INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Article

Aquasomes: A Novel Carrier for Drug Delivery

Akash Ingale, Dr. Parag Patil, Rushikesh Lohar, Manoj Bachche, Omkar Shelake, Dr. Nilesh Chougule

KYDSCTS College Of Pharmacy Sakegaon
Ashokrao mane institute of Pharmacy Ambap

ARTICLE INFO

Published: 01 Dec. 2024
Keywords:
Aquasomes, self-Assembling carrier system, Nanoparticles
DOI:
10.5281/zenodo.14253031

ABSTRACT

This method is known worldwide for nanoparticular carriers referred to as aquasomes. Aquasomes are the type of nanoparticles and made up of three-layered self-assembled structures, consisting of a solid-phase nanocrystalline core covered with oligomeric film, biochemically active molecules that are typically absorbed with or without modification. Aquasomes are a nano-biopharmaceutical carrier device consisting of a particle center made up of a nanocrystalline calcium phosphate or a ceramic diamond surrounded by a polyhydroxy oligomeric film. Aquasomes are spherical in form containing 60–300 nm particles used for drug and antigen distribution. Their characteristics are that they shield and maintain delicate biological molecules, conformation integrity, and surface visibility, allowing aquasomes to be a good carrier mechanism for unique sites for bio-active molecules such as peptides, proteins, hormones, antigens, and genes. Three types of core materials are primarily used for the processing of aquasomes: tin oxide, nanocrystalline carbon ceramic (diamonds), and brushite (calcium phosphate dihydrate). Brushite is unstable, and it is converted to hydroxyapatite when stored for a long time. Calcium phosphate is the core that is naturally present in the body. As a result, hydroxyapatite appears to be the better core for aquasome preparation. It is primarily used in the preparation of implants for drug delivery. Drug delivery via aquasomes is facilitated by precise targeting, molecular shielding, and a slow, sustained release process.

INTRODUCTION

The “Somes” are cell-like formulations of novel drug delivery systems. In the last few decades, many technological strategies have been proposed for obtaining nanoparticles of different natures, leading to a revolutionary change in drug administration systems. Drug delivery vehicle aquasomes are colloidal-range biodegradable nanoparticles designed to concentrate in the liver and muscles. Because the drug is absorbed on the

***Corresponding Author:** Akash ingale
Address: *KYDSCTS College Of Pharmacy Sakegaon.*
Email ✉: ingaleakash111@gmail.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

surface of the system without surface modification, they do not face difficulty in recognizing receptors at active sites. Aquasomes, also referred to as "Bodies of water," possess water-like properties that protect and preserve fragile biological molecules. This property ensures the conformational integrity and high surface exposure of bio-active molecules like peptides, protein hormones, antigens, and genes at specific sites. Aquasomes were first developed by Nir Kossovsky, with a particle size of less than 1000 nm. These pharmacologically active molecules are unified by copolymerization, diffusion, or adsorption to carbohydrate surfaces of pre-formed nanoparticles. Three types of core materials are commonly used for producing aquasomes: tin oxide, nanocrystalline carbon ceramics (diamonds), and brushite (calcium phosphate dihydrate). The self-assembly of these three-layered structures occurs through non-covalent bonds in aqueous environments. The principle of "self-assembly of macromolecules" is governed by three physiochemical processes:

1. Interaction between charged groups.
2. Hydrogen bonding and dehydration effects.
3. Structural stability.

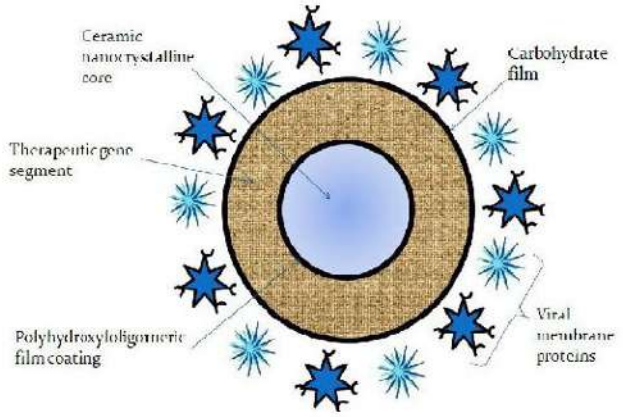
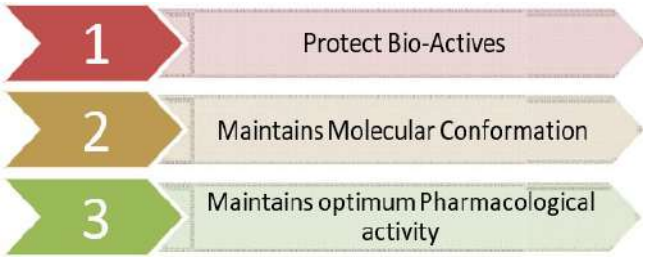


Fig. 1 - Structure of Aquasomes

OBJECTIVE



PROPERTIES

1. Aquasomes have a large size and an active surface, so significant quantities of agents can be loaded efficiently by ionic, non-covalent bonds, van der Waals, and entropic forces. The physical properties of colloids are seen as solid particles scattered in an aqueous environment.
2. The mechanism of action of the aquasomes is regulated by their surface chemistry. Aquasomes provide content by incorporating precise targeting, molecular shielding, and the mechanism of gradual and sustained release.
3. The water-like properties of aquasomes provide a medium to maintain the conformational integrity and biochemical stability of bio-actives.
4. Aquasomes avoid clearance by the reticuloendothelial system or degradation by other environmental challenges because of their size and structural stability.
5. As a carrier, aquasomes protect the drug/antigen/protein from harsh pH conditions and enzymatic degradation, resulting in lower doses.
6. The mechanism of action of aquasomes shall be governed by their surface chemistry.

METHOD OF PREPARATION OF AQUASOMES [11-16]

1. Core preparation.
2. Coating of core material.
3. Immobilization of drug candidate.

- **Core Preparation**: The first step in the preparation of the aquasome is the production of the ceramic core. The ceramic core preparation process depends on the selection of

core materials. Colloidal precipitation and sonification, inverted magnetron sputtering, plasma condensation, and other processes can produce these ceramic cores. Ceramic materials have been widely used for the core since ceramics are structurally the most common materials known. The high degree of ceramic order, crystalline, means that any surface alteration can have only a minimal impact on the existence of the atoms below the surface layer, thereby maintaining the ceramic's bulk properties. The high degree of order also ensures that high levels of surface energy are exhibited on the surfaces that favor the binding of polyhydroxy oligomeric surface film. In order to extract sodium chloride produced during the action, the precipitated cores are centrifuged and then washed with appropriate distilled water. In distilled water, the precipitates are resuspended and passed through a fine membrane filter to collect particles of the desired size.

- **Carbohydrate Coatings**: The second stage involves carbohydrate coating on the surface of the ceramic cores. There are a range of processes that allow the coating of carbohydrates (polyhydroxy oligomers) to adsorb epitaxially on the surface of nanocrystalline ceramic cores. The processes usually include the addition of polyhydroxy oligomers to the dispersion of meticulously washed ceramics in ultra-pure water, sonication, and lyophilization to facilitate the mostly irreversible adsorption of carbohydrates on ceramic surfaces. Excess and quickly desorbing carbohydrates are extracted by ultrafiltration of the stir cells. The most widely used coating materials are cellobiose, citrate, pyridoxal-5-phosphate, sucrose, and trehalose.
- **Drug Immobilization**: Surface-modified nanocrystalline cores provide a solid step for subsequent non-denaturing self-assembly for a wide variety of biochemically active molecules. The drug can be charged by partial electron microscopy of adsorption. Morphology and size distribution were obtained through scanning electron microscopy images.

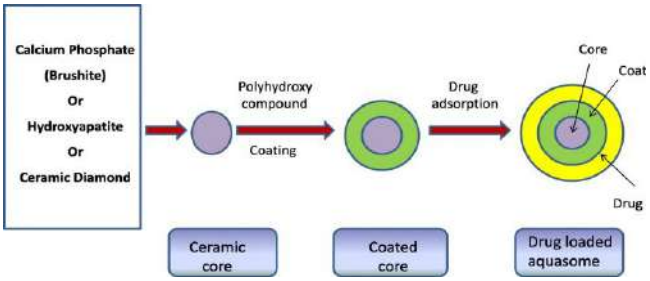


Fig. 2 - Drug Immobilization

MATERIALS USED AND ITS IMPORTANCE [17-23]

Polymers and ceramics both cores can be used initially for the preparation of nanoparticles. The polymers used are albumin, gelatin, or acrylate. Diamond flakes, brushite (calcium phosphate), and tin oxide core are the ceramics used. Ceramic materials were commonly used for hearts, since ceramics are structurally the most commonly known materials, being crystalline, high order guarantees a high degree of order.

Any alteration of the surface will have a minimal effect on the nature of the atoms below the surface layer and thus the bulk properties of the ceramic will be preserved. The surface will exhibit a high degree of surface energy which will favor the binding of the polyhydroxy oligomer surface film. Within fractions of seconds, the freshly prepared particles have good adsorbing molecules. The second stage was preceded by the epitaxial coating of carbohydrates over the nanocrystalline ceramic heart. Cellobiose, pyridoxal-5-phosphate, sucrose, and trehalose are the widely used coating products. The presence of carbohydrate film prevents soft drugs from changing form and being weakened when surface attached. Adsorbed third-stage bioactive molecules have the property of

interacting with the film through non-covalent and ionic interactions.

CHARACTERIZATION OF AQUASOMES

1. X-ray powder diffractometry.
2. Transmission electron microscopy.
3. Scanning electron microscopy.
4. Drug Loading Efficiency.
5. Particle size distribution.
6. Zeta Potential.
7. In-vitro drug release.
8. Structural and morphological properties.

APPLICATIONS OF AQUASOMES

1. Aquasomes are hemoglobin immobilized on the oligomer surface as red blood cell substitutes because hemoglobin release of oxygen is confirmatively responsive. This toxicity decreases the concentration of hemoglobin by 80%, which is recorded to deliver blood in a non-linear way, like normal blood cells.
2. Aquasomes are used as vaccines for viral antigen delivery, i.e., in order to elicit the right antibody, Epstein-Barr and Immune Deficiency Virus, the purpose of vaccine therapy must be caused by unique conformational target molecules.
3. Aquasomes have been used for active targeted intracellular gene therapy, a five-layer composition consisting of ceramic center, polyoxyoligomeric film, therapeutic gene section, additional carbohydrate film, and a conformationally conserved viral membrane protein targeting layer.
4. Aquasomes for the delivery of pharmaceuticals, i.e., insulin, produced as the action of drugs is conformationally specific. Preserved bioactivity and activity increased to 60% relative to intravenous administration and toxicity unreported.
5. Aquasomes are also used to distribute enzymes such as DNA and pigments/dyes since the activity of enzymes fluctuates with molecular conformation and pigments' cosmetic properties are sensitive to molecular conformation. [28-32]

CONCLUSION

In this paper, it is observed that aquasomes are one of the simplest yet novel drug carriers based on the fundamental principle of self-assembly. Even when conformationally sensitive drug candidates are delivered via aquasomes, they show better biological activity.

Aquasomes, which are self-assembling surface-modified nanocrystalline ceramic cores, appear to be promising carriers capable of preserving the structural integrity of protein pharmaceuticals and serving as a carrier for a wide range of molecules such as viral antigens, hemoglobin, and insulin, resulting in improved therapeutic effects. However, a considerable further study of aquasomes with respect to pharmacokinetics, toxicology, and animal studies is needed to confirm their efficacy and safety, in order to establish their clinical usefulness and commercially launch them. The aquasome-based strategy would therefore be significant in the novel delivery of other bioactive molecules.

REFERENCES

1. Chaudhari M, Pandya D, Thakkar P, Soni A, Modi D. Aquasomes: a novel drug delivery system. Chem Inform. 2013; 44(38).
2. Girotra L, Bajaj R. Emerging Trends and Recent Advances inAquasomes: A Review. InVentiv Rapid: Pharm Tech. 2012
3. Bhairav BA, Wagh YB, Saudagar RB. Review:aquasomes a potential drug delivery carrier. Int JInstitutional Pharmacy Life Sci, 2015; 5(6): 36-47.
4. Narang N. Aquasomes: Self-assembled systems forthe delivery of bioactive molecules. Asian J Pharm,2012; 6: 95-100.
5. Jain SS, Jagtap PS, Dand NM, Jadhav KR, KadamVJAquasome: a noval drug carrier J. Appl. Pharm.Sci. 2012; 2(1): 184-192

6. Pandey RS, Dixit VK, Sahu S, SudheeshMS,Madan J, Kumar M. Carbohydrate modifiedultrafine ceramic nanoparticles for allergenimmunotherapy. Int Immunopharmacology, 2011; 11:925-931.
7. Shahabade Gururaj S, Bhosale Ashok V, Mutha Swati S, Bhosale Nilesh R, Khade Prashant H. An overview on nanocarrier technology-Aquasomes. Journal of Pharmacy Research, 2009; 2(7).
8. Irma Rojas-Oviedo, Rodrigo A. Salazar-L ´opez, "Elaboration and structuralanalysis of aquasomes loaded with Indomethacin" europeanjournalof pharmaceutical sciences Nov; 32(3):223-30.
9. Kumar J, Kumar VV, Mounica R, Bolla SP, Pavani M.Aquasomes-the best carriers for protein and peptide delivery. Asian J Pharm Res Dev 2013;1(4):16-23.
10. Jain S, Jain NK, Jain NK.Liposomes as drug carriers. In: Jain NK editors. Controlled and novel drug delivery,1st ed.New Delhi: CBSPublishers& Distributors; 1997:304-352.
11. Kossovsky, N.; Gelman, A; Sponsler, E.E.; Hnatyszyn, AJ.; Rajguro, S.; Torres, M.; Pham, M.; Crowder, J.; Zemanovich, J.; Chung, A and Shah, R "Surface modified nanocrystalline ceranlic for drug delivery applications." Biomaterials, 1994a 15: 1201-1207.
12. Kossovsky N. and Millett D. "Materials biotechnology and blood substitutes." Matr. Res. Soc. Bull., Sept.: 1991 78-81.
13. Kossovsky, N.; Bunshah, R F.; Gelmm, A; Sponsler, E.D.; Dmarjee, D.M.; Suh; T.G.; Pralash, S.; Doel;H. J. and Deshpandey, Cv. "A non-denaturing solid phase pharmaceutical carrier comprised of surface modified nanocrystalline materials." 1. Appl. Biomater. 1990 1:289-294.
14. Kossovsky, N.; Gelman, A; Sponsler, E.D.; Millett, D. "Nano-crystalline Epstein-Bar Vims decoys." 1. Appl. Biomater. 1991 2: 251-259.
15. Umashankar MS, Sachdeva RK, Gulati M.Aquasomes: A promising carrier for peptides andprotein delivery. Nanomedicine, 2010; 6; 419-426.
16. Leclerc L, Chauvierrea C, Mardenb MC, VauthieraC, Labarrea D, Couvreura P. Heparin coated poly(alkyl cyanoacrylate) nanoparticles coupled tohemoglobin: A new oxygen carrier. Biomaterial,2004; 25: 3081-3086.
17. Herbert, T.A.; Brash, J.L." proteins at interface; current issues and future prospects "in; Brash. J.L. and Herbert, T.A," Proteins at interfaces physiochemical and biological studies" ACS Symposium Series, 343; Washington: Acs, 1987. pp 1-33.
18. Israelachvilli, J.N.;"Intermolecular and surface force" New York. Academic press.1985.
19. Johnson, L.N; Cheetham, J: Mclaughlin, P.J.; Acharya, k. R.: Barford, D and Philips. D. C."Protein oligosaccharide interactions: lysozyme phosphorylase amylase. "cur top. 1985. 139:81-134.
20. Bauman, H. and Gaul die, J."The acute phase response" Immunol. Today, 1994; 15:74-78.
21. Byfield, D.C.; Phren, J.L. and Jordan's, s.: Stimulus specific 1'25(oh) 2d3 modulation of TNF and beta gene expression in
22. human peripheral blood mononuclear cells and monocytic cell lines. "Transplantation 51" 49824503. 1991.
23. S.M. Moghimi, A.C. Hunter, and J.C. Murray. Nanomedicine: current status and future prospects. FASEB J. 2005; 19: 311-330.
24. R.D. Handy, F.D. Kammer, J.R. Lead, M. Hassello¨v, R. Owen, M. Crane, Ecotoxicology, 2008; 17, 287.
25. Girotra L, Bajaj R. Emerging Trends and Recent Advances inAquasomes: A Review. InVentiv Rapid: Pharm Tech. 2012.

26. Sirikonda AK, Kumar BV, Soma Sekhar A, Gopi M, Babu HS, Rao GS. Aquasomes: A Review. Chem Inform. 2014; 45(14).
27. Gholap AD, Bo rude SS, Mahajan AM, Gholap MAD. Aquasomes: A potential drug delivery carrier. Pharmacology Online. 2011; 3: 230-7.
28. Sirikonda AK, Kumar BV, Soma Sekhar A, Gopi M, Babu HS, Rao GS. Aquasomes: A Review. Chem Inform. 2014; 45(14).
29. Kosovska, Gelman. A. and Sponsler, E.E." Cross linking encapsulated hemoglobin solid phase supports: lipid enveloped hemoglobin adsorbed to surface modified ceramic particles exhibit physiological oxygen lability artificial cells blood sub "biotech, 1994; 223: 479-485
30. Cherian, A. and Jain S.K. "Self-assembled carbohydrate stabilized ceramic nanoparticles for the parenteral drug delivery of insulin". 2000; 459-463.
31. Vyas S P, Khar R k., Targeted & controlled Drug Delivery, CBC Publisher & distributors, New Delhi, 2004: 28- 30.
32. Pavani V, Dintakurthi S, Aslam S, Gollagudem R, Pabbapi K. Aquasomes: A Novel Drug Carrier System. Chemical Inform. 2013; 44(22).

HOW TO CITE: Akash Ingale, Dr. Parag Patil, Rushikesh Lohar, Manoj Bachche, Omkar Shelake, Akash Ingale, Dr. Nilesh Chougule, Aquasomes: A Novel Carrier for Drug Delivery, Int. J. of Pharm. Sci., 2024, Vol 2, Issue 12, 9-14. https://doi.org/10.5281/zenodo.14253031