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Application of Graphene Oxide-Chitosan Nanocomposite in Drug Delivery: a Review

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APPLICATION OF GRAPHENE OXIDE-CHITOSAN NANOCOMPOSITE IN DRUG DELIVERY: A REVIEW

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Abstract: Development of nanostructured composite has become an interested area of researchers in recent years. Particularly significant are nanocomposites made of chitosan, which is obtained Deacetylation of chitin is a linear amino polysaccharide, and graphene oxide (GO). These combinations, due to the significant properties of both components such as non-toxicity, biocompatibility with human tissues and organs as well as bacteriostaticity, are characterized by a wide range of biomedical applications. Apart from its biodegradability, it can be chemically modified to produce derivatives which also contribute varied applications. These derivatives are easy to produce and can be made commercially available easily. They may be used in emergency medicine as dressing materials which accelerate wound healing, as well as carriers of drugs/genes and biological macromolecules. In chapter provide an overview of continuous development of Graphene oxide-chitosan nanostructured composite with different properties are being used as a carrier for drug delivery. Also, the current publication presents the studies undergone with different research conducted from the past years of chitosan–graphene oxide nanocomposites in medicine considering the characteristics of the system components.

Keywords: Drug delivery, biopolymers, chitosan, nano composite, graphene oxide

Introduction

Recent inventions in the area of nanotechnology and nanomedicine made a beneficial path for the modern drug delivery system. The main advantage of using nanoscale material in drug delivery helps to reduce the side effects as well as enable controlled drug delivery.

Due to the non-toxic, good biocompatibility, biodegradable and bacteriostatic properties of GO-CS

composite their applications become widespread in the area of biomedical fields such as Drug delivery, Gene delivery, Immunosensors, Tissue engineering, and regenerative medicine.

While processing of shellfishes such as prawns, crabs, shrimps, Lobsters only meat is being used and the shell and head portions are discarded as waste[1]. Even though this waste is biodegradable it takes too much time to degrade and cause serious environmental nuisance[2]. By utilizing this waste shell into another useful derivative can reduce the effect of this waste disposal. Chitin is a biopolymer present in the shell material. Deacetylation of chitin [Fig 1] can produce biodegradable derivative which is a Chitosan.

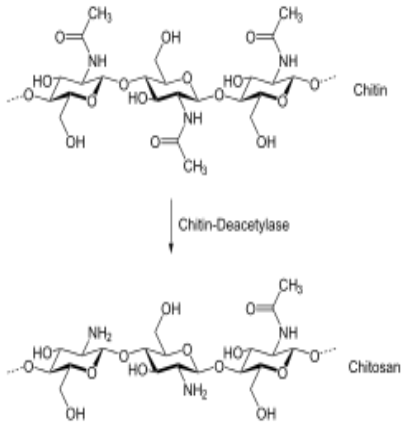

Fig: 1

Due to the nontoxic, cheap manufacturing and biocompatible nature of chitosan can be used in several areas such as photography, cosmetics, food processing also bio-medical field[3]

Continuous development of graphene has been motivated by increasing research attention to investigate new material for the drug delivery system. Due to its unique property and geometry properties such as excellent electrical and thermal conductivity, high fracture strength, large specific surface area, fast mobility of charge carriers, and biocompatibility[4,5]enable them to apply in different areas like energy research, nanoelectronics, catalysis and engineering of nanocomposites and biomaterials**.** Graphene oxide is an oxidized form of graphene. Due to the presence of oxygen functionalities [fig 2], graphene oxide can easily disperse in organic solvents, water, and different matrixes. This is a major benefit when combining the material with polymer or ceramic matrixes to enhance their mechanical and Bio-medical properties.

Fig:2

The application of a biopolymer combined nanoparticle has become one of the significant areas of researchers in the medical field. In this review focusing on the latest development in the area of graphene oxide – chitosan nanocomposite in drug delivery.

Drug Delivery behavior of graphene oxide –chitosan nanocomposite

The drug release performance of chitosan-graphene oxide nanocomposite has been characterized by Richard Justin[6]**.** He has investigated drug delivery behavior by varying concentration of graphene oxide using sodium fluorescein (FL) as a model drug. His result showcases that 2 wt % of graphene oxide gives an optimal combination of mechanical properties and drug loading capacities. It offered a faster and a more substantial release of drug than chitosan as well as a slower biodegradation rate, owing to the abundant oxygenated functional groups, hydrophilicity and large specific surface area of GO sheets.

Richard Justin also studied drug release property of reduced graphene oxide along with chitosan[7]. The electrical conductivity of chitosan composite can be improved by using 1wt % and 2wt 5 reduced graphene oxide; it provides delivery of pharmaceuticals by employing electroporation and ionophoresis.

Yang Gong and Yingchun Yu synthesized Graphene oxide chitosan composite aerogel and studied its mechanical performance[8].CSAs/GO composite aerogel was manufactured by an environmentally friendly freeze-drying process with different GO composition. The crystallinity (CrI) of composite aerogel increased from 27% to 81%, which indicates that graphene oxide improves the mechanical properties of chitosan by chemical cross-linking.

Hailin Lei and Meng Xie have developed Chitosan/sodium alginate modified graphene oxide-based nanocomposite as a carrier for drug delivery[9]. By using electrostatic self-assembly process the anti-cancer drug -loaded nanocarrier of functionalized graphene oxide (GO) with chitosan (CS) and sodium alginate (SA) was prepared. Using doxorubicin hydrochloride (DOX) as an anticancer drug they had synthesized and identified that DOX loaded nanocomposite exhibit significant pH-dependent drug release behaviors. SA increased the solubility of both GO and DOX loaded GO nanocomposites as well as limited the undesired non-specific adsorption of protein in physiological conditions.

Emadi et al[10] developed a CS-GO system to prevent the proteolysis of proteins while maintaining their activity. The nanocomposite was

combined with bovine serum albumin (BSA) and collagenase to assess the degree of protein stability and activation. Based on the tests carried out for the GO-BSA and GO-CS-BSA systems, the authors did not notice any significant changes in the structure of proteins after a period of 30 and 60 minutes of exposure to protease. However, the bovine serum albumin itself was completely digested after 1 hour

A Hybrid system of graphene oxide, chitosan and, chitosan modified with dimethylanhydride(GON/CS/CS-DMMA) has developed by Zhao[11] which is used for the extracellular and intracellular delivery of doxorubicin. He has identified good encapsulation efficiency and prolonged circulation time of the developed carrier for a chemotherapeutic agent in the blood. The system provided enhanced capture of HepG2 cancer cells and could potentially be a promising drug carrier for oncological treatment.

Huilan Hu and Cui Tang have developed Folate conjugated trimethyl chitosan/graphene oxide nanocomplexes[12]as potential carriers for drug and gene delivery. They had synthesized via electrostatic self-assembly were here developed as a targeted delivery vehicle for both doxorubicin (DOX) and plasmid DNA (pDNA). Negligible cytotoxicity of FG NCs was observed in Hela and A549 cells. s. Both DOX and pDNA could be loaded into FG NCs, wherein the loading capacity of DOX reached 30.9% and the migration of pDNA could be completely retarded. Therefore, FG NCs could be served as a promising candidate for the targeted delivery of both anticancer drugs and genes.

Conclusions

The use of graphene oxide-chitosan nanocomposite indifferent field of medical science has been identified by rapid growth from recent years. The efficient delivery of an anticancer drug to the infected cell or tissue for a continuous period would result in clinical response over an extended period. By incorporating polymer nanomaterials can enhance efficiency by delivering the desired amount of drug to the targeted site in a controlled manner. The main advantage of Graphene oxide-chitosan nanocomposite is since which is biocompatible polymer-based can deliver a drug in a controlled manner as well as helps to targeted delivery by increasing the concentration of drug in the infected site. It is already proved that the combination of Graphene oxide- chitosan can enhance mechanical properties also this composite has an environment-friendly impact. By using this specified composite can break many barriers that prevent conventional therapy and

leading to efficient and economical treatment methods.

However, it should make practical that laboratory studies should be conducted before the implementation of such nanocomposite.

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Fig. 1. Deacetylation of chitin

Fig. 2. Structure of graphene oxide