

Fabrication and Invitro Evaluation of Starch/MWCNT Composites as Drug Delivery Device.

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Abstract:

Aim:

Fabricate starch drug loaded composite and study its in vitro drug release profile.

Objectives:

To Functionalize MWCNT using HNO₃ and adsorb tetracycline onto it. Fabricate starch/drug loaded MWCNT and perform in vitro drug study in Phosphate buffered solution (PBS) with PH 7.0 using UV visible spectrophotometer.

Background:

Starch is a biopolymer, biodegradable and is biocompatible. Starch has been used for many medical applications. MWCNT can be functionalized and is known to be a good absorbant for many chemicals including drugs such as tetracycline. Tetracyclines is a broad spectrum antibiotic and is very effective against microbes causing periodontal disease.

Reason:

The composite proposed is a novel combination and the study is designed to exploit the favorable properties of both starch and MWCNT for medical applications.

INTRODUCTION:

Starch is a natural polymer and is biocompatible, biodegradable and water soluble. Pure starch is a white, tasteless and odorless powder that is insoluble in cold water or alcohol. It consists of two types of molecules: the linear and helical amylose and the branched amylopectin. The structure of starch is given in figure 1.

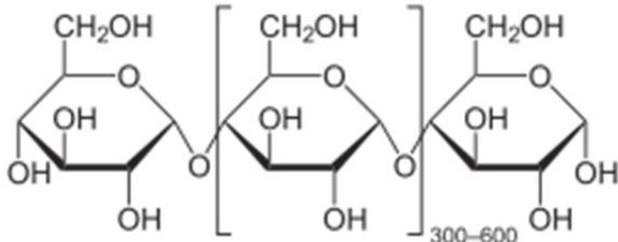


Figure 1: Structure of starch molecule

Carbon nanotubes (CNTs) are widely researched as multi-functional nano materials due to their unique electronic, mechanical, optical and chemical properties (1) A CNT can either be single-walled (SWCNT) or multi-walled (MWCNT) (Fig. 2).

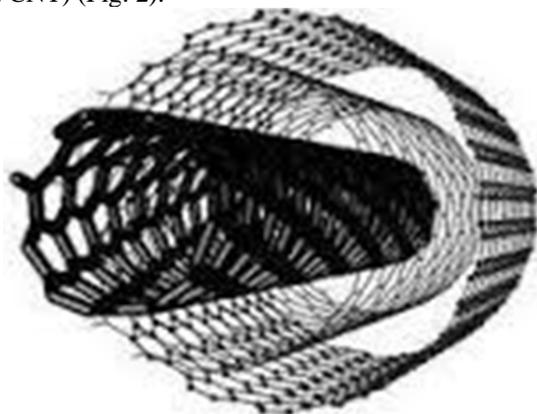


Figure 2: structure of MWCNT

MWCNTs, the cylinder can be conceptualized as concentric layers of graphene sheets. The well-ordered arrangement of carbon atoms linked via sp² bonds provides superior mechanical stiffness, electrical and thermal conductivity. CNTs have a high aspect ratio. The diameter is between 2–100 for MWCNTs.

Many researchers around the world have worked on starch based systems for the applications in drug delivery and tissue engineering applications. In this study, starch MWCNT composites were fabricated. The drug tetracycline was adsorbed onto MWCNTs and incorporated into the starch solution. The application of these composite membranes as drug delivery devices was studied.

MATERIALS AND METHOD:

Starch was procured from Sigma Aldrich. According to previously published procedure (2) the Multi-walled Carbon Nanotubes 100 mg/60 ml were heated at 1000C in 3:1 ratio of 20% H₂SO₄ and 20% HNO₃ for 60 m with stirring. These treated MWCNTs were washed until neutral pH and dried at 600C (3) for further use.

The drug tetracycline of 500 mg which is absorbent into various concentration of MWCNT. Functionalized MWCNT adsorbed onto drug tetracycline using magnetic stirrer in 360 rpm for 2 hrs. The test group include 4 samples which has various concentration of MWCNT. The absorbed MWCNT is incorporated into starch of 10 mg.

Sample 1: 0.5 mg MWCNT and tetracycline

Sample 2: 1 mg MWCNT and tetracycline

Sample 3: 1.5 mg MWCNT and tetracycline

Sample 4: 2 mg MWCNT and tetracycline

And the sample from the group where to perform invitro study using UV spectrophotometer in phosphate buffered

solution of PH 7.0. The PBS of PH 7.0 is prepared by,
Sodium chloride- 8 g/L
Potassium chloride- 0.2 g/L
Disodium phosphate – 1.44 g/L
Potassium dihydrogen phosphate – 0.24 g/L.

RESULTS:

Codings:

- SCT 1: 0.5 mg MWCNT, tetracycline and starch
- SCT 2 : 1 mg MWCNT, tetracycline and starch
- SCT 3 : 1.5 mg MWCNT, tetracycline and starch
- SCT 4: 2 mg MWCNT, tetracycline and starch

HRS	SCT 1	SCT 2	SCT 3	SCT 4
24	0.08 mg	0.3 mg	0.5 mg	0.8 mg
48	0.12 mg	0.45mg	0.75 mg	1.1 mg
72	0.35 mg	0.62 mg	0.83 mg	1.4 mg
96	0.35 mg	0.62 mg	0.83 mg	1.4 mg

Table 1: invitro study of drug release

DISCUSSION:

The invitro study of starch/MWCNT composite performed using UV spectrophotometer for 96 hrs and the study show that there is a drug release for 72 hrs and the drug release is same as of 72 hrs when it is studied at 96 hrs. Carbon nanotubes have shown unexpected advantages in the field of cancer treatment and drug delivery systems.

Cancer is one of the most common causes of death worldwide. Nanoparticles have been applied to drug delivery and showed improved drug efficiency and reduced off-target tissue toxicity due to accumulation in tumor tissues. Nanoparticles target tumor tissues by two mechanisms: passive targeting and active targeting. As fast growing tissues, tumours display enhanced vascular permeability due to high demand for nutrients and possible oxygen. The features of the leaky vasculature are employed for delivery of nanoparticle drugs since the size of nanoparticle allows them to accumulate in tumor tissues (4).

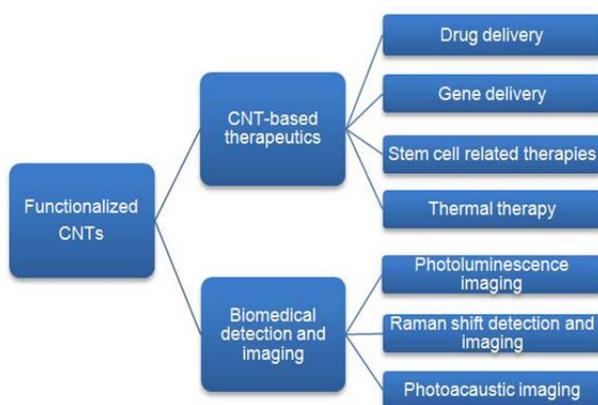


Figure 3: functionalized CNT in major biomedical applications.

The phenomenon is termed as tumor-selective enhanced permeability and retention (EPR) effect. For many therapeutics, oral and targeted delivery are challenge. One way to deliver them at the targeted site is by novel methods of encapsulating them in polymeric artificial cells.(5). Non aromatic small molecules drug can be chemically conjugated to CNT for drug delivery (6). CNTs can be used as drug carriers to treat tumors (7). For avoiding the harmful effect of anticancer drug on healthy organs and cells, our group has linked epirubicin with a magnetic CNTs complex obtained by fixing a layer of magnetite (Fe₃O₄) nanoparticles on the surface of the nanotubes with necklace-like type and on the tips of shortened MWCNTs (8)

CONCLUSION:

Carbon nanotubes show great promise as a single platform with multi-functional capabilities for regenerative medicine. Carbon nanotubes have exhibited diverse physical, chemical and mechanical properties suitable for a variety of applications. In last decade, biomedical applications of Carbon nanotubes have undergone rapid progress. Their unique properties, such as, ultrahigh surface area, high aspect ratio, distinct optical properties have been applied to develop innovative, multi-functional Carbon nanotubes based nano-devices for broad applications.

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