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Effect of SWCNTs-Polymers Nanocomposites on Cancer Cell Line Applications

A Thesis
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By

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(مَن يَتَّقِ ٱللَّهَ يَجۡعَل لَّهُۥ مَخۡرَجٗا وَيَرۡزُقۡهُ مِنۡ حَيۡثُ لَا يَحۡتَسِبُۚ وَمَن يَتَوَكَّلۡ عَلَى ٱللَّهِ فَهُوَ حَسۡبُهُۥٓۚ إِنَّ ٱللَّهَ بَٰلِغُ أَمۡرِهِۦۚ قَدۡ جَعَلَ ٱللَّهُ لِكُلِّ شَيۡءٖ قَدۡرٗا)

[الطلاق: ٢-٣]

Dedication

To my Country AL-Iraq…

To my Family….

To my Teacher and my Father Prof.

Dr. Tahseen H. Mubarak

To my Friends……

To all who have given me a hand

throughout this work…...

Marwa Al-Soabei

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Published and Accepted Research Articles

List of Publications

1- Marwa R.Jwameer, Farah T. M. Noori, Sabah A. Salman, **Carbon Nanotube Conjugate with PEG as a Drug Delivery in to AMJ13 and HepG2 Cell**, Journal of Mechanical Engineering Research and Developments, ISSN: 1024-1752, Volume 44, No.8, PP. 44-56, 2021.

2- Marwa R.Jwameer, Sabah A. Salman, Farah T. M. Noori, **Smart Drug Delivery Systems Based on Single-Wall Carbon Nanotubes Loaded with Nanocurcumin Extract for Cancer therapy and Toxicity,** Diyala Journal for Pure Science, No. 96, Date of acceptance 10-8-2022.

Abstract

This study included three parts; the first part included functionalization of single well carbon Nanotubes (SWCNTs) using (Hcl) and mixture of acids (H_2SO_4, HNO_3) to convert them to (SWCNTs-COOH), and then followed by an esterification process of (SWCNTs-COOH) with (PEG, PEG-PEI), an ester reaction was performed between the group of carboxylic acids PEG and PEG-PEI which contains amino groups. Then the physical properties were studied using XRD, FTIR, UV-Vis, RS, TEM and AFM the techniques to characterize the composite (PEG – SWCNTs). SWCNTs had a sharp peak at (291 nm) in UV-vis, whereas (PEG – SWCNTs) and (PEG-PEI-SWCNTs) had a peak at 289 nm and 300.98 nm. In Fourier transforms infrared spectroscopy (FTIR) spectra, a strong OH bond can be seen for both materials, as well as the C–H bond of (PEG-SWCNTs) and C –H, N-H, C-N bond of (PEG- PEI-CNTs) also showed. In XRD pattern SWCNTs have a sharp peak at $2\theta = 25.6299^{\circ}$, which is related to 002 with d – spacing (3.4729 Å) while functionalization of PEG-SWCNTs is conformed to a broad peak at $2\theta= 23.4473^{\circ}$ with d – spacing (3.8447Å) and functionalization of PEG-PEI-SWCNTs conform by broad peak at ($2\theta= 23.51^{\circ}$) with d – spacing (3.7816Å). The values of crystallite size for SWCNTs, PEG-SWCNTs and PEG-PEI-SWCNTs equals ((3nm), (7.7nm) and (8.48nm)), respectively. Atomic force microscopy (AFM) and SWCNTs images show a single wall carbon nanotube with a grain size of (60 nm). In PEG-SWCNTs and PEG-PEI-SWCNTs, the grain size increases with functionalization to (83.60 nm, 80.68 nm), respectively. In Raman Spectroscopy, we notice a shift in the D and G bands in PEG-SWCNTs and PEG-PEI-SWCNTs. In TEM the raw

SWCNTs are long curved aggregates, which appear to be a bundle of inhomogeneous aggregates consisting of many tubes, The tubular structure of CNTs-PEG-PEI is rough, and some particles appear to be attached and distributed along the SWCNTs sidewalls, maybe indicating that PEG and PEI groups are conjugated onto nanotubes.

The second part included loading nanocurcumin (N.Cur) on to SWCNTs containing polyethylene glycol (PEG) and polyethyleneimine (PEI), which contains amino groups, were synthesized (PEG-PEI-SWCNTs). The spectral and structural characteristics of (PEG–PEI-SWCNTs-N.Cur) were comprehensively analyzed by XRD, FTIR, UV- Vis, RS, TEM and AFM. XRD patterns revealed that PEG-PEI-SWCNTs had different crystalline structures and defects, as well as a higher interlayer spacing. AFM results showed SWCNTs with the grain size of (60 nm), while PEG-PEI-SWCNTs revealed SWCNTs aggregation with the grain size of (79.6 nm) after loading N. Curcumin extract, which was verified by TEM examination. A strong OH bond appeared in FTIR spectra. Furthermore, UV- Vis absorbance peaks at (289, 300.98, (282,425) and (273,431)) nm seemed to be correlated with SWCNTs, PEG-PEI-SWCNTs, N. Curcumin extract, and PEG- PEI-SWCNTs- N. Curcumin extract. The Raman spectra for PEG-PEI-SWCNTs-N. Cur, the radial breathing mode (RBM) band, the disorder band (D band), the tangential mode (G band) and the overtone of the D band (2D band) shifting to ((171,264),1283, 1593 and 2131 cm^{-1})) respectively. The peaks for the nanocurcumin around (958, 1183 and 1428) cm^{-1} experienced shift to (939, 1168 and 1470) cm^{-1} in the drug loaded sample due to nano-encapsulation and indicates successful drug loading. The lines at (716 and 853) cm^{-1} can be assigned to the C-N stretching vibrations.

Part third included the samples in the all parts of this study using in three type of bio application, first type of bio application include effect SWCNTs and PEG-SWCNTs on two type of anti-bacterial Gram-negative bacterial strain *Pseudomonas aeruginosa* and Gram-positive bacterial strain *bacillus spp*. were exposed to a series of concentrations from prepared (PEG-SWCNTs) ((25-100) µg/ml). The results exhibited significant inhibitory activity and that the rate of bacterial growth inhibition increased with increasing concentration. Second type of bio application include effect SWCNTs, PEG-SWCNTs, PEG-PEI-SWCNTs and PEG-PEI-SWCNTs-N.Cur on two type of anticancer the breast cancer AMJ13 cell line and liver cancer HepG2 cell line were exposed to a series of prepared (SWNTs, PEG-SWCNTs, PEG-PEI-SWCNTs, PEG-PEI-SWCNTs-N.Cur) concentrations ((6.25- 100) µg/ml), and the inhibition rate of growth in cells was measured for 72 h. The cytotoxicity screening showed that there was a highly toxic effect on the cancer cells. Third type of bio application include effect (SWCNTs, PEG-PEI-SWCNTs and PEG-PEI-SWCNTs-N.Cur) on the normal cell line (RD). Inhibition rates in the normal cell line RD by the effect of different concentrations ((6.25- 100) µg/ml) of (SWCNTs, PEG-PEI-SWCNTs and PEG-PEI-SWCNTs-N.Cur) for an exposure period of (72 hours) and a temperature of (37 ° C).