Renewable resources applications and its biopolymers

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In the present world, plastic waste is great problem for the environment pollution. Conventional polymeric substances are not easily degraded because they are resistant against microbial attack; they accumulate in the environment and represent a significant source of environmental pollution. To end these problems, synthetic waste led to the development of new biopolymers that are biodegradable and biocompatible to the environment, to replace the conventional polymers. In last decade, many countries spend huge amounts on biopolymer research based on renewable resources because of wide range of applications in packaging, agriculture and medical feilds. Biodegradable natural polymers are mainly based on renewable resources (like starch, collagen, cellulose, etc.) and are produced naturally or synthesized from renewable resources. This paper is mainly, on the development of biopolymers and biocomposites based on renewable resources, their properties and the area of their application.

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Heparin-based self-assembly for controllable drug delivery application

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Introduction: Heparin has promising potential in drug delivery due to its excellent biocompatibility and abundant modification sites. It can not only incorporate polymer chains via its functional groups such as hydroxyl, amine and carboxyl, but load cationic moieties via static interaction. Thus, heparin was considered as a versatile platform to design and prepare various self-assembly for drug delivery applications. For example, polycaprolactone(PCL) and paclitaxel(PTX) were covalently incorporated into heparin to form two conjugates respectively in our previous work. Both can self-assemble into micelle in water and be used as multifunctional drug carrier with tumor targeting ability and pH sensitive drug release behavior. However, the complicated and tedious synthetic route suffered the preparation and restricted further application. Thus, a simple and feasible strategy was carried out in this study to prepare heparin based self-assembly via non-covalent interaction. This strategy is able to well control the morphology and the size of heparin based self-assembly so that the self-assembly can be applied as smart multifunctional drug carrier.

Experiment: The pre-determined amount (3, 5 and 7 mL) of aqueous solution of heparin (1 mg/mL) was slowly added into 15 mL dodecy dimethyl benzyl ammonium bromide (DBAB) aqueous solution with concentration of 2 mg/mL. The mixing solution was continued to stir for 2 h and then lyophilized to get heparin based self-assembly. The pre-determined amount of aqueous heparin solution (1 mg/mL) was slowly added into 15 mL DBAB aqueous solution (2 mg/mL) with predetermined amount of doxorubicin (DOX). The mixing solution was continued to stir for 2h and then lyophilized to get multifunctional drug carrier.

Results & Discussion: The self-assembly was prepared by static interaction between the anionic heparin and cationic DBAB, and its morphology can be tuned by the charge ratio of heparin and DBAB. The morphology changed from vesicle to micelle with the decreasing of cationic DBAB in feed. Furthermore, DLS measurement showed the diameter ranged from 500-600 nm for vesicle and 200-300 nm for micelle. The Zeta potential of both vesicle and micelle significantly decreased compared with heparin, which implied two assemblies were formed by static absorption. The two assemblies can successfully encapsulate hydrophobic drug DOX to get multifunctional drug carrier, and the drug load content was found to be 55% and 20% for micelle and vesicle correspondingly. Due to the hydrolysis effect, both carriers possessed pH sensitive release behavior because the self-assemblies would decompose in acid circumstance resulting in the acceleration of drug release. This was proved by *in vitro* drug release measurement. The *in vitro* cytotoxicity showed the micelle with DOX showed significant cytotoxicity against tumor cells. The cellular uptake was finally characterized by confocal laser scanning microscope test.

Conclusion: The heparin based self-assembly was obtained by static absorption between heparin and DBAB. The morphology of assemblies changed from vesicle to micelle with the change of DBAB amount in feed. The assemblies can be applied as anti-tumor drug carrier with pH sensitivity.

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