SYNTHESIS, CHARACTERIZATION AND BIOLOGICAL EVALUATION OF 2-(4,6-DIMETHYLPYRIMIDIN-2-YL)-1-[1-(4-HYDROXY-6-METHYL-PYRAN-2-ONE-3-YL)ETHYLIDENE]HYDRAZINE SCHIFF’S BASE TRANSITION METAL COMPLEXES: ANTIBACTERIAL AND DNA PHOTOCLEAVAGE STUDY

A. K. Gupta1*, S. Saini1, R. Pal1, R. Kumar1, V. Beniwal2

1Department of Chemistry, Maharishi Markandeshwar University, Mullana (Ambala), India
2Department of Biotechnology, Maharishi Markandeshwar University, Mullana (Ambala), India

ABSTRACT

The synthesis of a series of some new tridentate Schiff’s base complexes of Cu(II), Ni(II), Co(II), Mn(II), Zn(II) (M:L=1:2) with a tridentate Schiff’s base has been achieved by the reaction of 2-hydrazino-4,6-dimethyl pyrimidine with dehydroacetic acid (DHA) in ethanol under reflux. All the compounds were characterized on the basis of elemental analysis, UV-Visible, 1H and 13C-NMR, FTIR spectroscopy and mass spectrometry. The FTIR spectral data suggest that azomethine N and enolic O atoms are involved in coordination with metal ion, and the ligand behaves as a N,N,O-tridentate donor atoms. The mass spectrum of the complexes reveals the formation of metal ligand bonding in 1:2 (metal: ligand) stoichiometric ratios. All the synthesized compounds were screened for their antibacterial activity against gram (+) and gram (-) bacteria using Oxacillin as a standard drug. Synthesized compound were also screened for their DNA photocleavage potential using plasmid DNA. It has been found that metal complexes show enhanced activity as compared to ligand and some modification in ligand structure may lead to better antibacterial and DNA photocleaving agents in future.

Keywords: Dehydroacetic acid, 2-Hydrazino-4,6-dimethylpyrimidine, Schiff’s base, metal complexes, DNA photo cleavage and antibacterial activity.
1. INTRODUCTION
There has been growing continuous interest to synthesize Schiff’s bases metal complex because it has been found that they play a major role in coordination chemistry [1-4]. It has already been reported that the azomethine group (>C=N-) of Schiff’s bases has considerable biological significance [5], thus, Schiff’s base is regarded as model system of biochemical interest. Literature survey revealed that DHA and its derivatives has both bactericidal and fungicidal properties [6,7]. Aqueous solution of dehydroacetic acid at low concentrations (0.02-0.2%) is known to possess a strong antiseptic effect [8]. The DHA has been widely employed in food technology to protect vegetables during food processing [9] due to enhancement of vitamin C stability and is used as a preservative. Schiff’s bases based on DHA and their first transition metal complexes have already been synthesized in our previous research work and were found to possess good in vitro antibacterial and DNA photocleavage activities [10,11].

Pyrimidine derivatives attracted a great interest due to the wide variety of interesting biological activities such as anticancer [12], antitumor [13], antiviral [14], anti-inflammatory [15], analgesic [16], antimicrobial [17], antimycobacteria [18], antifungal [19], antihistaminic [20] and antiproliferative [21]. Presence of more than one hetero atom in pyrimidine makes them suitable chelating candidate in coordination chemistry as compared to simple pyridine bases, hence can serve as better models in biological systems [22-24]. In recent years, studies on the interactions of small molecules like coordinated metal ions with DNA have gained importance in urge to search of some novel and potential chemotherapeutic agents to combat against worldwide spread of cancer. Because of specific binding abilities of these molecules, they can be used as photo cleaving, non-radioactive probe for DNA structure as well as potential antitumor agents [25]. In view of the above mentioned facts, we report synthesis and characterization of Schiff’s base based on DHA such as 2-(4,6-dimethylpyrimidine-2-yl)-1-[1-(4-hydroxy-6-methylpyran-2-one-3-yl)ethylidene]hydrazine (PRDLH1) for our current studies. All the compounds were also evaluated for their antibacterial and DNA photocleavage activities with an aim to explore the biological potential of the synthesized compound as a new chemotherapeutic agent.

2. MATERIALS AND METHODS
Dehydroacetic acid was purchased from Aldrich and used as such without purification. All other chemicals including solvents were of LR grade and were used as supplied without any
purification or distillation. All the reactions were performed on magnetic stirrer equipped with hot plate under stirring. Double distilled water was used in the present investigation. The ligand was purified from ethanol before preparing metal complexes. The $^1$H and $^{13}$C NMR spectra of the ligand and the complexes were recorded on Bruker 400 MHz instrument at frequencies of 400 MHz and 100 MHz, respectively using TMS as an internal reference standard. IR spectra were recorded on Shimadzu IR Affinity in 4000 to 400 cm$^{-1}$ range using KBr pellet method. The electronic spectra were recorded using Shimadzu UV 1800 instrument in DMSO as a solvent. Mass spectra were recorded on Agilent Mass Spectrometer. Carbon, Nitrogen, Hydrogen contents were analyzed using LECO 9320 analyzer. All the melting points were uncorrected and determined using an open capillary method.

2.1 Preparation of 2-(4,6-Dimethylpyrimidin-2-yl)-1-[1-(4-hydroxy-6-methylpyran-2-one-3-yl)ethylidene] hydrazine (PRDLH$_1$)

The starting material 2-hydrazino-4,6-dimethylpyrimidine (1) was prepared according to the literature procedure $^{[26,27]}$. 2-Hydrazino-4,6-dimethylpyrimidine (0.01 mol) was dissolved in 40 ml aqueous ethanol (70%) in a 100 ml round-bottom flask. The temperature of reaction mixture rose to 75ºC, followed by addition of hot ethanolic solution of dehydroacetic acid (2) (0.01 mol) to the above reaction mixture under continuous stirring for 3 hours. The progress of reaction was monitored by thin layer chromatography. On completion, the reaction mixture was allowed to cool at room temperature. Yellow crystals of the product thus obtained were filtered and washed with excess of ethanol. The product was recrystallized from ethanol and dried in vacuum over fused CaCl$_2$ (Scheme 1). Yellow colored solid, Yield: 76%. M.pt: 180-183 ºC.

![Scheme 1: Synthesis of ligand, PRDLH$_1$](image-url)
Table 1: \(^1\)H NMR values of ligand and their metal complexes

<table>
<thead>
<tr>
<th>Proton</th>
<th>PRDLH(_1) (^1)H ppm</th>
<th>PRDL(_2)Zn (^1)H ppm</th>
<th>(^{13})C ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>-CH(_3) (Pyrimidine)</td>
<td>2.41 (S)</td>
<td>2.34, 2.37, 2.45</td>
<td>21.40(C(<em>{11})), 21.63(C(</em>{14})), 23.39(C(<em>{11}, C</em>{14}))</td>
</tr>
<tr>
<td>C=-N -CH(_3)</td>
<td>2.64 (S)</td>
<td>2.02, 2.08</td>
<td>19.23(C(_8)), 19.47(C(_8))</td>
</tr>
<tr>
<td>-CH(_3) (DHA Ring)</td>
<td>2.20 (S)</td>
<td>1.85, 1.86</td>
<td>18.87(C(_1)), 19.03(C(_1))</td>
</tr>
<tr>
<td>H (DHA Ring)</td>
<td>5.89 (S)</td>
<td>5.38, 5.69</td>
<td>165.74(C(_6)), 169.91(C(_6))</td>
</tr>
<tr>
<td>H(Pyrimidine Ring)</td>
<td>6.60 (S)</td>
<td>6.53, 6.66</td>
<td>164.26(C(_7)), 64.37(C(_7))</td>
</tr>
<tr>
<td>O-H (broad signal)</td>
<td>16.60 (S)</td>
<td>-</td>
<td>157.73(C(_9)), 12.23(C(_12)), 159.01(C(_10))</td>
</tr>
<tr>
<td>N-H</td>
<td>-</td>
<td>10.69 (broad) ad</td>
<td>159.68(C(_2))</td>
</tr>
</tbody>
</table>

Pale yellow solid yield: 76%. M.pt. 180-183\(^0\)C. IR (KBr, cm\(^{-1}\)) 3401(s), \(\nu\)(O-H); 1621(s), \(\nu\)(C=O); 1693(s), \(\nu\)(C=O); 1027(s), \(\nu\)(C-O). Electronic spectra (\(\lambda_{max}\) nm) in DMSO: 328.5, 355. \(^1\)H NMR (DMSO-\(d_6\), 400 MHz) (ppm): 2.41 (s, 3H, \(-\)CH\(_3\) Pyrimidine ring); 2.64 (s, 3H, N=\-C\(-\)CH\(_3\)); 2.20 (s, 3H, \(-\)CH\(_3\) DHA ring); 5.89 (s, H, DHA ring proton); 6.60 (s, 2H, Pyrimidine ring); 16.60 (s, broad signal,1H enolic). MS: \(m/z\) [M+1]\(^+\) 289.1. Analytical Calculated for C\(_{28}\)H\(_{31}\)N\(_8\)O\(_6\)Co: C 52.56, H 4.74, N 17.52, M 10.24; found C 52.55, H 4.72, N 17.51, M 10.22.

2.1.1. Synthesis of metal complexes of Schiff’s base (PRDLH\(_1\))

To the ligand (PRDLH\(_1\)) (0.1 mol) in a round bottom flask, 40 ml of methanol was added and heated at 80\(^0\)C to get a clear solution. An appropriate amount of transition metal acetates (0.05 mol) was dissolved in 15 ml of methanol and added to the above reaction mixture. The resulting reaction mixture was refluxed for 2-3 h. It was concentrate to around 30 ml. The
crystalline metal complexes precipitated out were filtered and washed with methanol followed by petroleum ether to remove the traces of impurities. Complexes were dried in a hot air oven for 4 h to obtain the colored complexes.

(C$_{28}$H$_{31}$N$_8$O$_6$)Co
Dark green solid yield: 54%. M.pt:250-256(d) °C. IR (KBr, cm$^{-1}$) 3469(s), $\nu$(O-H); 1604(s), $\nu$(C=N); 1679(s), $\nu$(C=O); 1022(s), $\nu$(C-O); 589(s), $\nu$(M-N); 545(s), $\nu$(M-O). Electronic spectra ($\lambda_{max}$ nm) in DMSO: 376.5, 775.3. MS: m/z [M+1]$^+$ 634.10. Anal. Calculated for C$_{28}$H$_{31}$N$_8$O$_6$Co: C 53.10, H 4.78, N 17.70, M 9.32; found C 58.08, H 4.77, N 17.69, M 9.30.

(C$_{28}$H$_{31}$N$_8$O$_6$)Ni
Light green solid yield: 68%. M.pt. 295-298(d) °C. IR (KBr, cm$^{-1}$) 3391(s), $\nu$(O-H); 1606(s), $\nu$(C=N); 1682(s), $\nu$(C=O); 1036(s), $\nu$(C-O); 525(s), $\nu$(M-N); 465(s), $\nu$(M-O). Electronic spectra ($\lambda_{max}$ nm) in DMSO: 261.5, 342, 793.5. MS: m/z [M+1]$^+$ 633.1. Anal. Calculated for C$_{28}$H$_{31}$N$_8$O$_6$Ni: C 53.11, H 4.79, N 17.70, M 9.28; found C 53.10, H 4.77, N 17.69, M 9.27.

(C$_{28}$H$_{31}$N$_8$O$_6$)Cu
Light green solid yield: 82%. M.pt. >300°C. IR (KBr, cm$^{-1}$) 3435(s), $\nu$(O-H); 1650(s), $\nu$(C=N); 1687(s), $\nu$(C=O); 1000(s), $\nu$(C-O); 554(s), $\nu$(M-N); 465(s), $\nu$(M-O). Electronic spectra ($\lambda_{max}$ nm) in DMSO: 376.5, 259, 204.5, 658.4. MS: m/z [M+1]$^+$ 638.1. Anal. Calculated for C$_{28}$H$_{31}$N$_8$O$_6$Cu: C 52.71, H 4.73, N 17.58, M 9.68; found C 52.70, H 4.74, N 17.56, M 9.69.

(C$_{28}$H$_{31}$N$_8$O$_6$)Zn
Light yellow solid yield: 78%. M.pt. 258°C. IR (KBr, cm$^{-1}$) 3434(s), $\nu$(O-H); 1611(s), $\nu$(C=N); 1686(s), $\nu$(C=O); 1033(s), $\nu$(C-O); 571(s), $\nu$(M-N); 457(s), $\nu$(M-O). Electronic spectra ($\lambda_{max}$ nm) in DMSO: 239. $^1$H NMR (DMSO-d$_6$, 400 MHz) (ppm): 2.34 and 2.37 (s, 6H, -CH$_3$ pyrimidine ring); 2.45 (s, 6H, -CH$_3$ pyrimidine); 2.02 and 2.08 (s, 6H, N=C–CH$_3$); 1.85 and 1.86 (s, 6H, -CH$_3$ DHA ring); 5.38 and 5.69 (s, 2H, DHA ring proton); 6.53 and 6.66 (s, 4H, H Pyrimidine ring); 10.69 (s, 2H, -NH). MS: m/z [M+1]$^+$ 639.1. Anal. Calculated for C$_{28}$H$_{31}$N$_8$O$_6$Zn: C 52.56, H 4.74, N 17.52, M 10.24; found C 52.55, H 4.72, N 17.51, M 10.22.

(C$_{28}$H$_{31}$N$_8$O$_6$)Mn

Light yellow solid yield: 52%. M.pt. 254°C. IR (KBr, cm$^{-1}$) 3443(s), $\nu$(O-H); 1651(s), $\nu$(C=N); 1712(s), $\nu$(C=O); 1029(s), $\nu$(C-O); 507(s), $\nu$(M-N); 390(s), $\nu$(M-O). Electronic spectra ($\lambda_{\text{max}}$ nm) in DMSO: 393,376.5, 423.25, 543.6. MS: m/z [M+1]$^+$ 639.10. Anal. Calculated for C$_{28}$H$_{31}$N$_8$O$_6$Mn: C 52.42, H 4.81, N 17.82, M 8.74; found C 53.42, H 4.80, N 17.80, M 8.73.

Fig. 1 Mass spectrum of Ligand (3)
Fig. 2 $^1$H NMR spectrum of Ligand, PRDLH$_1$

Figure 3: Mass spectrum of PRDL$_2$Zn
Scheme 2: Proposed mass fragmentation of Schiff’s base metal complex

Table 2 IR and UV data of ligand and its metal complexes

<table>
<thead>
<tr>
<th>Entry</th>
<th>Compound</th>
<th>$\nu_{OH}$ (cm$^{-1}$)</th>
<th>$\nu_{C-N}$ (cm$^{-1}$)</th>
<th>$\nu_{C=O}$ (cm$^{-1}$)</th>
<th>$\nu_{M-N}$ (cm$^{-1}$)</th>
<th>$\nu_{M-O}$ (cm$^{-1}$)</th>
<th>$\lambda_{max}$ (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PRDLH$_1$</td>
<td>3401</td>
<td>1621</td>
<td>1693</td>
<td>1027</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>PRDL$_2$Co</td>
<td>3469</td>
<td>1604</td>
<td>1679</td>
<td>1022</td>
<td>589</td>
<td>545</td>
</tr>
<tr>
<td>3</td>
<td>PRDL$_2$Ni</td>
<td>3391</td>
<td>1606</td>
<td>1682</td>
<td>1036</td>
<td>525</td>
<td>465</td>
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<tr>
<td>4</td>
<td>PRDL$_2$Cu</td>
<td>3435</td>
<td>1650</td>
<td>1687</td>
<td>1000</td>
<td>554</td>
<td>465</td>
</tr>
<tr>
<td>5</td>
<td>PRDL$_2$Mn</td>
<td>3443</td>
<td>1651</td>
<td>1712</td>
<td>1029</td>
<td>507</td>
<td>390</td>
</tr>
<tr>
<td>6</td>
<td>PRDL$_2$Zn</td>
<td>3434</td>
<td>1611</td>
<td>1686</td>
<td>1033</td>
<td>571</td>
<td>457</td>
</tr>
</tbody>
</table>

3. RESULTS AND DISCUSSION

In the continuation of our research interest in the synthesis of biological active Schiff’s base metal complexes, in the present study it was planned to synthesize some new metal complexes of first transition series based on Schiff’s base ligand, derived from the condensation reaction between DHA and Pyrimidine hydrazine. All the synthesized compounds were colored except Zn(II) complexes and stable at room temperature, they are highly soluble in DMF and DMSO. The structures of synthesized compounds were established on the basis of different analytical technique like elemental analysis, NMR, IR, UV, Mass spectrometry. Synthesized compounds were further explored for their DNA photo cleaving as well as antibacterial activities.

Table 3 Physio-chemical data of Schiff’s base and its metal complexes

<table>
<thead>
<tr>
<th>Ligand/Complex</th>
<th>Color</th>
<th>M.Wt</th>
<th>Found (Calculated)%</th>
<th>M.P(°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>H</td>
</tr>
<tr>
<td>PRDLH$_1$</td>
<td>Pale Yellow</td>
<td>288.3</td>
<td>58.32</td>
<td>5.59</td>
</tr>
<tr>
<td></td>
<td>(58.34)</td>
<td></td>
<td>(5.60)</td>
<td></td>
</tr>
<tr>
<td>PRDL$_2$Co</td>
<td>Dark green</td>
<td>633.52</td>
<td>53.08</td>
<td>4.77</td>
</tr>
<tr>
<td></td>
<td>(53.10)</td>
<td></td>
<td>(4.78)</td>
<td></td>
</tr>
<tr>
<td>PRDL$_2$Ni</td>
<td>Light green</td>
<td>633.28</td>
<td>53.10</td>
<td>4.77</td>
</tr>
<tr>
<td></td>
<td>(53.11)</td>
<td></td>
<td>(4.79)</td>
<td></td>
</tr>
<tr>
<td>PRDL$_2$Cu</td>
<td>Light green</td>
<td>638.13</td>
<td>52.70</td>
<td>4.74</td>
</tr>
<tr>
<td></td>
<td>(52.71)</td>
<td></td>
<td>(4.73)</td>
<td></td>
</tr>
<tr>
<td>PRDL$_2$Zn</td>
<td>Light yellow</td>
<td>639.98</td>
<td>52.55</td>
<td>4.72</td>
</tr>
<tr>
<td></td>
<td>(52.56)</td>
<td></td>
<td>(4.74)</td>
<td></td>
</tr>
<tr>
<td>PRDL$_2$Mn</td>
<td>Light yellow</td>
<td>629.53</td>
<td>53.42</td>
<td>4.80</td>
</tr>
<tr>
<td></td>
<td>(53.42)</td>
<td></td>
<td>(4.81)</td>
<td></td>
</tr>
</tbody>
</table>

d= decomposed
3.1 Chemistry and Characterization

$^1$H NMR of ligand displayed six signals at 2.2 ppm (3H, CH$_3$, DHA ring), 2.40 ppm (6H, Pyrimidine ring), 2.64 ppm (3H, N=C-CH$_3$), 5.89 ppm (1H, DHA ring), 6.60 ppm (1H, Pyrimidine ring) and 16.60 ppm (1H, enolic proton) (Table-1). In $^1$H NMR spectrum of Zn(II) complex disappearance of enolic proton signal suggested the involvement of enolic oxygen donor atom of ligand in coordination with metal ions and subsequent deprotonation. The IR spectrum of free ligand has been compared with the spectrum of metal complexes to probe the mode of binding. The characteristic IR stretching frequencies of free ligand observed at 3401, 1621, 1693 and 1027 cm$^{-1}$ were assigned due to $\nu_{OH}$, $\nu_{C=N}$, $\nu_{C=O}$ and $\nu_{C-O}$, respectively (Table-2). Two additional bands were observed in case of metal complexes at 640-521 cm$^{-1}$ and 545-390 cm$^{-1}$ which were assigned due to $\nu_{M-N}$ and $\nu_{M-O}$ stretching frequencies, respectively. All the other stretching frequencies showed some shift as compared to ligand which suggests their involvement in coordination with metal ions. Mass of ligand as well as all the metal complexes was confirmed on the basis of mass spectrometry as depicted in fig 1 and fig 3. The mass fragmentation of Schiff’s base zinc complex (PRDL$_2$Zn) is shown in Scheme-2. Thus, mass and IR spectral data is in close agreement with proposed structures of the synthesized compounds as depicted in Fig. 5.

The electronic spectra of the ligand as well as all synthesized complexes were recorded in 10$^{-4}$ M DMSO solution at room temperature. The ligand showed the following two signals centered at 328.5 and 355 nm, these absorption bands were appearing due to $\pi \rightarrow \pi^*$ and n- $\pi^*$ of carbonyl or the azomethine moiety, respectively. These bands showed blue shift in case of synthesized metal complexes as compared to ligand suggesting the involvement of azomethine group in coordination. PRDL$_2$Co, PRD L$_2$Cu, PRD L$_2$Mn and PRD L$_2$Ni showed weak bands at 775.3, 658.4, 543.6 and 793.5 nm due to d–d transitions having poor molar extinction coefficient, respectively.

3.2 Biological activity

3.2.1 DNA photocleavage activities

There has been a great deal of interest in transition metal complexes-mediated DNA photocleavage reactions (Liu et al., 2005). Photocleavage study on pBR322 plasmid DNA was performed by agarose gel electrophoresis. The results of cleavage study are presented in Fig.4. Whenever electrophoresis is performed on plasmid DNA, the fastest migration is
observed for the super-coiled form (SC) as compared to another. If one strand of super-coiled form is cleaved, the super-coiled form is relaxed to produce a slower moving open-circular form (OC). If both strands of super-coiled form are cleaved, a linear form (NC) is generated that migrates in between the super-coiled and open-circular form. It was clear from Fig. 4 that control (lane 1) consists of the super-coiled and nicked circular coiled forms of plasmid DNA.

![Fig. 4 DNA photocleavage agarose gel electrophoresis](image)

Lane 1st DMSO + plasmid DNA, lane 2nd ligand + plasmid DNA, lane 3rd PRDL₂Co; lane 4th PRDL₂Ni; lane 5th PRDL₂Cu; lane 6th PRDL₂Mn; lane 7th PRDL₂Zn with plasmid DNA, respectively.

In case of the ligand (lane 2), PRDL₂Co complexes (lane 3), PRDL₂Cu complex (lane 5), and PRDL₂Mn complex (lane 6) no change in SC form but decreases the intensity of NC form were observed. There was significant change in the plasmid DNA in nicked form in all the cases indicated that these compounds have DNA photocleaving properties. However, in case of PRDL₂Ni complexes (lane 4) and PRDL₂Zn complex (lane 7) there was a complete degradation of plasmid DNA. The result indicates that with 40µg concentration of metal complex as well as ligand the intensity of NC DNA decreased due to the binding affinity of complex to DNA. It was found that metal complexes possess very good DNA photo-cleaving activities as compared to free ligand and may serve as the basis of same novel and efficient antitumor agent in future.

### 3.2.2 Antibacterial activity of Pyrimidine DHA metal complexes

The antibacterial activity of these compounds was compared with Oxacillin as a standard drug as shown in Table 4 and Fig. 6. It was found that metal complexes have good antibacterial activity than a free ligand under identical experimental conditions. It was evident from the data that this activity is significantly increased on coordination. Moreover,
coordination reduces the polarity \(^{29,30}\) of the metal ion mainly because of the partial sharing of its positive charge with the donor groups \(^{31,32}\) within the chelate ring system formed during coordination. This process, in turn, leads to increase in the lipophilic character of metal chelate so as to make it more permeable through the lipid layer of microorganism \(^{33}\) thus destroying them more aggressively. Once the compound enters into the microbial cell, it restricts the growth of microorganism by binding at the active site of enzymes which involves in various essential biochemical processes including cell respiration and proteins synthesis of the cell.

Table 4 Antibacterial activity of Schiff’s base and its metal complexes

<table>
<thead>
<tr>
<th>Entry</th>
<th>Zone of Inhibition in (mm)(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B. subtilis (2063)</td>
</tr>
<tr>
<td>PRDLH(_1)</td>
<td>11</td>
</tr>
<tr>
<td>PRDL(_2)Co</td>
<td>10</td>
</tr>
<tr>
<td>PRDL(_2)Ni</td>
<td>10</td>
</tr>
<tr>
<td>PRDL(_2)Cu</td>
<td>10</td>
</tr>
<tr>
<td>PRDL(_2)Mn</td>
<td>10</td>
</tr>
<tr>
<td>PRDL(_2)Zn</td>
<td>18</td>
</tr>
<tr>
<td>Oxacillin</td>
<td>38</td>
</tr>
</tbody>
</table>

The bioactivity of the ligand and its complexes is found to be in the order PRDL\(_2\)Zn > PRDLH\(_1\) > PRDL\(_2\)Ni > PRDL\(_2\)Cu > PRDL\(_2\)Co = PRDL\(_2\)Mn. The higher activity of Cu(II) complexes can be explained as, on chelation the polarity of Cu(II) ion is found to be reduced to a greater extent due to overlap of the ligand orbital and partial sharing of the positive charge of the copper ion with donor groups. Therefore, Cu(II) ions are easily adsorbed on the surface of the cell wall of microorganisms \(^{34,35}\). The adsorbed Cu(II) ions disturb the respiratory process of the cells, and block the synthesis of proteins and restricts further growth of the organisms.

Where M = Co(II), Ni(II), Cu(II), Mn(II) and Zn(II)
CONCLUSION
In present investigation we reported the synthesis of ten new Schiff’s base metal complexes of first transition series of 2-(4,6-Dimethylpyrimidine-2-yl)-1-[1-(4-hydroxy-6-methylpyran-2-one-3-yl)ethylidene]hydrazine (PRDLH₁). The Structure of synthesized compounds were established on the basis of various spectroscopic techniques. ¹H NMR data suggested the deprotonation of enolic proton upon coordination with metal ions. DNA photocleavage activity on plasmid DNA suggested good DNA cleaving activity under similar experiment conditions. In general metal complexes were more potent chemical nucleases than ligand and Cu(II), Ni(II) complexes were found to be most effective. Antibacterial activities against two gram positive and two gram negative bacteria showed good growth inhibiting abilities of metal complexes. So, it can be concluded that coordination of metal ions has modified the ligand environment in such a manner so that their antibacterial as well as DNA photocleaving activity enhanced to a greater extent. Further, ligand environment may be tuned to explore some effective antibacterial or DNA cleaving agents in future.

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