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NIOSOMES IN PHARMACEUTICAL APPLICATIONS STRUCTURES, PREPARATION, AND THERAPEUTIC POTENTIAL

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Abstract:

Niosomes are elegant vesicular systems composed of non-ionic surfactants that are well known for their potential in effective medication administration. Although having a composition similar to liposomes, these tiny structures are more stable, economical, and easier to produce. They are created when surfactants self-assemble in an aqueous phase, frequently with cholesterol, and they can contain medications that are soluble in fat or water. For a variety of therapeutic applications, they are appropriate due to their low toxicity, biocompatibility, and capacity to regulate drug release. In fields like cancer treatment, ocular and transdermal drug delivery, and vaccine development, niosomes have demonstrated encouraging outcomes.

Keywords: Niosomes, Cholesterol, Hydrophilic and Lipophilic Drugs, Surfactants, Targeted Delivery, Bioavailability improvement, Factors, Applications.

INTRODUCTION

In recent years, niosomes have drawn a lot of interest as potentially useful drug delivery vehicles. As with liposomes, these vesicular structures have a bilayer architecture and are mostly composed of non-ionic surfactants, frequently in combination with cholesterol. The fact that they can encapsulate both fat-soluble and water-soluble medications gives them the capacity in terms of administration modes, such as injectable, topical, and oral forms.

One of the main causes of the increased interest in niosomes, based on my research and understanding, is their improved stability and biocompatibility. In contrast to the traditional delivery method, they offer the possibility of regulated and targeted release, lessen side effects, and enhance medication absorption.

Likewise, the use of non-ionic surfactants makes niosomes safer for clinical usage by lowering the possibility of negative immunological reactions. Recent developments in noisome design, including surface modification and functionalization methods, have allowed them to be customized for a variety of therapeutic uses, such as virus delivery, cancer treatment, and gene delivery. My goal is to examine the foundation of niosomal technology through this review, going over their structure, classification, preparation techniques, advantages, drawbacks, and developing medicinal uses. By providing light on these nano-scale systems, I intend to help shape the future of effective and customized medication delivery.

STRUCTURE OF NIOSOMES:

Niosomes are tiny, spherical vesicles that resemble biological membranes due to their bilayer structure, which is mostly made up of cholesterol and non-ionic surfactants. The aqueous and lipophilic spaces are produced by the bilayer hydrophilic (which attracts water) heads pointing outwards and hydrophobic (which repels water) tails pointing inside. Because of their dual nature, lipophilic compounds are integrated into the bilayer itself, while hydrophilic substance is stored in the core. Niosomes may encapsulate and transport a wide variety of medications.

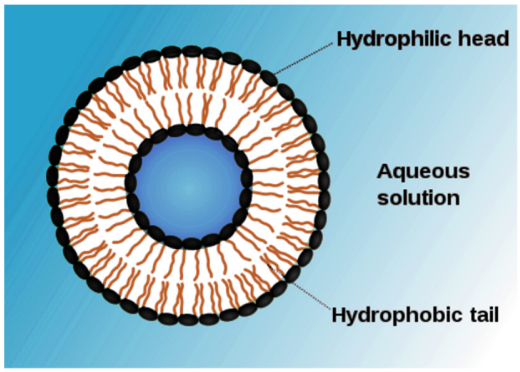


Fig No: 1 Structure of Niosomes.

TYPES OF NIOSOMES:

Niosomes can be classified into three categories based on their vesicle size. These categories include:

1. Small unilamellar vesicles (SUV, Size=0.025-0.05µm),
2. Multilamellar vesicles (MLV, Size >0.05µm),
3. Large unilamellar vesicles (LUV, Size >0.10µm).

ADVANTAGES OF NIOSOMES:

- Improved stability of drugs
- Low toxicity and biocompatibility
- Capacity for drugs that are lipophilic and hydrophilic
- Targeted and managed drug administration
- Enhanced bioavailability
- Economical and simple preparation.

DISADVANTAGES OF NIOSOMES:

- Physical instability during storage
- Batch-To-Batch variability
- Some molecules have limited drug loading
- Sensitivity associated with surfactants
- The complications of large-scale manufacturing.

COMPOSITION OF NIOSOMES:

1. **Non-ionic Surfactants:**

Non-ionic surfactants form the backbone of every niosomal structure. Because of their hydrophilic characters, I usually take into account surfactants like Span (e.g., Span 20,40,60,80), tween (e.g., tween 20,60,80), and Brij. Vesicle production and the effectiveness of drug entrapment are influenced by the surfactant's hydrophilic lipophilic balance (HLB) value.

2. **The Cholesterol:**

As far as I can tell, cholesterol is necessary to give the bilayer membrane stability and rigidity. It lowers membrane permeability and stops the medicine that is encapsulated from leaking out.

METHOD OF PREPATION OF NIOSOMES:

1. **Thin film hydration method (Hand shaking method).**

One of the most common methods I've employed is this one. This method involves dissolving cholesterol and surfactants in a strong organic solvent, such as methanol or chloroform. A thin lipid layer is then left behind when the solvent is evaporated using a rotary evaporator at low pressure. Multilamellar niosomes are hydrated with an aqueous drug solution and gently stirred.

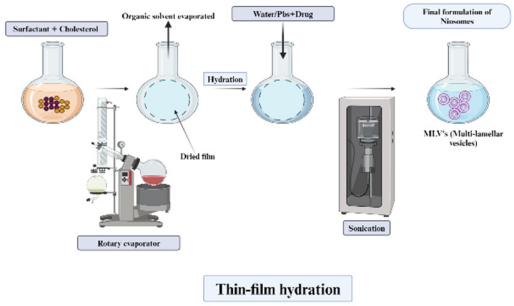


Fig No 2: Thin film hydration.

2. **Ether injection method:**

Using this technique, I gradually inject a heated aqueous phase containing the medication with a solution of surfactant and ether. Niosomes are created spontaneously when the ether evaporates when they come into contact with the heated aqueous medium.

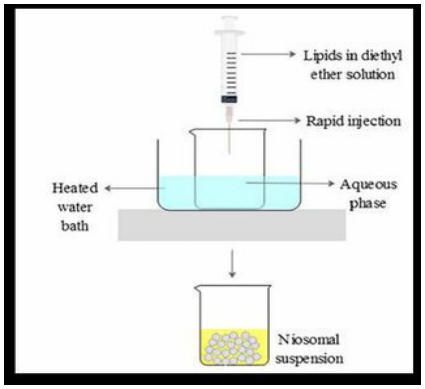


Fig No 3: ETHER INJECTION METHOD.

3. Sonication Method:

This technique is helpful when I want to make vesicles smaller. By applying sonication to hydration-formed multilamellar niosomes, smaller unilamellar vesicles are produced.

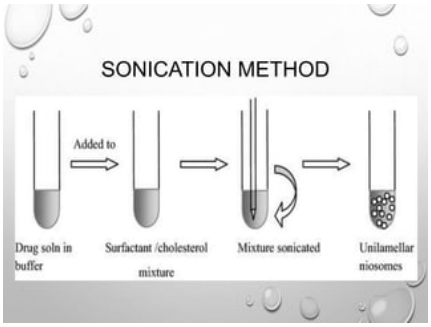


Fig NO 4: SONICATION METHOD.

4. Reverse Phase Evaporation Method:

An aqueous medication solution is introduced after surfactants and cholesterol have been dissolved in the organic phase to create a water-in-oil emulsion using sonication. A gel-like phase is created by evaporating the organic solvent under low pressure, and when it hydrates, it forms large unilamellar vesicles.

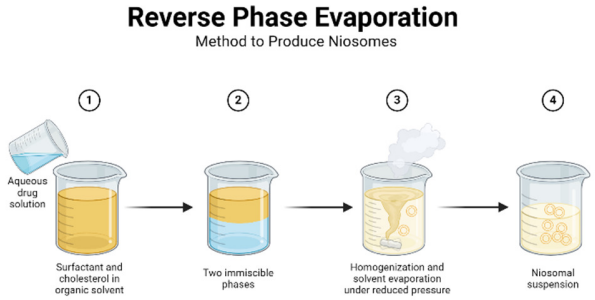
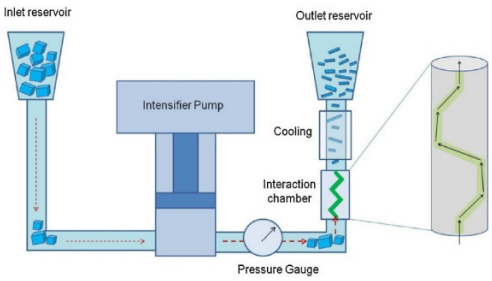


Fig .No 5: REVERSE PHASE EVAPORATION.

5. Microfluidization and Heating Methods.

I've observed the employment of heating and microfluidization techniques for large-scale, repeatable production. These techniques enable more precise control over the size and distribution of vesicles, making them appropriate for large-scale manufacturing.



CHARACTERIZATION OF NIOSOMES:

1. Particle size and Distribution :

The average vesicle size and polydispersity index (PDI) of niosomal formulations are frequently determined using dynamic light scattering (DLS). These variables affect cellular absorption, stability, and drug release. For reliable therapeutic efficacy, a more homogenous vesicle population is typically indicated by a lower PDI score.

2. Morphological analysis:

The vesicle form, surface structure, and lamellarity can be seen in great detail using methods like Atomic Force Microscopy(AFM), Transmission Electron Microscopy(TEM), and Scanning Electron Microscopy (SEM). Generally speaking, spherical shapes with smooth surfaces are ideal for drug administration.

3. Zeta Potential:

The stability of the vesicular suspension is indicated by surface charge on niosomes as determined by zeta potential measurements. Strong electrostatic repulsion is suggested by high absolute zeta potential values, either positive or negative, which improve colloidal stability and inhibits formation.

4. Etrapment Efficiency (EE%):

This is the proportion of drugs that are effectively encapsulated in niosomal vesicles.Usually, centrifugation, dialysis, or gel filtration are used to separate the free drugs from the vesicle-bond drugs, and then spectrophotometric or chromatographic analysis is performed to assess them. To optimize the therapeutic payload, high EE is preferred.

The entrapment efficiency (EE) was then calculated using the formul $entrapment\ efficiency = \underline{amount\ of\ drug\ in\ niosomes} \times 100$ amount of drug

5. In vitro drug release studies:

These studies investigate the encapsulated drug's release characteristics in physiological settings. Franz cell diffusion and dialysis membrane diffusion techniques are frequently employed to assess.

6. Stability studies:

Stability testing is carried out under a range of storage conditions (such as temperature, light, and humidity) to ensure the dependability and shelf life of niosomal systems. Zeta potential, drug retention, and vesicle size are among the parameters that can be monitored over time.

7. Surface modification and functionalization(optional):

Niosomes can be described for surface modification, like pegylation or ligand attachment, for more complex uses. Depending on the alteration, FTIR, NMR, or XPS can be used to examine these properties.

CONCLUSION

Niosomes have gained recognition as a promising and adaptable nanocarrier system in drug delivery, presenting numerous benefits including biocompatibility, chemical stability, affordability, and the capability to encapsulate both hydrophilic and lipophilic medications. Their structural similarity to liposomes, along with enhanced physical and chemical stability, makes them particularly appealing for use in pharmaceutical and therapeutic fields.

Improvement in niosomal formulation techniques and characterization methods have considerably boosted their effectiveness in targeted and controlled drug release. Aspects such as the type of surfactants, cholesterol level, preparation techniques, and environmental conditions significantly affect their performance, highlighting the importance of careful formulation strategies.

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