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Aquasomses: An Innovative Method for Drug Delivery

Mr. Sanket P. Shinde[1], Ms.Sayyad Sana Sadik Ali[2], Ms.Safiya Abdul Inamdar[3],

Department of Pharmaceutical Quality assurance, Assistant professor, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India[1]

Scholar,B. Pharmacy, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India[2]

Scholar, ,B. Pharmacy, Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India[3]

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KEYWORDS

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ABSTRACT:

Recently, a class of nanoparticle carrier system known as aquasome has come to light as a potentially effective means of delivering bioactive compounds like peptide and protein.Around 60-300nm in size, aquasomes are round particles. They consist of an oligometric film covering a nanocrystalline solid core,onto which biochemically active molecules are adsorbed,either modified or not.Three-layered self-assembling strucutres make up aquasome. Aquasomes are useful in many ways such as targeted delivery vehicles for viral antigens,a substitute for red blood cells, and a means of delivering intracellular gene therapy. The capacity of aquasome to release bioactive compounds continuously over an extended period of time is one of their main advantages as a delivery mechanism. This may lessen the need for frequently dosage and increase the effectiveness of the moleules delivered.

Conclusions: Aquasome the novel drug delivery system has come with the satisfying hope for pharmaceutical scientists for the administration of formulation. Though Aquasomes have many advantages yet extensive researchers are identifying and studying on its toxicity, safety & efficacy in human body.

1. Introduction

The direction of drug delivery has shifted in the last few years due to the development of novel approaches that yield nanoparticles with complex functionalized features when combined with pharmaceuticals. Instead of being made up of simple core nanoparticles, aquasomes are nanoparticulate carrier systems that have an oligomeric film coating [1] that allows biochemically active molecules to be adsorbed.[2] Aquasomes have a wide range of potential uses, including imaging and diagnosis as well as medicine delivery for conditions like diabetes, cancer, and cardiovascular disease. The nanoparticles are highwater content and ability to stay stable in water.[3]Aquasomes, which were initially developed by Nir Kossovsky, are dissolve thought to be the most recently developed drug delivery system[4] for therapeutics because of their capacity to deliver active molecules, including proteins, peptides, hormones, antigens, genes, and drugs of various categories, to specific sites.[5] Often referred to as "bodies of water," aquasomes' water-like characteristics shield and maintain delicate biological components.[6] Nanotechnology has surfaced fields of biomedical exploration in the last many decades the presents context is an attempt to present the brief information about nanobiotechnological applications.[7] Aquasomes are one of the mostly developed delivery system for bioactive moles like peptide, protein, hormones, antigens and genes to specific spots. Aquasomes are globular in shape with of 300 nm particles size. [8]

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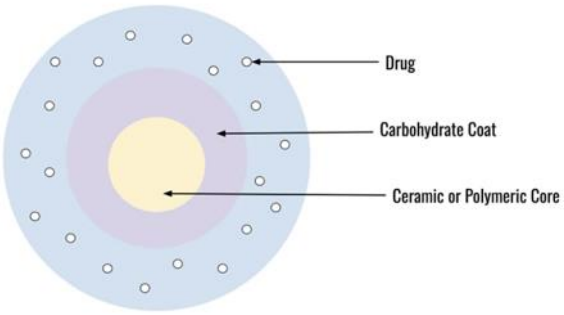

Fig.1 Structure of Aquasome

2. Objectives

1. The objective of preparing aquasome is to protect bio-actives.[9]
2. Maintains molecule conformation and optimum pharmacological activity.[10]
3. Preserving molecule in dry solid state by using stabilizer like various polyhydroxy sugars acts as dehydro protectant maintains water.[11]

3. Methods

Composition of Aquasomes

a. Core material
b. Coating material
c. Cellobiose
d. Trehalose
e. Bio-active molecule [15]

1. Preparation of the core: this core preparation is depend on the type of the core to be used. Example of core material is carbon ceramic (diamond), calcium phosphate etc. The choice of core material affects the ceramic core preparation process. The two most popular ceramic cores are made of calcium phosphate and diamond. [3,16,23]
2. Nanocrystalline brushite (calcium phosphate dihydrate) is prepared by different method co-precipitation, sonication etc. uncontrolled pH leads to formation of large, elongated particles with micrometer size range. when pH was maintained in between 8 &10 & no sintering took place. [18,24]
3. Core coating: carbohydrate is added to core by sonication, coating can also be done by adsorption by direct incubation & by nonsolvent addition [16] without carbohydrate coating drug laoding was less as compared to carbohydrate coated core. so, it is found that carbohydrate film on core facilitates rate of drug absorption. [18,32]
4. Drug immobilization or drug loading: at last, the medication molecule is transferred to the coated aquasomes surface. Various techniques, including adsorption and covalent bonding [3,23] drug loading vary when loaded with different carbohydrate. [25,26]

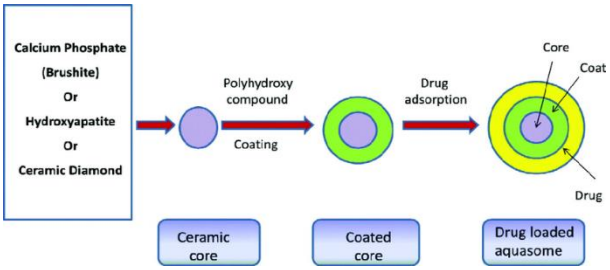

Fig.2 Method of preparation of Aquasome

4. Properties of Aquasome:

1. Aquasomes may efficiently load huge amounts of agents employing ionic, non-covalent, van der Waal, and entropic forces due to their vast size and active surface.[12]
2. The medium that aquasomes offer helps to preserve the biochemical stability and bioactive conformational integrity.[12]
3. Aquasomes are resistant to degradation.[13]
4. These carriers also protects the drug from harsh pH condition.[14]
5. Nanoparticle-Since aquasomes are nanoparticles, they have large surface area thus can be loaded with significant amount of biochemically active molecule through van der waals forces, entropic forces, ionic and non- covalent bonds. The core material widely used is calcium phosphate. [15]
6. Calcium phosphate-Calcium phosphate which is used as core material in aquasome, is biodegradable in nature. It is prepared from the precipitation of a monobasic sodium phosphate solution and calcium chloride solution with mechanical agitation.[16]
7. Carbohydrate coating: Aquasomes provides water like environment due to presence of carbohydrate coating and preserves conformational stability of biochemically active molecule Polysaccharide film stabilizes the ceramic core through ionic, non-covalent, and entropic forces. [17]
8. Self-assemble-three layered structure is based on the principle of self assembly which is achieved by non-

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covalent & ionic bonds. This surface free energy influenced self-assembly.

9. Drug incorporation process-Biochemically active molecules are absorbed through ionic and non-covalent system by adsorption carbohydrate coated core increases the system by drug encapsulation efficiency.[18]
10. Aquasomes as a carrier are resistant to degradation brought on by various external factors as well as removal by the reticuloendothelial system.Deliver content through combination of specific targeting, molecule shielding & sustained release process.[19]

5. Advantages

1. In aquasome carbohydrate coating prevents destructive denaturing interaction between drug & solid carrier.
2. Beneficial to avoid multiple injection schedule.
3. Increase therapeutic efficacy pharmacologically active ingredient & prevents phagocytosis.
4. Aquasomes offer a medium for preserving the biochemical stability and conformational integrity of bioactive drugs. [2,19,20,21]

6. Limitation

1. In Aquasome film coating poor tablet finish occurs due to high viscosity of coating solution.
2. The opsonisation and phagocytic clearance of aquasome may occur.
3. If the drug is poorly absorbed, it may cause burst release in the body that cause toxicity [15,22]

7. Evaluation

1. **Colormetric analysis of sugar coating on to the ceramic core**- Anthrone method is one of the method which produces green coloured product. It used to quantify the unbound residual sugar after coating. By addition of anthrone reagent sample are heated in boiling water bath and cooled rapidly. After greenish solution obtained, absorption is recorded.
2. **Zetapotential**- Zeta potential dispersity calculated by the sugar coated particles can be further characterized by FTIR, transmission electron microscopy powder, X-ray diffraction, Electrophoretic light scatter analysis.
3. **In vitro drug releasestudies -** The in vitro release kinetics is to study the release pattern of drug from the aquasomes bye incubating. sample are centrifuged at high speed for certain lengths of time. Equal volume of medium must be replaced after each withdrawal the supernant are then analyzed.
4. **Drug Loading Efficacy** -This test done to ensure the amount of drug each is bound on surface of aquasome.
5. **The Antigen Loading Efficacy**-Accurately, weight antigen loading aquasome formulations were suspended in Triton X-100 and incubated for 1h. Then, samples are centrifuged at and absorbance is determined by using micro BCA method. Antigen loading is expressed gram of antigen / mg of sample (as per unit weight of aquasome particles). [27,28,33]

8. Application

1. In Diabetic patient-the aquasome with core coated with disaccharides like cellobiose, pyridoxine-5-phosphate. One protects drug molecule dehydration and other is more effective than cellobiose respectively.
2. Transportation of enzyme: aquasomes are utilized for the transport of enzymes such as DNAase and pigments/dyes. The ceramic core based system for oral administration of acid-liable enzyme serratiopeptidase.
3. Oxygen carrier: Red blood cells replenish aquasomes, and because haemoglobin's release of oxygen is conformationally sensitive, haemoglobin becomes immobile on the oligomer's surface. The concentration of haemoglobin surpassed 80% by lowering this toxicity. The loading capacity approximately 13.7mgHb /gm of core.
4. Delivery of Vaccine.
5. Gene Therapy: Targeted intracellular gene therapy has been successfully implemented with the use of Aquasomes. [2,9,23,25,31]

9. Results

ACTIVE INGREDIENTS	PURPOSE OF USE	RESULTS
Mussel adhesive Protein[29]	Antigen delivery	Stability of antigen due to prescene of carbohydrate.
Haemoglobin[16]	Oxygen carrier	Oxygen carring capacity was same as fresh blood & Hb

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		was stable over 30 days.
Piroxicam [18]	Poorly water soluble drug delivery	Diffusion controlled release of drug.
Etoposide [34]	Poorly water soluble drug delivery	Maximum percentage of injected dose was in liver & spleen.

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