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Synthesis and characterization of novel rhenium(I) complexes towards potential biological imaging applications

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Abstract

Background: Re(I) tricarbonyl complexes exhibit immense potential as fluorescence imaging agents. However, only a handful of rhenium complexes have been utilized in biological imaging. The present study describes the synthesis of four novel rhenium complexes, their characterization and preliminary biological studies to assess their potential as biological imaging agents.

Results: Four facial rhenium tricarbonyl complexes containing a pyridyl triazine core, (L1 = 5,5′(3-(2-pyridyl)-1,2,4-triazine-5,6-diyl)-bis-2-furansulfonic acid disodium salt and L2 = (3-(2- pyridyl)-5,6-diphenyl-1,2,4-triazine-4′,4″-disulfonic acid sodium salt) have been synthesized by utililzing two different Re metal precursors, $Re(CO)_5Br$ and $[Re(CO)_3(H_2O)_3]OTf$ in an organic solvent mixture and water, respectively. The rhenium complexes $[Re(CO)_3(H_2O)L1]^+$ (**1**), $Re(CO)_3L1Br$ (**2**), $[Re(CO)_3(H_2O)L2]^+$ (**3**), and $Re(CO)_3L2Br$ (**4**), were obtained in 70–85% yield and characterized by ^1H NMR, IR, UV, and luminescence spectroscopy. In both H_2O and acetonitrile, complexes display a weak absorption band in the visible region which can be assigned to a metal to ligand charge transfer excitation and fluorescent emission lying in the 650–710 nm range. Cytotoxicity assays of complexes **1**, **3**, and **4** were carried out for rat peritoneal cells. Both plant cells (*Allium cepa* bulb cells) and rat peritoneal cells were stained using the maximum non-toxic concentration levels of the compounds, 20.00 mg ml^{-1} for **1** and **3** and 5.00 mg ml^{-1} for **4** to observe under the epifluorescence microscope. In both cell lines, compound concentrated specifically in the nuclei region. Hence, nuclei showed red fluorescence upon excitation at 550 nm.

Conclusions: Four novel rhenium complexes have been synthesized and characterized. Remarkable enhancement of fluorescence upon binding with cells and visible range excitability demonstrates the possibility of using the new complexes in biological applications.

Keywords: Rhenium tricarbonyl, NMR spectroscopy, Cytotoxicity, Fluorescent

Background

Metal complexes possess unique properties such as radioactivity [1, 2], preferential binding to certain proteins or organelles [3–7], inertness [8], lower toxicity than the purely organic molecules [9] and special photophysical properties [10–13] which make them eligible for both therapeutic and diagnostic applications [14–18]. Two-photon absorption behavior of certain transition metal complexes containing conjugated ligands show high applicability in biological imaging [19, 20]. Specifically, rhenium(I) metal complexes have attracted special attraction over other metals as their chemical characteristics demonstrate better potentiality for biochemical applications [20–22]. Longer life times [13, 14], high photostability [7, 20] and large Stoke's shifts [7, 23] make them ideal candidates for either in vitro or in vivo visualization of biological processes [24, 25].Their visible light excitation minimizes the UV damage to cells whereas conjugation with proteins and lipids facilitate their compatibility with biological systems [26]. Since Re(I) has d^6 electronic

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