Chapter 5

Synthesis, characterisation and DNA cleavage of ruthenium(III) complexes

5.1 Introduction

The chemistry of ruthenium is currently receiving a lot of attention, because of their use in catalytic reactions like oxidation (1-6) and hydrogenation (7-8) and also due to their biocidal activity (9-19). Ruthenium offers a wide range of oxidation states and the reactivity of the ruthenium complexes depends on the stability and interconvertibility of these oxidation states (20-22). Steric and electronic effects around the Ru core can be finely tuned by an appropriate electron withdrawing or electron donating substituents attached to the Schiff bases.

With a view to study the catalytic activity in oxidation reactions we have synthesised new ruthenium(III) complexes by the reaction of the Schiff base ligands, quinoxaline-2-carboxalidene-5-aminoidazole (qc5in), quinoxaline-2-carboxalidene-6-aminoidazole (qc6in), 3-hydroxyquinoxaline-2-carboxalidene-5-aminoidazole (hqc5in), 3-hydroxyquinoxaline-2-carboxalidene-6-aminoidazole (hqc6in), 3-hydroxyquinoxaline-2-carboxalidene-8-aminquinoline (hqaqn) with Ru(III) chloride. The results of studies on the synthesis and characterisation are
presented in this chapter. The details of the catalytic activity are presented in chapter VII.

5.2 Experimental
5.2.1 Materials

The details of materials used for the synthesis of the Schiff base ligands are given in Chapter 2.

5.2.2 Synthesis of Schiff base ligands

The procedure for the synthesis of the Schiff base ligands are given in Chapter 2

5.2.3 Synthesis of complexes

All the ruthenium(III) complexes were prepared by mixing an ethanolic solution (10 mL) of RuCl₃·3H₂O (1.30 g, 5 mmol) with an ethanolic solution (100 mL) of the ligand, qc5in (1.36 g, 5 mmol), qc6in (1.36 g, 5 mmol), hqc5in (1.45 g, 5 mmol), hqc6in (1.45 g, 5 mmol) or hqaqn (1.50 g, 5 mmol) in a molar ratio of 1:1 and refluxing for 3 hours. The complex separated out was washed with ethanol and then with petroleum ether and dried over anhydrous calcium chloride in a desiccator.

5.3 Results and discussion

All the complexes are black and non-hygroscopic. They are soluble in DMSO but are insoluble in benzene, ethanol and chloroform.

5.3.1 Elemental analyses

Analytical data and conductance data are given in Table 5.1. The data suggest a metal to Schiff base ratio of 1:1 for all the complexes. The molar conductance values of the complexes in DMSO (10⁻³ mol) indicate non-electrolytic nature of the complexes [23].
Table 5.1. Analytical and conductance data of the ruthenium(III) complexes

<table>
<thead>
<tr>
<th>Complexes of</th>
<th>C (%)</th>
<th>H (%)</th>
<th>N (%)</th>
<th>Cl (%)</th>
<th>Ru (%)</th>
<th>Molar conductance (ohm⁻¹cm²mol⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>qc5in</td>
<td>37.12</td>
<td>2.86</td>
<td>13.46</td>
<td>19.40</td>
<td>20.02</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td>(37.19)</td>
<td>(2.93)</td>
<td>(13.55)</td>
<td>(20.58)</td>
<td>(19.56)</td>
<td></td>
</tr>
<tr>
<td>qc6in</td>
<td>37.24</td>
<td>2.92</td>
<td>13.46</td>
<td>19.26</td>
<td>19.46</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>(37.19)</td>
<td>(2.93)</td>
<td>(13.55)</td>
<td>(20.58)</td>
<td>(19.56)</td>
<td></td>
</tr>
<tr>
<td>hqc5in</td>
<td>37.28</td>
<td>2.20</td>
<td>13.70</td>
<td>18.62</td>
<td>19.52</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>(37.33)</td>
<td>(2.55)</td>
<td>(13.61)</td>
<td>(20.66)</td>
<td>(19.64)</td>
<td></td>
</tr>
<tr>
<td>hqc6in</td>
<td>37.26</td>
<td>2.96</td>
<td>13.56</td>
<td>21.82</td>
<td>18.98</td>
<td>5.8</td>
</tr>
<tr>
<td></td>
<td>(37.33)</td>
<td>(2.55)</td>
<td>(13.61)</td>
<td>(20.66)</td>
<td>(19.64)</td>
<td></td>
</tr>
<tr>
<td>hqaqn</td>
<td>42.00</td>
<td>3.20</td>
<td>10.68</td>
<td>13.28</td>
<td>18.14</td>
<td>6.2</td>
</tr>
<tr>
<td></td>
<td>(41.15)</td>
<td>(3.26)</td>
<td>(10.67)</td>
<td>(13.50)</td>
<td>(19.24)</td>
<td></td>
</tr>
</tbody>
</table>

5.3.2 Thermal Analysis

Thermal stability of the complexes were investigated using TG at a heating rate of 20 °C /min in nitrogen over a temperature range of 40-1000 °C. TG curves of the complexes are given in Figures 5.1-5.5. The initial weight loss below 130 °C observed for all the complexes is attributed to the removal of lattice water molecules associated with the complex. Loss of coordinated water occurs in the range 130-250 °C. This is followed by two or three stages of decompositions leading to the removal of other ligands. In nitrogen atmosphere the decomposition was incomplete even after 1000 °C.

Figure 5.1. TG-DTG of [Ru(qc5in)Cl₃H₂O].H₂O
Figure 5.2. TG-DTG of [Ru(qc6in)Cl\textsubscript{3}H\textsubscript{2}O].H\textsubscript{2}O

Figure 5.3. TG-DTG of [Ru(hqc5in)Cl\textsubscript{3}(H\textsubscript{2}O)].H\textsubscript{2}O
Synthesis, characterisation and DNA cleavage of ruthenium(III) complexes

Figure 5.4. TG-DTG of [Ru(hqc6in)Cl$_3$(H$_2$O)]H$_2$O

Figure 5.5. TG-DTG of [Ru(hqaqn)Cl$_3$(H$_2$O)]H$_2$O
Based on the analytical, molar conductance and TG data, the following molecular formula have been assigned for the complexes [Ru(qc5in) Cl$_3$H$_2$O].H$_2$O, [Ru(qc6in)Cl$_3$H$_2$O].H$_2$O, [Ru(hqc5in)Cl$_3$(H$_2$O)].H$_2$O, Ru(hqc6in) Cl$_3$(H$_2$O)].H$_2$O and Ru(hqaqn)Cl$_3$(H$_2$O)].H$_2$O

5.3.3 Infrared spectra

Selected vibrational stretching frequencies of the free Schiff base ligands and those ruthenium complexes, which are useful for determining the mode of coordination of the ligands, are given in Table 5.3. The FT-IR spectra of the ruthenium(III) complexes are given in Figures 5.6-5.10. In all these spectra there is a broad band in the range 3355-3432 cm$^{-1}$ assignable to coordinated water or uncoordinated water molecules (24). This fact is also indicated by the results of elemental analyses and TG-DTG of these complexes (25). The participation of azomethine nitrogen atom of the Schiff bases in coordination is evidenced by decrease in their stretching frequency. The bands entered at 1633 cm$^{-1}$ for qc5in, at 1630 cm$^{-1}$ for qc6in, at 1626 cm$^{-1}$ for hqc5in, at 1612 cm$^{-1}$ for hqc6in and hqaqn decreases to 1619 cm$^{-1}$, 1612, 1600, 1598 and 1528 cm$^{-1}$ respectively in the spectra of their metal complexes. The $\nu$(C=N) of the quinoxaline ring in the spectra of qc5in and qc6in undergoes a decrease in stretching frequency on complexation suggesting the coordination of the ring nitrogen to the metal in their complexes. However this band for the ligands hqc5in, hqc6in and hqaqn remains unchanged on complexation suggesting the noninvolvement of quinoxaline ring nitrogen in coordination to ruthenium. In addition, these complexes exhibit bands in the range 410-440 cm$^{-1}$, which may be due to $\nu$(Ru—N) (26). The bands in the range 1670-1680 cm$^{-1}$ due to the C=O group of the hqc5in and hqc6in, hqaqn shifted to lower frequency indicating the involvement of this group in coordination.
Table 5.3. The IR spectral data of Ru(III) complexes

<table>
<thead>
<tr>
<th>Compound</th>
<th>$\tilde{\nu}(O-H)$</th>
<th>$\tilde{\nu}(C=\text{N})^c$</th>
<th>$\tilde{\nu}(C=\text{N})^d$</th>
<th>$\tilde{\nu}(C=\text{O})$</th>
<th>$\tilde{\nu}(M-O)$</th>
<th>$\tilde{\nu}(M-N)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>qe5in</td>
<td>3208</td>
<td>1633</td>
<td>1489</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[Ru(qe5in)Cl$_3$H$_2$O]H$_2$O</td>
<td>3418</td>
<td>1619</td>
<td>1500</td>
<td>-</td>
<td>-</td>
<td>406</td>
</tr>
<tr>
<td>qe6in</td>
<td>3211</td>
<td>1630</td>
<td>1532</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[Ru(qe6in)Cl$_3$H$_2$O]H$_2$O</td>
<td>3432</td>
<td>1612</td>
<td>1514</td>
<td>-</td>
<td>-</td>
<td>436</td>
</tr>
<tr>
<td>hqe5in</td>
<td>3372</td>
<td>1626</td>
<td>1497</td>
<td>1670</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[Ru(hqe5in)Cl$_3$(H$_2$O)]H$_2$O</td>
<td>3412</td>
<td>1600</td>
<td>1497</td>
<td>1654</td>
<td>478</td>
<td>411</td>
</tr>
<tr>
<td>hqe6in</td>
<td>3376</td>
<td>1612</td>
<td>1493</td>
<td>1670</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>[Ru(hqe6in)Cl$_3$(H$_2$O)]H$_2$O</td>
<td>3418</td>
<td>1598</td>
<td>1493</td>
<td>1658</td>
<td>485</td>
<td>409</td>
</tr>
<tr>
<td>hqaqn</td>
<td>3378</td>
<td>1585</td>
<td>1511</td>
<td>1675</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>[Ru(hqaqn)Cl$_3$(H$_2$O)]H$_2$O</td>
<td>3432</td>
<td>1528</td>
<td>1510</td>
<td>1633</td>
<td>455</td>
<td>409</td>
</tr>
</tbody>
</table>

*a $\tilde{\nu}(N-H)$ or $\tilde{\nu}(O-H)$ of the free Schiff base or
*b $\tilde{\nu}(O-H)$ of coordinated water molecule
*c $\tilde{\nu}(CH=N)$ of azomethine group; d $\tilde{\nu}(C=N)$ of quinoxaline

Figure 5.6. FTIR spectrum of [Ru(qe5in)Cl$_3$H$_2$O]H$_2$O

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Figure 5.7. FTIR spectrum of [Ru(qc6in)Cl$_3$H$_2$O]H$_2$O

Figure 5.8. FTIR spectrum of [Ru(hqc5in)Cl$_3$(H$_2$O)]H$_2$O
5.3.4 Electronic spectra and magnetic moment data.

The electronic spectra of all the complexes were recorded in DMSO solution (see Table 5.4 and Figures 5.11-5.15). The ground state of ruthenium(III) is $^2T_{2g}$ and the first excited doublet levels in the order of increasing energy are
2A2g and 2T1g which arises from the t2g4eg1 configuration. In most of the ruthenium(III) complexes, the UV–vis spectra show only charge transfer bands. As ruthenium(III) in its complexes has relatively high oxidizing ability, ligand to metal the charge transfer bands become prominent in the low energy region and obscure the weaker bands due to d–d transition (27). Therefore it becomes difficult to assign conclusively the bands of ruthenium(III) complexes which appear in the visible region. However, the bands observed in the region 502-580 nm might be due to d-d transitions. Similar observations have been made for other ruthenium(III) octahedral complexes (28-32). The electronic spectral data of the complexes are given in Table 5.4 and in Figures 5.11-5.15.

Table 5.4. Electronic spectral and magnetic moment data of Ru(III) complexes

<table>
<thead>
<tr>
<th>Complex</th>
<th>Electronic spectral bands: nm (cm⁻¹)</th>
<th>Assignments</th>
<th>µeff (BM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Ru(qc5in)Cl₃(H₂O)]H₂O</td>
<td>265 (37,740) 313 (31,950) 613 (16,310)</td>
<td>Intraligand transitions CT 2T2g→4T1g</td>
<td>1.76</td>
</tr>
<tr>
<td>[Ru(qc6in)Cl₃(H₂O)]H₂O</td>
<td>230(43,480) 260(38,460) 322(31,060) 635(15,750)</td>
<td>Intraligand transitions CT CT 2T2g→4T1g</td>
<td>1.72</td>
</tr>
<tr>
<td>[Ru(hqc5in)Cl₃(H₂O)]H₂O</td>
<td>221 (45,250) 272 (36,760) 314 (31,850) 430 (23,255) 518 (19,310) 641 (15,600)</td>
<td>CT CT CT 2T2g→2A2g, 2T1g 2T2g→2T1g 2T2g→2A2g</td>
<td>1.64</td>
</tr>
<tr>
<td>[Ru(hqc6in)Cl₃(H₂O)]H₂O</td>
<td>264 (37,880) 309 (32,360) 384 (26,040) 521 (19,200) 583 (17,150)</td>
<td>Intraligand transitions CT 2T2g→2A2g, 2T1g 2T2g→4T2g 2T2g→4T1g</td>
<td>1.82</td>
</tr>
<tr>
<td>Ru(hqaqn)Cl₃(H₂O)]H₂O</td>
<td>300(33,330) 371(26,960) 550(18,180)</td>
<td>Intraligand transitions 2T2g→2A2g, 2T1g 2T2g→4T2g</td>
<td>1.62</td>
</tr>
</tbody>
</table>
All the complexes were found to be paramagnetic in nature. The magnetic moment values lie between 1.64-1.76 indicating the presence of one unpaired electron and +3 oxidation states for ruthenium (33).

Figure 5.11. The UV-Vis spectrum of $[\text{Ru(qc5in)}\text{Cl}_3\text{H}_2\text{O}]\text{H}_2\text{O}$

Figure 5.12. The UV-Vis spectrum of $[\text{Ru(qc6in)}\text{Cl}_3\text{H}_2\text{O}]\text{H}_2\text{O}$
Figure 5.13. The UV-Vis spectrum of 
[Ru(hqc5in)Cl$_3$(H$_2$O)]H$_2$O

Figure 5.14. The UV-Vis spectrum of 
[Ru(hqc6in)Cl$_2$(H$_2$O)$_2$]H$_2$O
5.3.5 EPR Spectra of the Complexes

The EPR spectra of all complexes in DMSO at 77K exhibit three lines with three different g values. The presence of three g values \([g_x \neq g_y \neq g_z]\) is an indication of rhombic distortion in these complexes. The average value was calculated using the equation: 

\[
g^* = \left[ \frac{1}{3} g_x^2 + \frac{1}{3} g_y^2 + \frac{1}{3} g_z^2 \right]^{1/2}.
\]

The average g values lie in the range 2.3–2.7 are close to the values reported for similar ruthenium(III) complexes [34-38].

Table 5.6. EPR spectral data of the Ru(III) complexes

<table>
<thead>
<tr>
<th>Complex</th>
<th>(g_x)</th>
<th>(g_y)</th>
<th>(g_z)</th>
<th>(g^*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Ru(qc5in)Cl(_3)(H(_2)O)]H(_2)O</td>
<td>2.6</td>
<td>2.4</td>
<td>2.1</td>
<td>2.4</td>
</tr>
<tr>
<td>[Ru(qc6in)Cl(_3)(H(_2)O)]H(_2)O</td>
<td>2.5</td>
<td>2.3</td>
<td>1.9</td>
<td>2.2</td>
</tr>
<tr>
<td>[Ru(hqc5in)Cl(_3)(H(_2)O)]H(_2)O</td>
<td>2.5</td>
<td>2.4</td>
<td>2.2</td>
<td>2.4</td>
</tr>
<tr>
<td>[Ru(hqc6in)Cl(_3)(H(_2)O)]H(_2)O</td>
<td>2.6</td>
<td>2.4</td>
<td>2.1</td>
<td>2.4</td>
</tr>
<tr>
<td>Ru(hqaqn)Cl(_3)(H(_2)O)]H(_2)O</td>
<td>2.7</td>
<td>2.3</td>
<td>2.0</td>
<td>2.3</td>
</tr>
</tbody>
</table>

\(g^* = \frac{1}{\sqrt{3}} \left( \frac{1}{3} g_x^2 + \frac{1}{3} g_y^2 + \frac{1}{3} g_z^2 \right)^{1/2}\). 

Figure 5.15. The UV-Vis spectrum of [Ru(hqaqn)Cl\(_3\)(H\(_2\)O)]H\(_2\)O
Figure 5.16. EPR spectrum of $[\text{Ru}(\text{qe5in})\text{Cl}_3\text{H}_2\text{O}].\text{H}_2\text{O}$

Figure 5.17. EPR spectrum of $[\text{Ru}(\text{qe6in})\text{Cl}_3\text{H}_2\text{O}].\text{H}_2\text{O}$
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Figure 5.18. EPR spectrum of $[\text{Ru(hqc5in)Cl}_3(\text{H}_2\text{O})]\text{H}_2\text{O}$

Figure 5.19. EPR spectrum of $[\text{Ru(hqc6in)Cl}_3(\text{H}_2\text{O})]\text{H}_2\text{O}$
5.3.6 Cyclic voltammetry

The electrochemical activity of the ruthenium complexes was studied in DMSO \((10^{-3} \text{ mol} \text{ l}^{-1})\) at a scan rate of 0.100 V in the potential range +1.5 to -1.5 V by cyclic voltammetry. The cyclic voltammograms of the ruthenium complexes are shown in Figures 5.21-5.25 and the voltammetric data are summarized in Table 5.5. In all the ruthenium(II) complexes the ratio, \(I_{pc}/I_{pa}\), falls in the range 1.08- 1.50, clearly confirming one electron transfer for redox processes. All the complexes showed only a reversible reduction wave in the -0.47 to -0.99 V range. The peak-to-peak separation (\(\Delta E_p\) value) ranging from 164 to 170 mV reveals that this process is quasi reversible (39). This is attributed to slow electron transfer and adsorption of the complexes on the electrode surface (40). The ruthenium(III) to ruthenium(II) redox processes are influenced by the coordination number, stereochemistry and the hard or soft character of the ligands (41). Patterson and Holm have shown that softer ligands tend to produce more positive \(E_{1/2}\) values, while hard ligands give rise to negative \(E_{1/2}\) values (42). The observed \(E_{1/2}\) values for these complexes
indicate considerable hard base character, which is likely to be due to an azomethine nitrogen donor atom involved in the coordination. Similar behaviour has been reported for mononuclear ruthenium(III) complexes (43).

Table 5.5. Cyclic voltammetric data of Ru(III) complexes

<table>
<thead>
<tr>
<th>Complex</th>
<th>$E_{pc}$ (V)</th>
<th>$E_{pa}$ (V)</th>
<th>($E_{1/2}$) (V)</th>
<th>$\Delta E_p$ (mV)</th>
<th>$I_{pc}$ (µA)</th>
<th>$I_{pa}$ (µA)</th>
<th>$I_{pc}/I_{pa}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Ru(qc5in)Cl$_3$H$_2$O]H$_2$O</td>
<td>-0.768</td>
<td>-0.599</td>
<td>-0.683</td>
<td>170</td>
<td>4.81</td>
<td>3.87</td>
<td>1.24</td>
</tr>
<tr>
<td>[Ru(qc6in)Cl$_3$H$_2$O]H$_2$O</td>
<td>-0.986</td>
<td>-0.468</td>
<td>-0.727</td>
<td>518</td>
<td>5.00</td>
<td>5.43</td>
<td>1.09</td>
</tr>
<tr>
<td>[Ru(hqc5in)Cl$_3$(H$_2$O)]H$_2$O</td>
<td>-0.789</td>
<td>-0.598</td>
<td>-0.693</td>
<td>191</td>
<td>7.62</td>
<td>6.80</td>
<td>1.12</td>
</tr>
<tr>
<td>[Ru(hqc6in)Cl$_3$(H$_2$O)]H$_2$O</td>
<td>-0.782</td>
<td>-0.618</td>
<td>-0.700</td>
<td>164</td>
<td>7.94</td>
<td>6.55</td>
<td>1.22</td>
</tr>
<tr>
<td>Ru(hqaqn)Cl$_3$(H$_2$O)]H$_2$O</td>
<td>-0.986</td>
<td>-0.550</td>
<td>-0.768</td>
<td>436</td>
<td>6.32</td>
<td>5.84</td>
<td>1.08</td>
</tr>
</tbody>
</table>

Figure 5.21. Cyclic voltammogram of $[\text{Ru(qc5in)Cl}_3\text{H}_2\text{O}]\cdot\text{H}_2\text{O}$
Figure 5.22. Cyclic voltammogram of Ru(qc6in)Cl$_3$H$_2$O]. H$_2$O

Figure 5.23. Cyclic voltammogram of [Ru(hqc5in)Cl$_3$(H$_2$O)]. H$_2$O
Figure 5.24. Cyclic voltammogram of [Ru(hqc6in)Cl₃(H₂O)].H₂O

Figure 5.25. Cyclic voltammogram of [Ru(hqaqn)Cl₃(H₂O)].H₂O
5.3.7 Geometry of the complexes

Based on the above discussion, an octahedral structure has been assigned for the complexes and tentative structures are shown in Figure 5.27.

Figure 5.27. The Proposed geometry of Ru(III) complexes where

\[ a = \text{[Ru(qc5in)Cl}_3\text{H}_2\text{O].H}_2\text{O}, \quad b=\text{[Ru(qc6in)Cl}_3\text{H}_2\text{O].H}_2\text{O} \]
\[ c = \text{[Ru(hqc5in)Cl}_3\text{(H}_2\text{O)}.{H}_2\text{O}, \quad d=\text{[Ru(hqc5in)Cl}_3\text{(H}_2\text{O)].H}_2\text{O} \]
\[ e = \text{[Ru(hqaqn)Cl}_3\text{(H}_2\text{O)].H}_2\text{O} \]
5.4 Cleavage of pUC18 DNA by Ru(III) complexes

The ability of the Ru(III) complexes to perform DNA cleavage was monitored by agarose gel electrophoresis using pUC18 plasmid DNA (Figure 5.26). Three clear bands were observed (lane 1 and 2) for pUC18 DNA corresponding to the conformations of the plasmid viz., open circular, supercoiled, and linear forms. After the addition of [Ru(qc5in)Cl$_3$H$_2$O]H$_2$O, [Ru(qc6in)Cl$_3$H$_2$O]H$_2$O only 2 bands are visible (Lane 3, 4 and 5). Thus the binding of the metal complexes results in the complete degradation of the open circular form of DNA. The complexes [Ru(hqc5in)Cl$_3$(H$_2$O)]H$_2$O and [Ru(hqc6in)Cl$_3$(H$_2$O)]H$_2$O failed to show a significant DNA cleavage activity (lane 6 and 7). But [Ru(hqaqn)Cl$_3$(H$_2$O)]H$_2$O completely degrades three forms of pUC18 plasmid DNA (lane 8). All the results indicate that complexes [Ru(qc5in)Cl$_3$H$_2$O].H$_2$O, [Ru(qc5in)Cl$_3$H$_2$O].H$_2$O and Ru(hqaqn)Cl$_3$(H$_2$O)].H$_2$O shows efficient DNA-cleavage activity.

![Gel electrophoresis diagram of Ru(III) complexes](image-url)
5.5 Conclusion

The elemental analyses suggest the molecular formulae of the complexes \([\text{Ru(qc5in)}\text{Cl}_3\text{H}_2\text{O}]\text{H}_2\text{O}, [\text{Ru(qc6in)}\text{Cl}_3\text{H}_2\text{O}]\text{H}_2\text{O}, [\text{Ru(hqc5in)}\text{Cl}_3(\text{H}_2\text{O})]\text{H}_2\text{O}, [\text{Ru(hqc6in)}\text{Cl}_3(\text{H}_2\text{O})]\text{H}_2\text{O}, [\text{Ru(hqaqn)}\text{Cl}_3(\text{H}_2\text{O})]\text{H}_2\text{O}]. \) The coordinated/ lattice water present in the complexes is evidenced by weight loss in TG and presence of characteristic stretching bands in the IR spectrum. The IR spectra reveal that the bonding of qc5in and qc6in to ruthenium is through azomethine nitrogen and quinoxaline ring nitrogen where as the bonding of hqc5in, hqc6in and hqaqn is through coordination of the azomethine nitrogen and through keto oxygen. The electronic spectral data suggests an octahedral geometry for the complexes. The cleavage studies show that the hqaqn complex was highly efficient in degrading three forms of pUC18 plasmid DNA.

5.6 References


Synthesis, characterisation and DNA cleavage of ruthenium(III) complexes


