilute solutions the associations are weaker and easily overcome during the flow while at higher concentrations the associations are stronger and little affected during the flow process, therefore ΔGv are high. The values of ΔGv also increase with molecular weight.

The polymer molecules have weaker associations in dilute solutions and provided less resistant to the flow process, while at higher concentrations the associations are stronger and little affected during the flow process [27, 28].

The increase of ΔG_V with rise in temperature indicated the shape conversion or transition of the polymer molecules during flow process. The values of ΔHv for MBPC were 11.917-11.811 KJ mol^{-1} higher than the ΔHv values for PMBPCPR, which were 10.838-10.943 KJ mol^{-1} and for poly metal complex PMBPCPRCu 8.5883-8.4919 KJ mol^{-1} and

for PMBPCPRNi 8.4237-8.3397 KJ mol^{-1} respectively. The lower values of ΔHv were observed for poly metal chelates as compared to polymeric ligand PMBPCPR, and monomer MBPC possibly, because of the increase in molecular weight in complex, since increase in molecular mass need more energy, to overcome the flow of polymeric solvents. The negative values of the compounds showed that the system is more ordered during the flow, the values of ΔSv for MBPC were -0.00286 – 00731 J/K, and for PMBPCPR were - 0.0130 – 0.0138 K.J.mol^{-1}. Whereas for poly metal complex PMBPCPRCu was - 0.022973-0.023507 K.J.mol^{-1} and for PMBPCPRNi - 0.023679-0.024167 K.J.mol^{-1}. The negative sign of ΔSv for ligands as well as for poly metal complexes showed that during the flow molecules were becoming extended due to uncoiling of the polymer molecules in the solutions. The entropy of monomer, polymer and polychelates showed that on increasing temperature the probability of randomness decreased, whereas chance of randomness increased in concentrations.

Biological Studies

The antibacterial and antifungal studies of polymeric ligand and its complexes were screened against *Micrococcus flavus* (G +ve), *Staphylococcuss aureus* (G +ve), *Bacillus cirroflgellosus*, *Shigella flexneri* (G+ve), *Escherichia coli* (G-ve) *Candida albicans* (G-ve), *Aspergillus flavus* (G-ve) and *A. Niger*, by using well diffusion method. Tetracycline (an antibacterial) and miconazole (antifungal) were used as standard drugs. Platinum wire loop was used to apply the strains. The cultures of all the samples were inoculated before pouring into the petri dishes. Wells with diameters of 24mm were dug in the media by using a germ-free or sterile cork borer. The concentrations suggested for making solutions of ligands and poly metal complexes was 1mgml^{-1} in DMF. The solutions of polymeric ligand and poly metal complexes were poured into the wells with the help of a micro pipette. The other wells were filled with DMF and reference antifungal and antibacterial drugs, serving as positive and negative controls respectively. The plates were incubated at once at 37°C for 24 h. Antifungal and antibacterial activities were observed by measuring the diameter of zones in millimeters, presenting complete inhibition. Tetracycline was used as standard drug for antibacterial activity and Miconazole was used for antifungal activity. The polymeric ligand PMBPCPR and their respective metal complexes showed individually the inhibitory effects against fungus and bacterial cultures. The polymeric ligands and complexes were screened against *M. flavus, S.*

aureus, B.cirroflgellosus, S.flexneri, E.coli for antibacterial studies and C. albicans, A. flavus and A. niger for antifungal studies. The results are summarized in Table-5 [A] and [B]. The results revealed that the synthesized polymeric ligand and its Cu (II) and Ni (II) complexes possessed remarkable biological activity. The polymeric ligand PMBPCPR exhibited (10,10,15,5,15mm),PMBPCPRCu(II) exhibited (24,15,20,15,24mm) zones of inhibition and the complex PMBPCPRNi exhibited (15,15,10,10,20mm) zones of inhibition against the reported bacteria. The complex PMBPCPRCu (II) exhibited the highest antibacterial activity against *M.flavus, S.aureus, B.cirroflgellosus, S.flexneri, E.coli.* The polymeric ligands and complexes exhibit zones of inhibition against C.albicans, A.flavus and Niger. The polymeric ligand PMBPCPR exhibited (10, 15,5mm), the PMBPCPRNi (II) complex exhibited (10, 15,15mm) whereas the (PMBPCPRCu (II) exhibited the highest antifungal activity (20, 24, 10 mm). All the synthesized metal complexes showed appreciable antimicrobial activity against all the microorganisms and their zones of inhibition are presented in Table-5 [A], [B]. An observable increase in antimicrobial activity of polymeric compounds was observed, when the polymer PMBPCPR was converted into Cu(II) and Ni(II) complexes [29].

Table-5: A: Antimicrobial activity of ligands and polymer metal complex (Antibacterial).

compound	Zone of inhibition(mm) $50\mu g/mL^{-1}$				
	M. Flavus	S. aureus	B. cirroflgellosus	S. flexneri	E. coli
PMB PCPR	+	+	++	-	++
PMBPCPRCu	++++	++	+++	++	++++
PMBPCPRNi	++	++	+	+	+++
Tetracycline[a]	-	+	-	+	++
Miconazole[b]	-	+	++	++	+++

[a] Standard drug +ve control   antibacterial activity
[b] standard drug –ve control antifungal activity

-	= inactive	5 mm
+	= weakly active	8 – 10 mm
++	= moderately active	11 – 15 mm
+++	= highly active	16 – 20 mm
++++	= most active	21 – 24 mm

Experimental

Synthesis of the Monomer, MBPC, the polymer PMBPCPR and of the Polymer metal complexesPMBPCPRCuand PMBPCPRNi is outlined inScheme-1

Pyridene-2-carboxaldehyde, (Fluka Switzerland) 1, 3-propylenediamine, (E. Merck, Germany), chloroform, n-hexane, dimethyl formamide (DMF). ethanol, (E-Merck, Germany), copper (II) acetate monohydrate [Cu (CH₃COO) ₂ H₂O] and nickel (II) acetate tetrahydrate [Ni (CH₃COO) ₂ 4H₂O] (E-Merck,Germany) were used.

The organisms *Micrococcus flavus, Staphylococcuss aureus, Bacillus cirroflgellosus, Shigella flexneri, Escherichia coli, Candida albicans, Aspergillus flavus,* and *A. Niger* were provided by Dr Mahesh Kumar, Eye Hospital Pathology laboratory, Hyderabad, and Institute of Microbiology University of Sindh, Jamshoro.

Synthesis of 5, 5'-methylene bis (2'-pyridine carboxaldehyde) (MBPC)

To the solution of 17.8 ml of 2-pyridinecarboxaldelyde in 12.5 ml of glacial acetic acid at 90-95 °C in nitrogen atmosphere was added 1.75 g of trioxane dissolved in a mixture of 0.13 ml of concentrated sulphuric acid and 0.63 ml of glacial acetic acid drop wise with constant stirring. The temperature was maintained for 22 h. The reaction mixture was then poured into 1L of ice water and allowed to stand overnight. The solid material formed was filtered and recrystallized from a mixture of chloroform and n-hexane. The product was filtered and dried in oven at the temperature 60-70 °C for 8-9 h. MP 257 °C, the % yield recorded was 90.

Preparation of Poly 5, 5-methylene bis (2-pyridinecarboxaldehyde)-1, 3-propylenediimine (PMBPCPR)

A mixture of 0.2 g of the monomer MBPC and 20 mL DMF was refluxed until most of the monomer.dissolved . The hot solution was filtered and 0.07 mL of 1,3-proplylenediamine dissolved in DMF 1 mL) was added to this solution. The resulting mixture was refluxed for 24 h and concentrated to half its .volume. Dark brown crystals were formed on concentration. The mixture was cooled and precipitate was filtered and washed with ether. The product was dried at 60 – 70 °C for 6 - 7 hrs. The product PMBPCPR has a melting points above 300 °C.

Synthesis of Copper (II) and Nickel (II) Complexes (PMBPCPRCu), (PMBPCPRNi)

Copper or Nickel were used to obtain the relevant polymer metal complex. For example.5 g of poly 5,5--methylene bis (2—pyridinecarboxalde-hyde)-1,3- diiminopropane in 20-25 mL DMF was refluxed with a solution of 0.5 g of nickel acetate in 20 mL of THF (0.4 g in 20 mL of THF for copper acetate)and 1 mL of acetic acid for 15 min. The mixture was allowed to cool at room temperature and was stirred continuously for six days, the precipitate formed were filtered and washed with water, ethanol, tetrahydrofuran and diethyl ether and dried overnight,

at room temperature at 0.01 mm pressure. The color of copper complexes was mustard brown and the color of nickel complexes were dark brown. The poly Schiff chelates decomposed above 355 ^{0}C, and showed poor solubility in most of the organic solvents

Measurements

The IR spectra were recorded on Nicolet Avatar 330 FT-IR (Thermo Nicolet Electron Corporation, USA) with attenuated total reflectance (ATR) accessory (smart partner) within 4000-600 cm^{-1}.The elemental .analysis of carbon, hydrogen and nitrogen was carried out by HEJ Research Institute of Chemistry; University.of Karachi, Pakistan .UV-Vis spectrophotometric studies were carried out in DMF on Perkin Elmer Lambda 35 .double beam spectrophotometer with dual quartz cells of 1cm path length, within 185-700 nm. The solubility of monomer, polymeric ligand and polychelates were tested in different organic solvents at room temperature. The thermo analytical studies of monomer, polymeric ligand and polychelates were recorded on Perkin Elmer Pyris Diamond TG/DTA thermal analyzer from room temperature to 600 °C with a nitrogen flow rate of 5 mL/min. A sample of 2 mg was placed in a platinum crucible and recorded at heating rate of 1020°C/min against alumina as reference. The ^{1}H-NMR of, polymeric ligand was recorded on a Bruker ACF 11.300 MHz NMR spectrometer using dimethylformamide (DMF) as solvent and tetramethylsilane (TMS) as an internal reference, from HEJ Research Institute of Chemistry University of Karachi

The viscometric analysis of monomer (MBPC), polymeric ligand (PMBPCPR) and polymeric metal complexes (PMBPCPRCu) and (PMBPCPRNi) was accomplished in DMF with a concentration range 0.024-0.064 g/dl, at a temperature range from 283-323^0 K with an interval of 10 K by using a suspended level viscometer (Technico ASTM 445). 15 ml of solution was used and average flow time was obtained from at least three readings. The flow time of solvent was also noted. To control the temperature, a Gallen kamp viscometer water bath was used. The reduced viscosity ($n_{red)}$ was obtained by dividing specific viscosity (η_{sp}), with concentration (g/dl), whereas intrinsic viscosity (η) was calculated by plotting (η_{red}) against concentration and extrapolating to zero concentration. From temperature dependency of viscosity the thermodynamic parameters of polymeric ligands and polymeric metal complexes were

determined. The activation energy (ΔG) was calculated from the equation.$\Delta G = 2.303$ RT log ($\eta_{abs}/10^{-3}$), where R is gas constant and T is absolute temperature.

A linear relationship was obtained by plotting log ηabs verses 1/T. The values of activation of heat of 2.flow (ΔHv) were calculated from the slope (slope XR). The entropy of activation of viscous flow (ΔSv) was 3.calculated from equation. $.\Delta$ Hv-T $\Delta Sv = \Delta$ Gv

Antimicrobial activity of the polymeric ligand and polymeric metal complexes was determined by consuming an adapted agar well diffusion method The monomer, MBPC, polymeric ligand, PMBPCPR, and poly metal complexes, PMBPCPRCu and PMBPCPRNi were synthesized. The synthesized poly metal complexes were non-hygroscopic and stable at room temperature. All compounds synthesized were characterized by C.H.N elemental analysis, spectral (FT-IR, UV-Vis,) analysis. The poly metal complexes showed poor solubility in organic solvents. The PMBPCPRNi poly chelate showed less heat stability as compared to PMBPCPRCu. The intrinsic viscosity for poly metal complexes PMBPCPRCu and PMBPCPRNi were calculated from Huggins equation. The biological studies of ligand and complexes revealed that they possesses significant antibacterial and antifungal properties, against all the fungaland bacterial strains, and the data revealed that coordination increased theantimicrobial activity.

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