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The effect of physico-chemical properties of multi-walled carbon nanotubes and its toxicity on saccharomyces cerevisiae

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2012-02-14
http://hdl.handle.net/10539/11312

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Abstract

Carbon nanotubes (CNTs) have remarkable properties that distinguish them from other materials and make them desirable in many applications. Despite being promising tools for biology and medicine little is known about the effects and safety of CNTs on biological objects. The toxicity of CNTs is a prime concern and the effects of multi-walled carbon nanotubes (MWCNTs) in vitro have been studied, delivering conflicting results. This is even further aggravated by the limited data on yeast cells. The aim of this study was to test the effects of the physicochemical properties of CNTs and its toxicity on *Saccharomyces cerevisiae (S.cerevisiae)* in vitro. CNTs were produced by the swirled floating catalytic chemical vapour deposition method (SFCCVD) (Iyuke, 2005) and were purified with nitric acid and sulphuric acid treatments. CNT physicochemical properties such as specific surface area, particle size distribution, were characterized by Brunauer-Emmett-Teller (BET), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Raman spectroscopy and Thermal Gravimetric Analysis (TGA). The toxicity of pristine and oxidised MWCNTs was compared and investigated in the yeast species *S.cerevisiae*, by cell growth analysis, electron microscopic examination and cell viability assessment by means of the standard plating technique. *S.cerevisiae* cells were exposed to concentrations of 2, 3, 6, 10, 20 and 40μg/ml of both oxidised and pristine MWCNTs. Compared to the control *S.cerevisiae* growth curves containing MWCNTs there was no significant change at both high and low doses of MWCNTs. Both pristine and oxidized MWCNTs do not affect the growth rate and viability of *S.cerevisiae* cells, this is adduced from the lack of toxicity in the cells during the observed time period. The cellular uptake of MWCNTs was evaluated by using standard fluorescent probes and confirmed by confocal microscopy images. MWCNT's were covalently functionalised by the 1, 3-dipolar cycloaddition of N-tritylglycine and the interactions between the MWCNTs and the covalent modifiers were characterised by H^1 NMR, TEM and TGA. Confocal observations clearly show that MWCNT-FITC are internalised by all (100%) *S.cerevisiae* yeast cells in less than 2 hrs incubation of 20 μg/ml MWCNTs.

Pheochromocytoma (PC12) cells were also cultured in Royal Park Memorial Institute (RPMI) media containing concentrations of nitric acid oxidised MWCNTs ranging from 50 μg/ml to 200 μg/ml. It was observed that oxidised MWCNTs demonstrated no cytotoxicity

towards PC12 neuronal cells. No significant CNT toxic effect was found in both *S.cerevisiae* and PC12 neuronal cell lines.