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A BRIEF REVIEW ON AQUASOMES

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ABSTRACT

Aquasomes are circular particles made of calcium phosphate or ceramic diamond coated with a polyhydroxyloligomeric film that function as nanoparticulate carrier systems. Despite their simplicity, aquasomes are three layered self-assembled structures made up of a hard stage crystalline nanostructures core covered with oligomeric film with or without modifications in pH on which biochemically active molecules are adsorbed. The carbohydrate coating prevents the biochemically lively molecules from dehydration and stabilises them, while the solid centre core offers structural stability. Following the synthesis of the solid ceramic core and polyhydroxyoligomeric material coatings such as cellulobiose and trehalose, the final stage was drug packing, in which the aquasomes serve as host particles, non-covalently interacting with the bioactive moiety through hydrogen and cationic bonding. Insulin, haemoglobin, and enzymes such as serratiopeptidase have also been successfully delivered using the delivery mechanism.

KEYWORDS: Introduction, Method of preparation, Characterization, Application.

INTRODUCTION

Multifunctional nanoparticles, quantum dots, Aquasomes, super paramagnetic iron oxide crystals, liposomes, Niosomes, and dendrimers are some of the biomaterials used in Nano biopharmaceutics. There are various forms of ‘somes’ such as Aquasomes (Carbohydrates-ceramic nanoparticles), which are a Nano biopharmaceutical carrier device with a polyhydroxyl oligomeric film covers a particle core consisting of nanocrystal line calcium phosphate or ceramic diamond.[1,2] Kossovsky suggested a method for preparing nanoparticles that carry so-called Aquasomes, which have a particle size (less than 1000 nm) that is suitable for parenteral administration because it prevents obstruction of bloodstream capillaries. Aquasomes are furthermore named as "bodies of water.[3,4]

METHOD OF PREPARATION OF AQUASOMES

1. Preparation of core material
2. Coating of core material
3. Immobilization of drug candidate

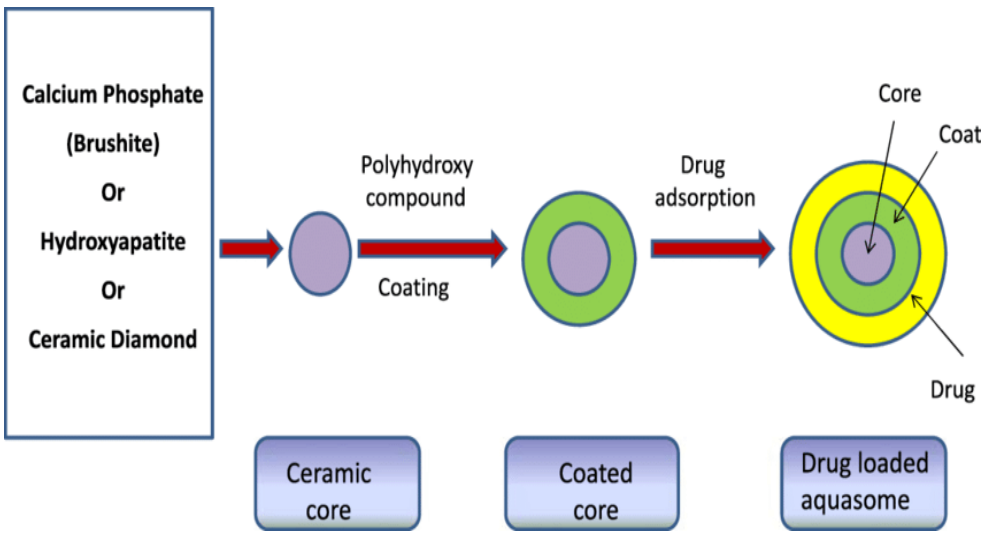

Fig: - Preparation of Aquasome.

Material used and its importance initially for preparation of nanoparticles core both polymers and ceramic can be used. Polymers used are albumin, gelatin or acrylates. Ceramics used are diamond particles, brushite (calcium phosphate) and tin oxide core. For core, ceramic materials were widely used because ceramics are structurally the most regular materials known, being crystalline high degree of order ensures (a) any surface modification will have only limited effect on nature of atoms below surface layer and thus bulk properties of ceramic will be preserved. (b) The surface will exhibit high level of surface energy that will favor the binding of polyhydroxy oligomer surface film. The freshly prepared particles possess good property of adsorbing molecules within fraction of seconds. Second step followed by coating of carbohydrate epitaxial over nanocrystal line ceramic core. The commonly used coating materials are cellobiose, pyridoxal-5-phosphate, sucrose and trehalose, presence of carbohydrate film prevents soft drug from changing shape and being damage when surface bound. Third step bioactive molecules adsorbed which possess property of interacting with film via non-covalent and ionic interactions.[5]

CHARECTERIZATION OF AQUASOMES

Aquasomes are characterized chiefly for their structural and morphological properties, particle size distribution, and drug loading capacity.

Characterization of ceramic core Size distribution

For morphological characterization and size distribution analysis, scanning electron microscopy and transmission electron microscopy are generally used. Core, coated core, as well as drug-loaded aquasomes are analyzed by these techniques. Mean particle size and zeta potential of the particles can also be determined by using photon correlation spectroscopy.

Structural analysis

FT-IR spectroscopy can be used for structural analysis. Using KBr sample disk method, the core as well as the coated core can be analyzed by recording their IR spectra in the range of 4000–400 cm–1; the characteristic peaks observed are matched with reference peaks. Identification of sugar and drug loaded over the ceramic core can also be confirmed by FTIR analysis of the sample.[6]

Crystallinity

The ceramic core can be analyzed for its crystalline or amorphous behavior using X-ray diffraction by comparing the diffraction patterns of the sample and standard and the interpretations are made.

Characterization of coated core

Carbohydrate coating

The concanavalin a induced aggregation method (which calculates the amount of sugar coated over the core) or the anthrone method (which determines the quantity of sugar covered above the core) can also be used to figure out how much sugar is smeared on the ceramic heart (determines the quantity of boundless sugar or remaining sugar left later coating). Zeta potential calculations can even be put to use validate sugar adsorption over the breast.[8, 9, 10]

Glass transition temperature

The result of carbohydrate on the drug burdened into Aquasomes can be studied using DSC. Glass transition temperatures of carbohydrates and proteins have been studied extensively using DSC techniques. Using a DSC analyzer, the changeover from glass to rubber can be calculated as a change in temperature when glass is melted.[16] Characterization of drug-loaded Aquasomes Drug payload by incubating the simple aquasome preparation (i.e., lacking medication) in a well-known attention of the drug solution for 24 hours at 4°C, the drug filling can be determined. In a refrigerated centrifuge, the supernatant is detached by high-speed centrifugation intended for 1 hour through short temperature. Any appropriate method of analysis can be used to estimate the quantity of drug left in the supernatant liquid later loading.[7]

In vitro drug release studies

The in vitro release kinetics of the loaded drug was calculated by hatching a known amount of drug-burdened Aquasomes in a buffer of appropriate pH at 37°C using nonstop stirring to research the discharge pattern of drug from the Aquasomes. Periodically, samples are taken and centrifuged at high speeds for a set amount of time. After each removal, equal volumes of medium must be substituted. Any appropriate method is then used to decide the amount of drug free from the supernatants.[16]

In-process stability studies

During the preparation of the Aquasomes, SDS-PAGE (sodium dodecyl sulphate polyacrylamide gel electrophoresis) can be used to assess the protein's stability and integrity.[8, 9, 10]

FATE OF AQUASOMES

1. Since aquasomes are biodegradable nanoparticles, so that they will be more concentrated in liver and muscles. Since the drug is adsorbed on to the surface of the system without further surface modification as in case of insulin and antigen delivery, they may not find any difficulty in receptor recognition on the active site so that the pharmacological or biological activity can be achieved immediately, in normal system, the calcium phosphate is a biodegradable ceramic.
2. Monocytic activities can be modulated by many soluble factors and are increased by IFN-g (interferon gamma) or 1, 25 dihydroxy cholecalciferol. Other cytokines can also contribute to inflammatory mechanism and may be involved in the biodegradation process.

PROPERTIES

• Aquasomes possess large size and active surface hence can be efficiently loaded with substantial amounts of agents.
• Aquasomes mechanism of action is controlled by their surface chemistry.
• They deliver contents through combination of specific targeting, molecular shielding, and slow and sustained release process.
• Water like properties provides a platform for preserving conformational integrity and bio chemical stability of bio-actives.
• Aquasomes due to their size and structure stability avoid clearance by reticuloendothelial system or degradation by other environmental challenges.
• Calcium phosphate is biodegradable and its degradation can be achieved by monocytes and osteoclasts.[11, 12]

ADVANTAGES

• Aquasomes based vaccines offer many advantages as a vaccine delivery system. Cellular and humoral immune responses can be elicted to antigens adsorbed on to aquasomes.[4]
• Multilayered aquasomes conjugate with bio recognition molecules such as antibodies, nucleic acids, peptides which are known as biological labels can be used for various imaging tests.
• They increase the therapeutic efficacy of pharmaceutically active agents and protects the drug from phagocytosis and degradation.
• These nanoparticles offer favorable environment for proteins thereby avoiding their denaturalization.

APPLICATION

- Prepared aquasomes using a calcium phosphate ceramic core for the parenteral delivery of insulin. The core was coated with various disaccharides such as cellobiose, trehalose, and pyridoxal-5-phosphate. Subsequently the drug was loaded to these particles by adsorption method. The in vivo performance of various aqua some formulations of insulin was evaluated using albino rats. Prolonged reduction of blood glucose was observed with all formulations except cellobiose-coated particles. Pyridoxal-5-phosphate coated particles were found to be more effective in reducing blood glucose levels than aquasomes coated with trehalose or cellobiose. This could be attributed to the high degree of molecular preservation by pyridoxal-5-phosphate.
- Aquasomes used as vaccines for delivery of viral antigen i.e., Epstein-Barr and Immune deficiency virus[14] to evoke correct antibody, objective of vaccine therapy must be triggered by conformationally specific target molecules.
- Aquasomes have been used for successful targeted intracellular gene therapy, a five layered composition comprised of ceramic core, polyoxyoligomeric film, therapeutic gene segment, additional carbohydrate film and a targeting layer of conformationally conserved viral membrane protein.[15]
- Aquasomes for pharmaceuticals delivery i.e. insulin, developed because drug activity is conformationally specific. Bioactivity preserved and activity increased to 60% as compared to i.e. administration and toxicity was not reported.[16]
- Aquasomes also used for delivery of enzymes like DNAase and pigments/dyes because enzymes activity fluctuates with molecular conformation and cosmetic properties of pigments are sensitive to molecular conformation.
- Aquasomes as red blood cell substitutes, hemoglobin immobilized on oligomer surface because release of oxygen by hemoglobin is conformation ally sensitive. By this toxicity is reduced, hemoglobin concentration of 80% was achieved and reported to deliver blood in nonlinear manner like natural blood cells.[17]

CONCLUSION

Aquasomes represent one of the simplest yet a novel drug carrier based on the fundamental principle of self assembly. The drug candidates delivered through the aquasomes show better biological activity even in case of conformationally sensitive ones. This is probably due to the presence of the unique carbohydrate coating the ceramic. Also these formulations have been found to evoke a better immunological response and could be used as immune adjuvant for proteinaceous antigens. This approach thus provides pharmaceutical scientists with new hope for the delivery of bioactive molecules. Still, considerable further study of aquasomes is necessary with respect to pharmacokinetics, toxicology, and animal studies to confirm their efficiency as well as safety, so as to establish their clinical usefulness and to launch them commercially.

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