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Niosomes: Prepration, Evaluation & Applications

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ABSTRACT

Researchers are now more interested in nanocarrier technology because it has many safety and effectiveness benefits, such as more fully therapeutic delivery with a range of pharmacological effects, better targeting capabilities, and fewer negative reactions than other carrier systems. Niosomes also showed promise as a new and innovative medication administration system. A vesicular drug carrier method that offers targeted and regulated drug delivery is niosomes. It can be unilamellar, oligolamellar, or multilamellar and contains charged molecules, cholesterol or its derivatives, & non-ionic surfactants. The essential knowledge about niosomes, including their structure, types, perks and drawbacks, administration routes, preparation techniques, factors influencing their formation, evaluation criteria for niosomes, applications, and currently available commercial formulations, is illustrated in this review article

Keywords: *Niosomes, NDDS, Targeted Drug Delivery, Non-ionic Surfactant*

1. INTRODUCTION

Novel Drug delivery System (NDDS) refers to the approaches, formulations, technologies, and systems for transporting a pharmaceutical compound in the body as needed to safely achieve its desired therapeutic effects. Novel drug delivery systems are proposed to attain a continuous delivery of drugs at predictable and reproducible kinetics over an extended period of time in the circulation. Molecular clusters called niosomes are created when surfactants that are not ionic in water self-assemble.Because of unique structure, niosomes are a potent delivery-system for drugs (NDDS) that can load both lipophilic and hydrophilic medicines. They are biodegradable, immunogenicity-free, and have flexible structural characterisation. Their potential for treating viral infections, cancer, and other microbial illnesses by targeted delivery and controlled release has been extensively researched. An alternative to liposomes are niosomes, which in an aqueous media and may transport both lipophilic and amphiphilic medicines. Non-ionic surfactant, the main ingredient, gives niosomes more stability than liposomes, overcoming problems like oxidation susceptibility, high cost, and difficulty reaching superior purity levels, which impact stability, size, and shape. Niosomes function as a depot for drugs within our bodies, releasing the drug through their bilayer in a controlled way to provide a prolonged release of the medication that is encapsulated.[3]

ADVANTAGES:[4-6]

1. They can accept a broad variety of solubility in medicinal compounds.
2. Orally, via parenteral, topical in nature, and ocularly administration are among the ways that niosomes can be given.
3. Niosomes are an appropriate delivery system for unstable and sensitive medications because their bilayers shield the active ingredient from damaging agents both within and outside the body.
4. Provide better patient-compliance.

5. The niosomes' surfactants are non-immunogenic, biocompatible, and biodegradable.
6. The osmotically active as well as stable nature of niosomes increases the long-term stability of the medicine that is encapsulated.
7. When used topically, they increase skin permeability and augment the gastrointestinal bioavailability of weakly soluble medications.
8. By slowing the rate of drug clearance, niosomes improve the therapeutic efficacy for medications.

They make it easier to target particular areas, which lowers the necessary dosage and related adverse effects

DISADVANTAGES:[4-6]

1. The niosome vesicles' physical fragility is a significant drawback of this technology(Aggregation & Fusion).
2. Entrapped drugs emission/Leakage.
3. The dispersion's shelf life is limited by the hydrolysis of encapsulated medications.
4. The consistency of medication distribution is impacted by the difficulty of making niosomes all the same size.
5. It demands time and costly assets to make & purify niosomes.

STRUCTURE OF NIOSOME:

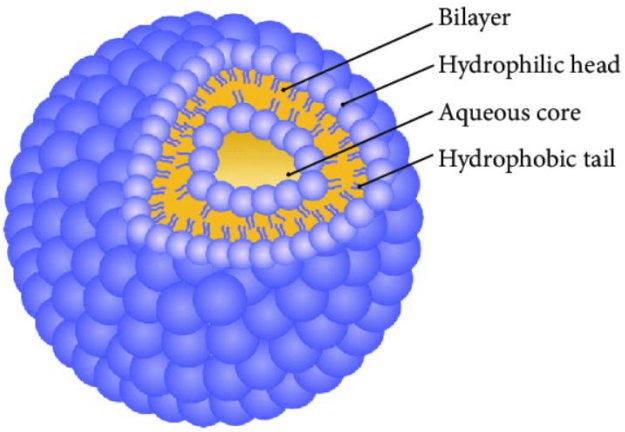
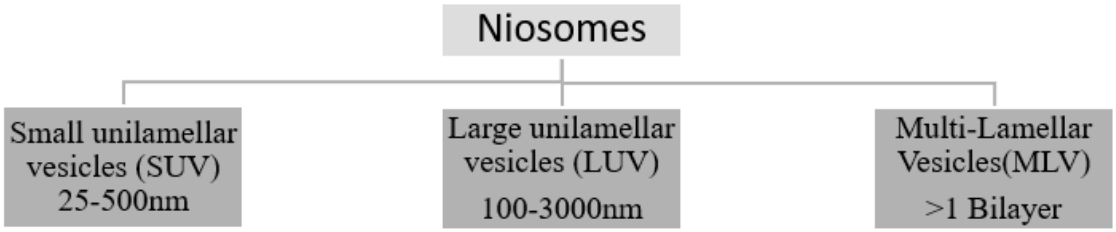


Fig 1: Structure of Niosome

TYPES OF NIOSOMES



FORMULATION COMPONENT OF NIOSOMES:[1]

A drug delivery system's constituent parts have a critical role in its efficacy; these parts must be identified by the biological, chemical, and clinical characteristics required to create niosomal systems with particular characteristics. Among these, cholesterol, surfactants that are non-ionic & Charge inducer are the building blocks of niosomes. which foster vesicle formation as well as boost formulation stability. The unique roles that each component plays are essential for maximising the effectiveness of medication delivery.

Non-ionic surfactants

Surfactants have 2 separate sections, one hydrophilic (attractive to water) and the other lipophilic (attractive to fat). These

two components can be joined together using ester, amide, or ether bonds. Among the best polymeric nanocarriers for regulated, continuous, targeted, and sustained drug administration are non-ionic surfactants. They are part of a class of surfactants that have hydrophilic heads that are free of charged groups.

When preparing niosomes, the following surfactants that are non ionic are frequently used:

As an illustration, consider

- Spans (20, 85, 80, 60, 40**)**
- Brijs (brij-30, 35, 52, and 58, 72, 76)
- Tweens (tween 20, 40, 60, 80).

These include the more recent surfactant varieties known as bola and gemini. With two hydrophilics groups of heads connected by spacers and two hydrophobic chains, gemini surfactants have two of each. In contrast, bola surfactants are bipolar amphiphiles that have one or more lengthy hydrophobic spacers separating the two polar head groups.

Cholesterol [7]

With surfactant,the medication being encapsulated, and the niosome manufacturing technique, cholesterol is a major contributor to the self-assemblage of surfactants into niosomes. It plays a role in niosome conformation, shape, and stiffness. Cholesterol decreases aggregation, increases stability, and helps create vesicles. Cholesterol can be present in significant molar ratios even though it does not alone form the bilayer. By combining its stiff steroidal structural with the molecules of surfactant in the bilayer, it gives the structure stiffness and restricts the mobility of the chains of hydrocarbons.

Charge inducers [8]

Membrane additives known as charge inducers are commonly added to niosomes. With the goal for better stability, size, and drug entrapment efficiency, charge inducers are essential. By adding a net charge to the niosomal vesicles, they enhance drug delivery and inhibit aggregation. To do this, charged compounds are added to the niosome structure.

Examples of electronically charged comp's -that employed to stop niosome aggregation are cetylpyridinium chloride and stearyl amine (SA), whereas dicetyl phosphates (DCP) and phosphatidic acid, respectively, are examples of polar molecules34.

METHOD OF PREPRATION OF NIOSOME:[4,6,7]

(I) The Thin Film Hydration Method [9,10]

This process uses an RBF to dissolve surfactant, cholesterol, and other excipients in an organic solvent like diethyl ether or chloroform. A thin layer of solid mixture is applied to the flask walls after organic solvent is removed using a rotary vacuum evaporator. Using an aqueous phase and mild stirring, the dry film can be rehydrated to produce typical multilamellar niosomes at temperatures between 0 and 60°C. Examples of drugs prepared using the TFH technique include minoxidil, nimesulide, insulin, hydroxycamptothecin, beclometasone dipropionate (BDP), glucocorticoids, salicylic acid, p-hydroxybenzoic acid, methotrexate, doxorubicin, and various antioxidants.

(II) Method of Ether Injection

Surfactants and other ingredients dissolved in diethyl ether, which is then gradually injected using a pointed needle onto a watery solution maintained at 60°C.Single-layer-vesicles are produced by-ether evaporating. By changing needle size along with additional parameters, the technique enables size control. But because materials are not very soluble in ether and it is difficult to extract ether from the finished product, it has limits. Adriamycin, fluconazole, rifampicin, and diclofenac sodium (DCS) are made this way.

(III) Sonication Technique [8]

An aqueous phase containing a combination of surfactants and cholesterol is initially disseminated in the sonication process. After 10 minutes of probe sonication at 60°C, this dispersion forms multilamellar vesicles (MLVs). These are further ultra-sonicate to produce unilamellar vesicles.

(IV) Microfluidization (11)

The approach of microfluidization employs the submerged jet concept to create niosomes, more especially unilamellar vesicles with a regulated size distribution. Aqueous and lipid-containing fluid streams are forced through microchannels at high velocities, colliding and mixing. Tiny, homogeneous niosomes are created as a result of this regulated mixing and fast contact.

(V) The Bubble Method (11)

This method uses a glass flask with 3 necks to disperse cholesterol & surfactant in a buffer at 70°C. After 15 seconds of

mixing this dispersion with a high shear homogeniser, nitrogen gas is instantly pumped through the homogeniser to produce massive unilamellar niosomes.

CHARACTERIZATION AND EVALUATION [10-13]

1. Size, Shape, and Morphology

To guarantee homogeneous dispersion, niosome shape, size, and morphology must all be assessed. For this analysis, a number of methods were employed, including:

a) SEM, or scanning electron microscopy

The Niosomes' form and surface properties are examined using SEM. Double-sided tape is used to mount samples on a SEM sample holder so that images can be taken at the proper magnification.

b) Transmission Electron Microscopy

Utilized to assess structural parameters of niosomes. A suspension of niosomes is combined with 1% percent phosphotungstic acid, Applied to carbon-coated grid & examined under a TEM.

c) Freeze-Fractured Microscopy

Both the surfactant and drug characteristics as well as drug entrapment can affect the size and form of niosomes. The process of freeze-fractured microscopy entails thawed the vesicles and then observing them to ascertain their dimensions.

d) Optical Microscopy

Optical microscopy is used to observe niosome size and shape. By measuring the size of niosomes against a stage micrometer and eyepiece micrometer, the dimensions of approximately 100 niosomes are determined.

2. Entrapment efficiency[14]

After niosomal dispersions are made, a dialysis/filtration/centrifugation using gels can be used to extract any medication that is still entrapped.

Entrapment efficiency (EF) = (Amount of Drug entrapped / total amount) x 100

3. Vesicle Diameter

Light microscopy, photon correlation microscopy and freeze fracture electron microscopy techniques are used to determine niosomal diameter.

4. In-vitro release study

Dialysis tubing is used for in vitro rate of release testing. After cleaning, a dialysis sac is submerged in distilled water. The tube-filled bag is shut once the vesicle suspension has been pipetted inside. With repeatedly shaking at either 25°C/37°C, the vesicle containing bag is put inside a 250 ml beaker filled with buffer sol'n (200 ml).

Using a suitable assay technique, the buffer is examined for drug concentration at different intervals.

4. Evaluation of Zeta potential

Niosomes behave in vivo differently depending on their surface charge. Indicating how stable of the vesicular formulations is the zeta potential value. Determined by Electrophoretic light scattering.

5. Uniformity & Rigidity of Bilayers

Niosome bio-distribution and degradation are impacted by the stiffness of the bilayer. A p-NMR analysis can be used to evaluate inhomogeneity between dispersed niosomes or inside the niosome structure34. Differential scanning calorimetry (DSC) and fourier transform-infra red spectroscopy (FT-IR) techniques also used.

6. Stability study

During a period of three months, the the formulation of niosome was stored in thermostatic ovens at Accelearted/real time condition 4ºC, 25ºC, and 40ºC to ensure stability. Drug was evaluated for-the entrapment efficiency measure after a month had passed for each formulation. The components of the stability test were Size, EE% & zeta potential analysis..

7. Drug loading & encapsulation efficiency

In order to ascertain the effectiveness of drug loading and encapsulating, the niosomal aqueous suspension was centrifuged, the supernatant was extracted, and the sediment was twice washed with distilled water to get rid of the adhered medication.

APPLICATIONS OF NIOSOMES[4,]

Therapeutic uses for niosomes, such as:

- Cancer Therapy: diminish toxicity to healthy cells through bettering the absorption & specificity of chemotherapeutic drugs (such as doxorubicin).
- Cosmetics: As a way for better absorption, niosomes are utilised for transferring active compounds such as vitamins, antioxidants, and moisturisers deeper into the skin.
- Vaccine Delivery: serve as immunological adjuvants and antigen carriers, boosting the body's defences against disease.
- Delivery of Protein and peptide
- Delivery to the lungs (Pulmonary way)
- Transdermal delivery of drugs by niosomes

ROUTE OF APPLICATION OF NIOSOMAL DRUGS [8,9]

Table 1: Administration route of Niosomes

Route	Drugs
Intravenous Route	Doxorubicin, Insulin, Zidovudine
Inhalation Route	All trans-retinoic acid
Transdermal Route	Nimesulide, Estradiol, Piroxicam, Ketoconazole
Ocular Route	Timolol Maleate, Cyclopentolate
Nasal Route	Sumatriptan, Influenza vaccine

2. CONCLUSION

With promising properties including controlled release, protection against cleavage and degradation, and the ability to distribute drug molecules to specific locations, nano-carriers offer a great method for drug delivery. Niosomes lessen adverse effects, increase patient compliance, and improve treatment efficacy when compared to traditional delivery methods. They are a very appealing choice for both research and commercial applications since they are more stable, affordable, and simpler to handle and store than other nanocarriers like liposomes. Niosomes are at the forefront of contemporary medication delivery technologies, to sum up. They are in a position to significantly influence how the pharmaceutical & biomedical sciences develop in the future thanks to continuous developments and clinical breakthroughs. Niosomes may serve as the basis for safer, more efficient, and patient-friendly treatment approaches as our knowledge grows

REFERENCES

[1] Kaur, P., Rani, R., Singh, A. P., & Singh, A. P. (2024). An Overview of Niosomes. Journal of Drug Delivery and Therapeutics, 14(3), 137–146. https://doi.org/10.22270/jddt.v14i3.6450

[2] Malhotra M, Jain NK. Niosomes as Drug Carriers. Indian Drugs. 1994; 31(3): 81-86.

[3] Maurya R, Pathak K, Saxena P, Tiwari J, A review on novel drug delivery system:Niosomes, Asian J Pharm Res Dev 2013; 1(4):51- 59.

[4] Vadlamudi CH, Sevukarajan M, Niosomal drug delivery system:A review. Indo AmJ PharmRes.2012;2(9).

[5] Katkale, Akshay, Review on niosomes as novel drug delivery system, World Journal of Pharmaceutical Research, 2022, 1137. 10.20959/wjpr20223-23338.

[6] Ali Nasir et al, Niosomes: An Excellent Tool For Drug Delivery, International Journal Of Research In Pharmacy And Chemistry, 2012, 2(2), 479-487.

[7] Sankhyan A, Pawar P, Recent trends in noisome as vesicular drug delivery system, J Applied Pharm Sci. 2012; 2(6):20-32

[8] Sankhyan A, Pawar P. Recent Trends in Niosome as Vesicular Drug Delivery System. Journal of Applied Pharmaceutical Science. 2012; 2: 20-32.10.

[9] Bagheri A, Chu B, Yaakob H. Niosomal Drug Delivery Systems: Formulation Preparation and Applications. World Applied Sciences Journal. 2014;32:1671–1685.

[10] Gurjar P, Naik N, Chouksey S, Niosome:A promising pharmaceutical drug delivery, Int J Pharm Analysis, 2014; 2(5):425-31.

[11] Kandpal, R., Joshi, A., Kumar, K., Rajput, V., & Chauhan, V. (2023). An updated review on niosomes: a promising drug carrier. International Journal of Indigenous Herbs and Drugs, 53–57. https://doi.org/10.46956/ijihd.v8i6.512

[12] Parmar RP, Parmar RB, Conceptual aspects of vesicular drug delivery system with special reference to noisome, Asian J Pharm Tech. 2013; 3(2):52-59.

[13] Kaur, D., & Kumar, S. (2018). NIOSOMES: PRESENT SCENARIO AND FUTURE ASPECTS. Journal of Drug Delivery and Therapeutics, 8(5), 35–43. https://doi.org/10.22270/jddt.v8i5.1886

[14] Kalra N, Jeyabalan G, Niosomes:A versatile drug delivery system, Res J life Sci Bioinformatics Pharm Chem Sci, 2016;2(4):44-54..