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Cubosomes and their role in various types of cancer treatment

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ABSTRACT

Cubosomes are special tiny lipid carriers that have a cubic phase structure. These little carriers are becoming popular in cancer treatment because of their neat features. For example, they can carry a lot of drugs, release them in a controlled way, and they are friendly to the body (that means biocompatible). This makes them great options for helping make cancer therapies work better while also cutting down on side effects.

In this review will thoroughly explore the structure and properties of cubosomes. This review will examine how they are made and explore all the ways they can be used in cancer treatment. This review also checks out how they stack up against other nanocarriers. There's a lot to learn about these fascinating little carriers.

Keywords: cubosomes, cancer therapy, drug delivery systems, liquid crystalline phases, nanostructures, targeted drug delivery, controlled release, surfactants, lipids, encapsulation, biocompatibility, high-pressure homogenization, microemulsion method functionalization, stimuli-responsive systems, chemotherapeutic agents, gene therapy immunotherapy, bioavailability, pharmacokinetics, surface modification, nanocarriers personalized medicine, scalability, stability regulatory requirements

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INTRODUCTION

Cancer is still a huge problem for many people everywhere. It can create a lot of health issues and sometimes, it can even lead to death. The usual treatments, like surgery, radiation, and chemotherapy, don't always do the trick. These methods often have downsides. They can fail to target the disease properly, hurt the whole body, and occasionally, the drugs just stop working [1-5].

But the latest nanotechnology is changing the game for cancer treatment. It helps deliver medicine right where it is needed, boosts how well treatments work, and reduces those nasty side effects. One type of nanocarrier, called cubosomes, has caught a lot of attention lately. Because they are very special with their own unique structures and functions.

Structure and properties of cubosomes

Cubosomes are tiny little particles that are made by nature, forming a special cubic shape. This shape is made of lipid bilayers all lined up in a three-dimensional way. Usually, they take on a structure called the Inverse Bicontinuous Cubic (IBC) phase.

Now, what makes them so fantastic? Well, here are some great reasons:

- Big surface area:

  Because of their cubic shape, they have a huge surface area which is perfect for loading drugs. This means you can fit a lot of medicine into them!

- Controlled release:

  Cubosomes help deliver medicine in a controlled way. Their sturdy design allows for a steady release, so the drugs can work for longer periods of time.

- Friendly to the body:

  The lipids used in making cubosomes are mostly safe for our bodies. They break down easily and usually don't cause bad reactions.

Synthesis and characterization

Cubosomes are usually made through methods like high-pressure homogenization, solvent evaporation, and microfluidic techniques. It is interesting to note that the method you pick can really change their size, shape, and how stable they are. For testing

and studying cubosomes, scientists use tools like Transmission Electron Microscopy (TEM), Small-Angle X-ray Scattering (SAXS), and Dynamic Light Scattering (DLS) [6, 7]. These techniques help figure out important details about the structure and properties of cubosomes (Figure 1).

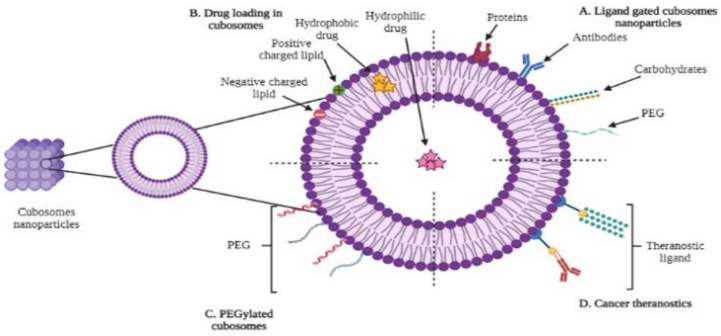

Fig. 1. Structure and properties of cubosomes

Applications in cancer treatment

Drug delivery:

Cubosomes show a lot of promise in delivering drugs. They can wrap hydrophobic drugs in a lipid layer and hydrophilic ones in aqueous channels. This makes them super flexible carriers for various types of medicines.

Some important drugs delivered through cubosomes are:

Chemotherapeutic agents:

Medicines like doxorubicin and paclitaxel have been designed into cubosomes. This helps them stay stable and lowers the chances of harming healthy cells.

Targeted therapy:

Cubosomes can be customized with ligands or antibodies. This way, they can find and focus on specific cancer cells much better.

Gene therapy:

Gene therapy aims to fix genetic issues or introduce helpful genes, especially for cancer treatment. Cubosomes play a big role here. They are special structures that can hold plasmid DNA or RNA. This is important because it keeps these materials safe from breaking down.

RNA interference (RNAi):

Cubosomes can carry tiny bits of RNA, like siRNA or miRNA, which help silence oncogenes and change gene activity.

Gene editing:

They also work for delivering CRISPR/Cas9 tools to edit genes right where it's needed in cancer cells.

Immunotherapy:

Immunotherapy uses our own immune system to fight with cancer. Cubosomes step in to deliver immune-boosting agents or bits that help get the immune system fired up.

Here's how they help:

Cancer vaccines:

They help send tumor-related antigens that kick off an immune reaction against those nasty cancer cells.

Checkpoint inhibitors:

Cubosomes can also deliver checkpoint inhibitors to tackle how tumours hide from the immune system.

Comparison with other nanocarriers

Cubosomes are often compared to other tiny carriers like liposomes, Solid Nanoparticles (SLNs), and polymeric. Each type has its own perks andides, and here a little breakdown for:

Liposomes:

Guys are popular and flexible. However, they sometimes struggle with much drug they cannot as much asosomes can.

Solid lip nanoparticles:

SLNs are stable and can release drugs in a controlled way. But there's always a but they don't have the same high surface area that cubosomes do.

Polymeric nanoparticles:

These carriers can be made for specific tasks, which is neat! Still, they might fall short when it comes to biocompatibility and that awesome drug-loading capacity we see with cubosomes [8].

Challenges and limitations

Cubosomes have a lot of promise, but they also have some bumps along the way. For instance, let's look at a few:

Complexity of synthesis:

Making cubosomes is not so simple. It needs careful control over various conditions. This can be tough and pretty pricey!

Stability issues:

Sometimes, cubosomes can become unstable in certain situations. This instability can hurt how well they work and how long they last on the shelf.

Regulatory and clinical translation:

Moving from lab experiments to real-world use isn't easy either. There are lots of tests involved and regulatory barriers to cross [9-12].

Future perspectives

The future for cubosomes in fighting cancer seems bright. There are exciting advancements in how they are made and used are looking into some cool areas:

Enhanced targeting:

They're working on new ligands and targeting parts to make cubosomes attack cancer cells more precisely [13-16].

Combination therapies:

This involves using cubosomes together with other treatments like radiation or targeted therapies. It's all about making treatments work better overall.

Personalized medicine:

This means changing cubosome formulas to fit each patient's needs and the specific traits of their tumours. It's a big step towards making cancer treatment more personal.

CONCLUSION

Cubosomes are really exciting in the world of nanomedicine. They have some pretty cool structural features and can used in many ways, especially for treating cancer. Sure, there are challenges out there, but ongoing research & development are working hard to tackle these issues. This means we could see some new and effective cancer therapies soon.

What makes cubosomes stand out is their ability to deliver drugs, genes, and even immune modulators. They're a valuable tool in the battle against cancer. Who knows? These tiny helpers might just change how we think about cancer treatment forever.

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