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Aquasomes: A Novel Nanoparticulate Drug Delivery System for Psoriasis Treatment

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ABSTRACT:-
New nanoparticulate carriers called aquasomes are applied topically to administer drugs, especially in dermatology. These carriers consist of a solid core, often made of calcium phosphate or ceramic, covered by a polyhydroxy oligomer layer. This unique shape protects the bioactivity of fragile molecules like proteins, enzymes, and genetic material. Aquasomes are particularly helpful for enhancing the regulated release, stability, and bioavailability of medicinal substances while lowering systemic absorption and undesirable side effects.

Skin conditions are among the most prevalent health issues in the world and have a significant financial burden. The psychological, social, and financial effects of skin diseases on patients, their families, and society as a whole are all included in the multifaceted concept of the burden of skin diseases. While malignant diseases like malignant melanoma carry a high death rate, chronic and incurable skin conditions like psoriasis and eczema are linked to severe morbidity in the form of physical discomfort and a reduction in patients' quality of life.

Treatment ideas have significantly evolved as a result of psoriasis, a systemic disorder with distinctive skin signs and related conditions. The intricacy of psoriasis necessitates not only the right treatment but also weight-loss and smoking cessation programs, as well as the removal of trigger factors. 1. Improved medication delivery; 2. Better skin penetration; 3. Anti-inflammatory benefits; 4. Skin barrier repair and moisturization; and 5. Decreased drug resistance and adverse effects are some of its mechanisms.

Keyword:-Aquasome, Psoriasis, Mechanism of aquasomes in treatment of psoriasis.

I. INTRODUCTION:-

Aquasome is a self-assembled nanoparticulate carrier system with three layers. The system is made up of a polyhydroxy oligomer-coated inner nanocrystalline solid core. Organic molecules or compuestosbioquímicamenteactivos are absorbed on the coated layer. In estecontexto, self-assembly se refiere a la formaciónindependiente de molecules en estructurasorganizadas, duraderos y no covalently vinculadas. Este documentoofreceun panorama de la formación de aquasome, abordandopropiedadesestructurales, métodos de formulación, y los pros y contras de estarecientetécnica de administración de medicamentos. El artículoprincipalmente se enfoca en los procedimientos de formulaciónempleados para construir nanostructures self-assembled y their diversasposiblesusos (1)

Aquasomes are a relatively new technique for delivering bioactive compounds like as peptides, proteins, hormones, antigens, and genes to particular areas. Aquasomes are spherical in shape and contain particles ranging in size from 60 to 300 nm. These are nanoparticulate carrier systems, but instead of simple nanoparticles, they are three-layered self-assembled structures made up of a solid phase nanocrystalline core coated with an oligomeric film onto which biochemically active molecules are adsorbed with or without modification. These structures are self-assembled via noncovalent and ionic bonding. The solid core offers structural stability, while the carbohydrate covering prevents dehydration and stabilises the biochemically active molecules. The delivery system has been effectively used for the delivery of insulin, haemoglobin, and enzymes such as serratiopeptidase.This article discusses the concepts of self-assembly, the difficulty of maintaining the conformational integrity and biochemical activity

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of immobilised surface pairs, the convergence of these principles into a single functional composition, and its application in diverse areas of pharmacy. (2)

Dr. Gregory Gregoriadis described the potential utilisation of nanoparticle systems as medicinal carriers in 1974. He proposed liposomes as a nanoparticulate medication delivery method. (3)

Nanocarriers for drug delivery include liposomes, solid lipid nanoparticles, dendrimers, polymers, niosomes, silicon nanoparticles, gold nanoparticles, carbon nanotubes, and magnetic nanoparticles. Drug is adsorbed, covalently bonded, or encapsulated within the nanocarrier system. (4)

The "somes" are cell-like formulations of innovative medication delivery systems. There are other sorts of'somes', such as aquasomes (carbohydrates-ceramic nanoparticles), which arenano-biopharmaceuticals. The carrier system consists of a particle core made of nanocrystalline calcium phosphate or ceramic diamond that is covered by a polyhydroxyloligomeric layer. Alternatively, aquasomes are known as "bodies of water." These three-layered structures are self-assembled via non-covalent bonds. Three physiochemical processes govern the "self assembly of macromolecule" principle. 1) Interaction between charged groups. The interaction of charged groups promotes a long-range approach of self-assembling subunits. Charge groups also help to stabilise tertiary structures in folded proteins.

2) Hydrogen bonding and dehydration effects Hydrogen bonds aid in base pair matching and stabilisation of secondary protein structures such as alpha helices and beta sheets. Hydrophilic molecules establish hydrogen bonds, which give surrounding water molecules a high degree of organisation. In the case of hydrophobic molecules, which are incapable of establishing hydrogen bonds, their inclination to resist water aids in the organisation of the moiety in its surroundings. Organised water reduces entropy and is thermodynamically unfavourable, causing the molecule to dehydrate and self-assemble.

3) Protein structural stability in biological environment: governed by interaction between charged groups and hydrogen bonds primarily exterior to the molecule and by van der Waals forces largely internal to the molecule.experienced by hydrophobic molecules, responsible for the hardness and softness of the molecule, as well as the maintenance of internal secondary structures, offers sufficient softness and permits conformation to be maintained during self assembly. Self assembly alters biological activity, necessitating the buffering of van der Waals interactions. Sugars contribute to molecular plasticization in aquasomes. (5)

Novel drug delivery systems, such as ethosomes, niosomes, polymeric liposomes, proliposomes, aquasomes, nanoparticles, nanocapsules, nanoemulsions, and microspheres, outperform traditional drug delivery systems in terms of drug safety, bioavailability, stability, improved tissue macrophage distribution, and sustained and controlled drug release. (6)

LakhanPatil B Pharm Nsk: Aquasomes are innovative nanoparticulate carriers used topically to deliver drugs, particularly in dermatology. These carriers are made up of a polyhydroxy oligomer layer that surrounds a solid core, which is often made of ceramic or calcium phosphate. This unique structure preserves the bioactivity of fragile molecules like proteins, peptides, and genetic material. Aquasomes are particularly useful for increasing the stability, bioavailability, and controlled release of medicinal substances while decreasing systemic absorption and negative side effects.Recent study has focused on the efficacy of aquasomes in treating dermatologic diseases. Their ability to deliver anti-inflammatory drugs for conditions such as acne, psoriasis, and wound healing has been examined. Additionally, study has been conducted.how successfully aquasomes can help larger molecules cross the epidermal barrier. Aquasomes' effectiveness, safety, and skin irritation were investigated by comparing them to typical topical preparations. (7)

OBJECTIVE OF AQUASOMES:-

- To create a self-assembled medication delivery device.
- To achieve medication and antigen delivery.
- To assist the protection and maintenance of delicate biological molecules, conformational integrity, and surface exposure, which resulted in a subsequent carrier system for bioactive molecules such as proteins, peptides, hormones, antigens, and genes to particular locations.
- Prepare implants for drug delivery.
- To develop compounds that improve immune response to recombinant or synthetic epitopes.
- Provide potency and adjuctivity.

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- To help protect bioactives and other carriers such as prodrugs and liposomes.
- To maintain the confirmational integrity and biochemical activity of immobilised surface pairs, and to combine these principles into a single functional composition. (8,9)

PROPERTIES OF AQUASOME-

- ✓ Aquasomes are circular nanoparticulate drug delivery systems ranging from 60 to 300 nm in size.
- ✓ Contain a three-layered self-assembled structure with ionic or non-covalent bonds.
- ✓ Comprises central A solid nanocrystalline core
- ✓ The core is covered with a polyhydroxyoligomeric layer.
- ✓ Biochemically active molecules are adsorbed onto this film, either modified or not.
- ✓ Solid cores give stability against dehydration and stabilisation for biochemically active compounds. (10,11)

METHOD OF PREPARATION OF AQUASOMES

The general technique comprises of an inorganic core production, which will be coated with lactose to form the polyhydroxylated core, which will finally be loaded by the model medication. Using the principle of self-assembly, the aquasomes are made in three steps, namely,

1) Preparing the core
2) Coating for core
3) Immobilisation of medicinal molecules.

1. Core preparation:The initial stage in aquasome preparation is to fabricate the ceramic core.The procedure of preparing a ceramic core is determined by the materials used. These ceramic cores can be manufactured by colloidal precipitation and Sonication, inverted magnetron sputtering, plasma condensation, and other procedures. Ceramic materials were commonly used for the core due to their structural consistency. Because ceramics are crystalline, their great degree of order means that any surface modification has only a minor effect on the nature of the atoms beneath the surface layer, preserving the ceramic's bulk qualities. The high degree of order also ensures that the surfaces have a high amount of surface energy, which promotes the binding of the polyhydroxyoligomeric surface coating.The precipitated cores are centrifuged and rinsed with enough distilled water to eliminate the sodium chloride that generated during the operation. The precipitates are resuspended in distilled water and filtered through a thin membrane to capture particles of the required size. The two most commonly utilised ceramic cores are diamond and calcium phosphate. The equation for the reaction is as follows:

$2Na2HPO4 + 3CaCl2 + H2O \rightarrow Ca3 (PO4)2 + 4NaCl + 2H2 + Cl2 + (O)$

2. Carbohydrate coatings: The second stage includes applying carbohydrate on the surface of ceramic cores. There are several mechanisms that allow the carbohydrate (polyhydroxy oligomers) coating to adsorb epitaxially onto the surface of the nano-crystalline ceramic cores.The techniques typically involve adding polyhydroxy oligomer to a dispersion of painstakingly cleaned ceramics in ultra pure water, sonication, and then lyophilization to facilitate the essentially irreversible adsorption of carbohydrate onto ceramic surfaces. Stir cell ultrafiltration removes excess carbohydrate that is easily desorbable. The most prevalent coating ingredients are cellobiose, citrate, pyridoxal-5-phosphate, sucrose, and trehalose.

3. Drug immobilisation: The surface-modified nano-crystalline cores serve as a solid phase for the subsequent non-denaturing self-assembly of a wide spectrum of biologically active compounds. The medicine can be loaded using partial adsorption electron microscopy. Scanning electron microscopy images were used to determine the shape and size distribution. (12,13,14,15,16))

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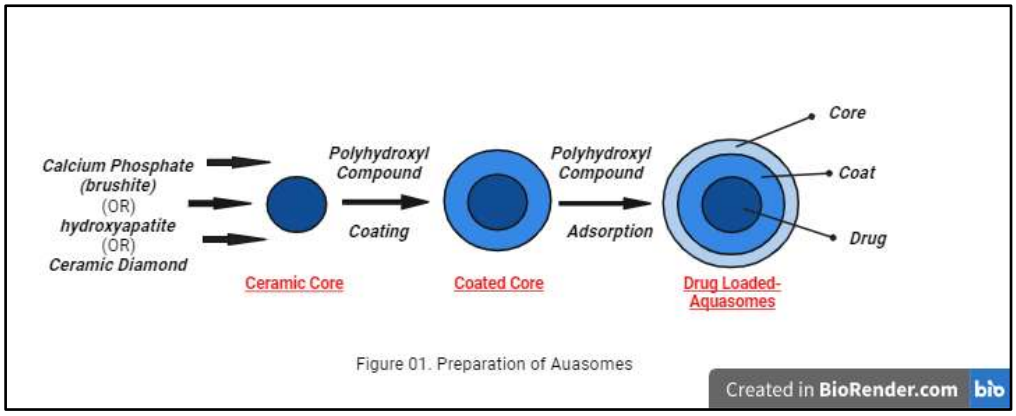

Figure 01. Preparation of Auasomes

Applications:

1. In order for aquasomes, which are employed as vaccines to deliver viral antigens such as Epstein-Barr and Immunodeficiency Virus 31, to elicit the proper antibody, the goal of vaccine therapy must be activated by target molecules that are conformationally specific.
2. Because hemoglobin's release of oxygen is conformationally sensitive, haemoglobin is immobilised on the surface of oligomers and used as a substitute for red blood cells in aquasomes. An 80% haemoglobin concentration is attained, toxicity is decreased, and it is said to transport blood in a nonlinear fashion similar to that of normal blood cells.
3. Aquasomes, a five-layered structure consisting of a ceramic core, polyoxyoligomeric film, therapeutic gene segment, extra carbohydrate film, and a targeting layer of conformationally conserved viral membrane protein, have been successfully employed for targeted intracellular gene therapy.
4. Because drug activity is conformationally specific, aquasomes were designed for the delivery of pharmaceuticals, such as insulin. Compared to intravenous treatment, bioactivity was maintained, activity rose to 60%, and no toxicity was noted.
5. Because enzyme activity varies with molecular conformation and pigments' aesthetic qualities are sensitive to molecular conformation, aquasomes are also employed to deliver enzymes such as DNAase and colours/dyes. (16,17)

Dermatological diseases

Skin conditions are among the most prevalent health issues in the world and have a significant financial burden. The psychological, social, and financial effects of skin diseases on patients, their families, and society as a whole are all included in the multifaceted concept of the burden of skin diseases. While malignant diseases like malignant melanoma carry a high death rate, chronic and incurable skin conditions like psoriasis and eczema are linked to severe morbidity in the form of physical discomfort and a reduction in patients' quality of life.The impact of the majority of skin conditions on patients' lives may be effectively assessed thanks to the availability of numerous health status and quality-of-life metrics. This review's objective is to provide some of the published data in order to illustrate the extent of the burden of several prevalent skin disorders and to offer methods for measuring that burden. (18)

What is psoriasis

Treatment ideas have significantly evolved as a result of psoriasis, a systemic ailment with distinctive skin signs and related conditions. The intricacy of psoriasis necessitates not only the right treatment but also weight-loss and smoking cessation programs, as well as the removal of trigger factors. The goal of a comprehensive approach to disease control may be best reflected by the term "management." When choosing a medication, comorbidity and the existence of psoriatic arthritis are crucial criteria. Nevertheless, there is a dearth of prospective data supporting the claim that antipsoriatic medication improves related disorders. Using treatment goals to ensure success aids in the establishment of an effective therapy and the management of inflammation. To closely monitor the course of the disease, it is necessary to regularly score the severity of the disease, evaluate the quality of life of the patients, and examine other clinically important factors. The possibility that early treatment could alter the

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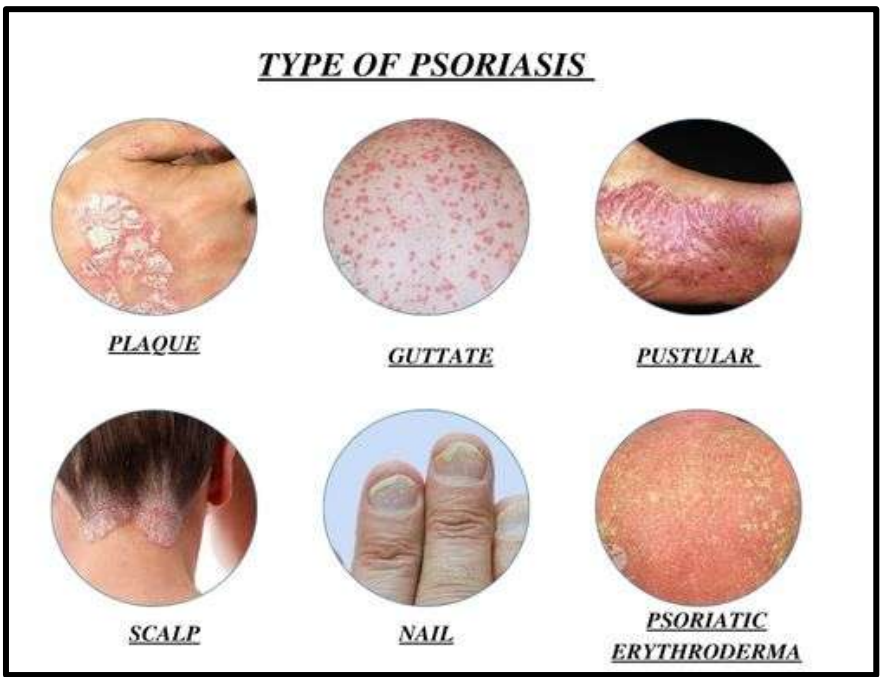
future course of psoriasis is up for dispute. In psoriasis, concepts of minimal disease activity have not yet been applied. Evidence about the appropriate duration of treatment, as well as when and how to stop it, is lacking. Lastly, in order to assess psoriasis-related things and the advantages of care from the patient's point of view, outcome instruments should be specially designed for the condition. (19)

SYMPTOMS

- Cracked, dry skin that could bleed
- Skin irritation
- Pain from burning skin
- Skin patches that are red
- Nails that are thicker or pitted Fever, chills, and a fast heartbeat are symptoms of more severe psoriasis.
- Skin that is peeling
- PsA-related heel discomfort and joint oedema
- PsA-related swelling in the fingers and toes Persistent exhaustion
- Eye inflammation: Uveitis, an inflammatory eye disorder, can occasionally be brought on by psoriasis (20).

TYPES:

There are several types of psoriasis, including pustular, guttate,plaque, nail, scalp,and psoriatic erythroderma.(20)



Mechanisms of Action of Aquasomes in the Treatment of Psoriasis:

1. Enhanced Drug Delivery

By facilitating the targeted and controlled delivery of anti-psoriatic medications (such as cyclosporine and methotrexate) to the afflicted skin areas, aquasomes improve therapeutic efficacy and lower systemic toxicity. They guarantee continuous drug release by shielding bioactive molecules from deterioration.

2. Improved Skin Penetration

Drug absorption in psoriatic plaques is improved by the tiny particle size (~60–300 nm), which permits better penetration through the stratum corneum. The carbohydrate coating, such as dextran or trehalose, helps the medicinal agents adhere to the layers of the skin and stabilises them.

3. Anti-Inflammatory Effects

By effectively delivering immunomodulatory agents like cyclosporine or tacrolimus, aquasomes help in suppressing T-cell activation, a key factor in psoriasis pathogenesis.Reducing cytokine release (e.g., TNF-α, IL-17, IL-23) mitigates inflammation and keratinocyte hyperproliferation.

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4. Moisturization and Skin Barrier Repair

Carbohydrate coatings provide a hydration effect, which is beneficial in restoring the skin barrier in psoriasis.This prevents excessive transepidermal water loss (TEWL) and promotes healing of psoriatic lesions.

5. Reduced Drug Resistance and Side Effects

Encapsulation of drugs in aquasomes prevents premature degradation, allowing for lower doses and minimizing adverse effects like hepatotoxicity and nephrotoxicity, commonly associatedwith systemic treatments. (21,22,23,24)

Marketed Preparation of Aquasomes:

Aquaphor: A topical cream containing aquasomes, marketed for dry skin conditions, including psoriasis

Cerave:A line of skincare products, including a psoriasis treatment cream, that utilize aquasome-like technologyto deliver ceramides and other therapeutic agents.

II. CONCLUSION:

Aquasomes are a promising development in medication delivery systems powered by nanotechnology, especially for dermatological conditions like psoriasis. Their special three-layered, self-assembled structure protects and stabilizes bioactive molecules, improving therapeutic bioavailability, controlled release, and targeted administration while reducing adverse effects and systemic absorption. Aquasomes provide several benefits for treating psoriasis, including as better skin penetration, longer-lasting medication release, and increased therapeutic efficacy with lower toxicity. They are a desirable alternative for treating chronic inflammatory skin disorders because of their effective delivery of immunomodulatory and anti-inflammatory drugs.

Despite their promise, more investigation is required to assess long-term safety, enhance formulation techniques, and investigate extensive clinical applications. Aquasomes have the potential to transform topical drug delivery with further developments, providing more patient-friendly and efficient treatment options for dermatological conditions.

III. RESULT:

A promising method for targeted medication delivery in dermatology, especially for the treatment of chronic disorders like psoriasis, is the use of aquasomes. They are a novel treatment approach because of their capacity to increase drug stability, boost bioavailability, and reduce systemic side effects.

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