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The Comprehensive Review on Role of Niosomal Gels and its Method of Preparation

Ms. Radha M. Kasar[1]*, Dr. S. S. Bakhle[2]

[1]New Montfort Institute Of Pharmacy,Ashti Wardha, 442202 (M.S) India
[2] Priyadarshini J. L. College of Pharmacy Nagpur, 440016 (M S), India
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ABSTRACT:

Niosomal gels enhance skin penetration by acting as a carrier system, improving drug solubility and bioavailability, and allowing for sustained release of encapsulated active ingredients. Niosomes are lipid-based vesicles, similar to liposomes, but they are made from non-ionic surfactants instead of phospholipids. They are multi-lamellar vesicles that can efficiently transfer active substances to epidermal layers or circulation. Niosomes can encapsulate both hydrophilic and hydrophobic drugs. Niosomal gels can be used for transdermal drug delivery, where drugs are absorbed into the bloodstream through the skin. Niosomes are multilamellar vesicles that efficiently transfer active substances to epidermal layers or circulation. They improve "active drug skin penetration in topical drug delivery systems. The goal of this work was to develop a luliconazole (LCZ) niosomal gel to promote skin permeability. Luliconazole treats tinea pedis, cruris, and corporis caused by Epidermophyton floccosum and Trichophyton rubrum. Luliconazole has improved skin pharmacokinetics. In the all formulations, the cholesterol ratio was consistent and was prepared by ether injection method using span 60 or tween 80 surfactants.

Keywords: Niosome, Niosomal gel, Targeted drug delivery, Topical drug Delivery

1. INTRODUCTION:

Niosomal gels are topical formulations that use niosomes, small vesicles made of non-ionic surfactants and cholesterol, to enhance the delivery of drugs through the skin, offering potential benefits like increased drug penetration and sustained release. Surfactants used in niosome formation include alkyl esters (Tweens, Spans) and alkyl ethers (Brijs). Niosomes can encapsulate both hydrophilic and lipophilic drugs. They can be unilamellar or multilamellar depending on the preparation method. [1]

How Niosomal Gels Work:

Niosomes are incorporated into a gel base, which can be a polymer like Carbopol. The niosomes act as a carrier, enhancing the penetration of drugs through the skin compared to conventional topical formulations. They can also act as a reservoir, allowing for a sustained release of the drug. The gel base provides a suitable vehicle for topical application, ensuring good spreadability and contact with the skin. Niosomal gels can be used for various applications, including antifungal, anti-inflammatory, and anti-acne treatments. [2]

Benefits of Niosomal Gels:

Niosomes can improve the penetration of drugs through the skin barrier. Niosomal gels can provide a sustained release of the drug, leading to a longer duration of action. Niosomes can be designed to target specific areas of the skin, improving the efficacy of the treatment. Niosomes can improve the solubility and stability of poorly soluble drugs. The sustained release and enhanced penetration of niosomal gels can allow for a reduction in the frequency of drug application. [2]

Niosome Structure and Function:

1. Niosomes are vesicles composed of non-ionic surfactants, which form a lipid bilayer similar to cell membranes.

2. They act as a reservoir for drugs, protecting them from degradation and allowing for controlled release.

3. Niosomes can increase the solubility of poorly soluble drugs, improving their bioavailability. [2]

Advantages of Niosomes: **[3,7, 12]**

Enhanced Stability: Niosomes are generally more stable than liposomes due to the nature of non-ionic surfactants, making them a preferred choice for drug delivery.

Versatile Drug Encapsulation: They can encapsulate both hydrophilic and lipophilic drugs, providing a versatile platform for various therapeutic applications.

Targeted Delivery: Niosomes can be designed for targeted drug delivery to specific tissues or cells, improving therapeutic efficacy and reducing side effects.

Controlled Release: The structure of niosomes allows for controlled and sustained drug release, which can be beneficial for certain therapeutic applications.

Improved Bioavailability: Niosomes can enhance the bioavailability of poorly soluble drugs

Gel Matrix and Enhanced Contact Time: **[3,13, 14]**

Incorporating niosomes into a gel matrix (like Carbopol gel) increases the contact time of the formulation with the skin, further enhancing drug penetration. The gel matrix also provides a sustained release mechanism, ensuring a prolonged therapeutic effect.

Example of Niosomal gel:

Fusidic Acid Niosomal Gel:

A study developed a niosomal gel of fusidic acid to increase its skin permeation, showing that niosomes enhanced the permeation of fusidic acid through the skin.

Luliconazole Niosomal Gel:

Researchers developed a luliconazole niosomal gel to promote skin permeability, demonstrating that niosomes improved the skin pharmacokinetics of luliconazole.

2. MATERIAL AND METHODS:

Fusidic acid Niosome gel: **[5]**

Niosome Preparation (Thin-Film Hydration):

Dissolve a non-ionic surfactant (like Span 60 or Tween 60), cholesterol, and fusidic acid in a solvent (like chloroform). Remove the solvent using a rotary evaporator to create a thin lipid film on the flask walls. Hydrate the dried film with a phosphate buffer saline solution (pH 7.2) by hand shaking the flask. Once formed, the niosomes are characterized for entrapment efficiency, size, polydispersity index (PDI), and zeta potential.

Gel Preparation:

Choose a suitable gel base, like Carbopol gel. Incorporate the prepared niosomes into the Carbopol gel base. Evaluate the pH, spreadability, rheological properties, and ex vivo permeation of the niosomal gel.

Example Formulation: [4]

Surfactant: Span 60 or Tween 60, Cholesterol: Vary the cholesterol to surfactant ratio., Fusidic Acid: Added to the lipid film., Gel Base: Carbopol gel. Hydration Solution: Phosphate buffer saline (pH 7.2).

Luliconazole Niosomal Gel:**[6]**

Niosome Preparation:

Luliconazole, non-ionic surfactants (Span 60, Tween 80), cholesterol, and a suitable solvent (like chloroform). Dissolve the surfactant and cholesterol in a suitable solvent. Evaporate the solvent to form a thin film on the walls of the flask. Hydrate the thin film with an aqueous solution containing luliconazole. The hydration process leads to the formation of niosomes, which are vesicles with a lipid bilayer structure.

Gel Base Preparation:

Carbopol 934, distilled water, and triethanolamine (TEA) or sodium hydroxide (for pH adjustment). Disperse a weighed amount of carbopol 934 in distilled water and stir continuously. Allow the carbopol to swell in water for a specific duration (e.g., 2 hours). Adjust the pH of the gel base to a desired level (e.g., pH 6.8) using TEA or sodium hydroxide. Adjust the final weight of the gel base with distilled water.

Niosomal Gel Formulation:

Incorporation: Incorporate the prepared niosomal formulation into the gel base. Mixing: Mix the niosomal formulation and the gel base thoroughly to ensure uniform distribution. Storage: Store the prepared niosomal gel in a dark place to prevent degradation.

Other Examples of Niosomal Gel:**[4]**

Lornoxicam Niosomal Gel:

A study developed a niosomal gel of lornoxicam for topical delivery, showing significant improvement in skin permeation and skin deposition compared to a plain lornoxicam gel. Researchers successfully integrated tretinoin and clindamycin hydrochloride into a niosomal gel for topical application in the treatment of acne.

1. Preparing Lornoxicam-Loaded Niosomes:

Thin-Film Hydration Method: Dissolve Surfactants and Cholesterol: Dissolve surfactants (e.g., Span 60) and cholesterol in a mixture of chloroform and methanol (e.g., 2:1 v/v).

Dissolve Lornoxicam: Dissolve lornoxicam (e.g., 1% w/w) in the same solvent mixture. Combine Solutions: Add the lornoxicam solution to the surfactant-cholesterol solution. Evaporate Solvent: Slowly remove the organic solvent under reduced pressure using a rotary evaporator, forming a thin lipid film on the flask walls.

Hydrate the Film: Hydrate the dry lipid film with double-distilled water at a temperature above the phase transition temperature of the surfactants (e.g., 55°C). Sonication: Subject the niosomal dispersion to sonication for particle size reduction. Stabilization: Allow the niosomes to form stable vesicles overnight. 2. Incorporating Niosomes into a Gel Base.

Gel Base: Use a suitable gelling agent, like Carbopol 980 NF, to create the gel base. Mix Niosomes and Gel Base: Incorporate the lornoxicam-loaded niosome dispersion into the gel base.

Optimization: Optimize the formulation by adjusting the concentrations of surfactants, cholesterol, and gelling agent to achieve desired properties like rheology, texture, and drug release.

Tretinoin and Clindamycin Hydrochloride Niosomal Gel: [16]

1. Preparation of the Niosomal Vesicles: Solubilization: Dissolve the non-ionic surfactant (like Span 60 or Tween 80), cholesterol, and the active drugs (tretinoin and clindamycin hydrochloride) in a suitable organic solvent (e.g., chloroform or methanol).

Thin Film Formation: Evaporate the organic solvent under vacuum, leaving behind a thin lipid film. Hydration: Hydrate the lipid film with a suitable aqueous medium (e.g., distilled water, saline) under mechanical stirring or shaking to form niosomal vesicles. Vesicle Size Control: Techniques like extrusion or sonication can be employed to control the size of the niosomal vesicles.

2. Gel Formation:

Gel Base: Choose a suitable gelling agent (e.g., Carbopol 940, hydroxypropylmethylcellulose) and dissolve it in the aqueous medium used for vesicle hydration.

Niosome Incorporation: Incorporate the prepared niosomal dispersion into the gel base, ensuring proper mixing and dispersion.

Gel Optimization: Evaluate the final gel formulation for parameters like viscosity, pH, and drug entrapment efficiency.

3. Other methods: Thin-film hydration method: This method involves preparing a thin film of the surfactant and cholesterol, then hydrating the film with an aqueous solution containing the drugs. Reverse-phase evaporation method: This method involves dissolving the surfactant and cholesterol in an organic solvent and then slowly evaporating the solvent in the presence of an aqueous solution. Microfluidics method: This method uses microfluidic devices to create niosomes with precise control over size and shape.

Ethanol injection method: This method involves injecting an ethanol solution of the surfactant and cholesterol into an aqueous solution containing the drugs.

Doxycycline-Loaded Niosomal Gels: [15]

Doxycycline-Loaded Niosome Preparation:

Surfactant and Cholesterol: Use non-ionic surfactants (like Span 60, Tween 60) and cholesterol to form the niosome bilayer.

Methods: Thin Film Hydration: Prepare a thin film of the surfactant, cholesterol, and doxycycline solution, then hydrate it with water.

Reverse-Phase Evaporation: Dissolve the surfactants, cholesterol, and doxycycline in an organic solvent, then slowly evaporate the solvent in the presence of water. Characterization: Once the niosomes are prepared, characterize them for size, zeta potential, morphology, and entrapment efficiency.

2. Niosomal Gel Formulation: Gel Base: Use a gel base like Carbopol 974, which is a common polymer used in gel formulations.

Preparation: Carbopol Hydration: Slowly add Carbopol to water and stir until fully hydrated, allowing the polymer chains to swell. Penetration **Enhancers:** Add penetration enhancers like poly(ethylene glycol) 400 (PEG 400) or propylene glycol (PG) to the gel base. Niosome Incorporation: Gradually add the doxycycline-loaded niosomes to the hydrated Carbopol gel base. Gelling and pH Adjustment: Use triethanolamine (TEA) to induce gelling and adjust the pH of the gel to a suitable range (e.g., 6.5-7.4). A study developed doxycycline-loaded niosomal gels for transdermal delivery, demonstrating that the niosomal gel could be an effective transdermal nanocarrier for enhancing the permeability of doxycycline.

3. EVALUATION PARAMETERS OF NIOSOMAL GEL: [8,9,10]

Physical Appearance:

Clarity, Color, Homogeneity: Assess the gel for any signs of cloudiness, color changes, or the presence of foreign particles.

Visual Inspection: Observe the gel for any signs of sedimentation, layering, or changes in texture.

pH:

Measurement: Determine the pH of the gel dispersion in water using a pH meter. Acceptable Range: Ensure the pH falls within a suitable range for topical application and stability.

Viscosity:

Measurement: Use a viscometer (e.g., Brookfield viscometer) to determine the gel's viscosity. Rheological Studies: Investigate the flow properties and consistency of the gel.

Drug Content:

Determination: Analyze the gel for its drug content using a suitable analytical method (e.g., dissolving a known amount of gel and measuring the drug concentration), Uniformity: Ensure the drug is uniformly distributed throughout the gel matrix.

Entrapment Efficiency:

Determination: Calculate the percentage of drug entrapped within the niosomal vesicles. Optimization: Optimize the formulation to achieve high entrapment efficiency.

In Vitro Drug Release/Permeation Studies:

Release Studies: Evaluate the rate and extent of drug release from the niosomal gel using a suitable apparatus (e.g., dialysis membrane).

Permeation Studies: Assess the ability of the gel to enhance drug penetration through the skin (ex vivo).

Ex Vivo Studies:

Use excised skin to determine the amount of drug that penetrates the skin from the niosomal gel. In Vivo Studies: Conduct studies in animals to assess the bioavailability and efficacy of the niosomal gel.

Other Important Considerations:

Stability Studies: Assess the stability of the niosomal gel formulation under various storage conditions (temperature, humidity).

Microscopic Analysis: Use techniques like transmission electron microscopy (TEM) to visualize the niosome morphology and size.

4. CONCLUSION:

The idial features of neosomes and neosomal gel, together with their applications and several advantages, were examined in the current review. Compared to earlier topical semisolids, the niosomal-based gel formulation with nanocarrier delivery penetrates the epidermal layer more deeply. Using luliconazole niosomal gel to increase skin permeability showed that niosomes enhanced luliconazole's skin pharmacokinetics. Fusidic acid's skin penetration was increased by niosomal gel, demonstrating that niosomes improved the acid's skin penetration. For the administration of a variety of formulations via the skin and for various topical medicines, the niosomal gel formulation might be more effective than comparable commercial dose forms.

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