



NANOTECHNOLOGY BASED COCOONS FOR TARGETED DRUG DELIVERY: A PROMISING APPROACH

Sreelekshmi M.S, Lekshmi M.S Panicker

Student, Assistant Professor

Department of Pharmaceutics

Mar Dioscorus College of Pharmacy, Thiruvananthapuram, Kerala, India

Abstract: Nano cocoons are hemo-compatible and are non-toxic, hence have a great potential to be loaded with naturally occurring anti cancerous drugs like curcumin. These nano cocoons were developed for targeted cancer treatments. These bio-inspired cocoon-like structures are made up of deoxyribonuclease-degradable DNA embedded with acid responsive DNase1 having negative charge. These negatively charged DNase1 are encapsulated with in an acid degradable polymeric nanogel having positive charge. The cocoon shell undergo degradation and release the drug at acidic environment by enhancing the activity of DNase1.

Index Terms – DNase, Cocoons, Nanogel.

INTRODUCTION

Drug delivery involves the transport of drug inside the body to attain a desired therapeutic action. Biomedical engineering researchers developed a nano scaled drug delivery system called as “cocoons”. Cocoons are structures made up of DNA which target the cancer cells and deliver the drug directly into the cell without any delay.

Nano cocoon based drug delivery systems are DNA based and hence they are safe for the use of patients. Drug and proteins (DNase) which are essential for the drug release are placed at the core of the cocoon. These DNase having function to cut up the DNA nano cocoon which is coated with a thin polymer. Folic acid ligands are present at the surface of nano cocoons. When these nano cocoons enters to a cancer cell, the acidic environment of the cell degrades the polymer and due to the presence of DNase the anti-cancer drug is released at the site of action.

Nano-cocoons are 100-200nm in size. Single strand of DNase self assembles into a cocoon like structure and each nano cocoons are made of single strands of DNase. Curcumin is a well-known anti cancerous agent derived from turmeric having poor bioavailability. Interestingly, curcumin-cocoon complex has successfully delivered curcumin inside cancerous tissues in the brain.



Figure showing nano cocoon

ADVANTAGES

- The structure is easy to manufacture and remains stable in the circulatory system.
- They can carry a large amount of drug and are able to release them very quickly, hence they can be widely used for cancer treatments.
- They are very safe to the patients as they are biocompatible than synthetic ones.

METHOD OF PREPARATION

Each capsule is made of only one strand of DNA which rolls and folds up into a ball-like structure through technique like rolling-circle amplification. These balls formed from cocoons measure about 150nm across. The anti-cancer drugs were placed along with DNase proteins with in the capsules. These proteins are protected by a thin polymer so that the enzymes may not cup up the DNA which makes up capsules. Nano-cocoons have multiple folic acid ligands spread throughout their surface to bind to the receptors on the surface of cancer cells. Acidic environment within the cancer cells causes the polymer to break down and release the DNase.

MECHANISM OF ACTION

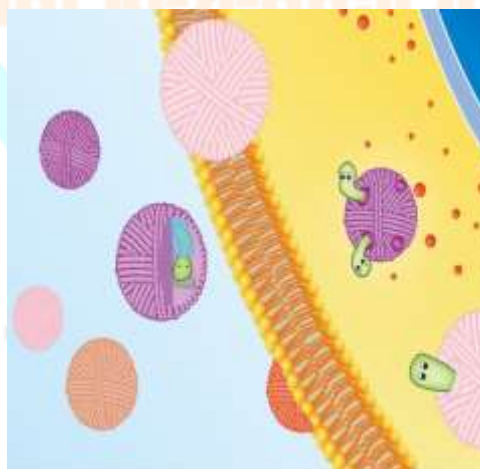


Figure showing mechanism of action of nano cocoon

The polymeric membrane of the cocoon breached when contact with the acidic environment and due to this the DNase spill out of the cocoon and they release the drug directly at the site of action, hence the drug is only released at the affected area so that the risk of toxicity can be avoided hence targeted drug delivery can be achieved.

TEMPLATING METHOD

One of the most effective and general method for the production of nano hollow particles are templating method against the colloidal system. Silica spheres are commonly used as colloidal templates as they are widely available in nature.

PRINCIPLE

Templating method is one of the most important technique for the preparation of nano structures. Due to arterial incompactabilities and need of surface modifications in template synthesis coating of the layer of designed material is a difficult practice. For this purpose different coating techniques has been used like sol-gel coating. A metal oxide structure having double wall can be prepared by the method of adsorption on both sides of a hollow latex sphere.

For the modification of the surface properties, atomic layer deposition and vapor deposition silica gels are used in coating process. Ones the nano coons enters to the cancer cells, the acidic environment of the cell destroys the polymer sheath and make the cocoon freed from the sheath. Due to this the DNase releases the drug directly into the cancer cells and kills them.

FUTURE OUTCOMES

They are currently evaluating the model in breast cancer cells and launching pre-clinical testing with phase I and phase II trials within few years. Due to the extra simplicity DNA based carriers enable a broad application in the future. They hold a promise for delivering a variety of drugs targeting cancer and other diseases.

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