STUDY ON NIOSOMES AND ITS METHODS AND APPLICATION

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Abstract:

Niosomes are novel, non-ionic surfactant-based vesicular structures that have garnered enormous interest within the subject of drug shipping due to their precise properties and advantages over conventional liposomes. Composed of non-ionic surfactants and cholesterol, niosomes offer better balance, controlled release, and progressed bioavailability of healing agents. This abstract gives an outline of the method, characterization, and applications of niosomes in various biomedical fields. We discuss their position in encapsulating hydrophilic and hydrophobic pills, capacity for concentrated on specific tissues, and packages in vaccine transport, cancer therapy, and gene remedy. Furthermore, the blessings of the use of niosomes in reducing toxicity and improving the efficacy of medication are highlighted. The methods of niosome preparation, the vesicle stability related aspects and many examples about pharmaceutical applications of NSVs will be presented. The routes of administration of these amphiphilic assemblies are also discussed.

Key word: Niosomes, cholesterol ,lipophilic, bioavaibility

Introduction

Niosomes are progressive drug delivery systems that encompass non-ionic surfactants, cholesterol, and, in a few instances, extra stabilizers. They constitute a massive advancement inside the discipline of pharmaceutical formulations, imparting an alternative to conventional liposomes. Unlike liposomes, which are formed from phospholipids, niosomes make use of non-ionic surfactants, making them less steeply-priced, greater solid, and less difficult to supply.

These vesicular systems can encapsulate each hydrophilic and hydrophobic pills, allowing for flexible applications across diverse therapeutic areas, along with oncology, vaccines, and gene remedy. The precise shape of niosomes, characterised with the aid of a bilayer membrane, facilitates managed launch and focused transport, enhancing the bioavailability of encapsulated retailers while minimizing facet consequences.

Recent research have tested that niosomes can enhance the solubility and balance of poorly water-soluble capsules, making them a precious tool in cutting-edge pharmaceutical development. Additionally, their ability to shape a solid dispersion in biological fluids further complements their capability for powerful drug transport.

This creation outlines the fundamental homes of niosomes, their formula techniques, and the significance in their application in improving drug delivery structures, in the end contributing to more

suitable therapeutic efficacy and patient compliance.quite a number clinical programs

. Niosomes are microscopic lamellar systems shaped by means of non-ionic surfactants and cholesterol. They show off a bilayer structure, with hydrophilic ends going through outward and hydrophobic ends dealing with inward. Their unique structure makes them perfect for various packages, appreciably in drug shipping structures. Niosomes excel in encapsulating both hydrophilic and hydrophobic drugs, enhancing drug balance and bioavailability. They are adaptable for tailored drug release and feature garnered interest across prescription drugs, cosmetics, and agriculture for their biocompatibility and flexible residences

STRUCTURE

Niosomes are non-ionic surfactant-based totally vesicular structures used for drug delivery. Their shape commonly consists of:

Surfactant Bilayer: Niosomes are fashioned by way of non-ionic surfactants that assemble into bilayer systems, much like liposomes. Common surfactants consist of polysorbates (e.G., Tween) and others like Span.

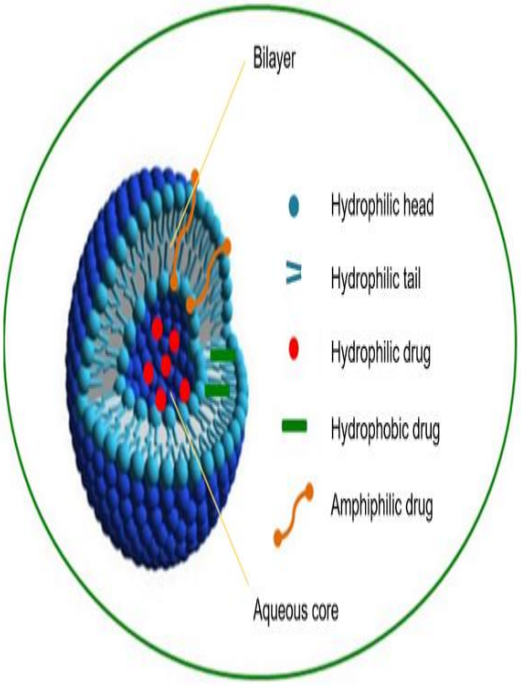
Hydrophilic Core: The relevant aqueous compartment can encapsulate hydrophilic tablets, taking into account managed launch

Hydrophobic Region: The bilayer membrane can incorporate hydrophobic capsules, improving their solubility and balance.

Stabilizers: Additional stabilizers or additives can be blanketed to decorate balance and shelf-life.

Size and Shape: Niosomes can vary in length (generally from 50 nm to several micrometers) and may be unilamellar or multilamellar.

These capabilities make niosomes flexible for drug shipping programs, including focused remedy and progressed bioavailability



SIZE RANGE OF NIOSOMES:

Niosomes usually range in length from approximately 50 nm to a thousand nm (1 μm). However, most formulations are typically determined in the range of one hundred to 500 nm. The size can vary based totally on the composition and technique of education used. Smaller niosomes can enhance drug absorption, whilst large sizes may be used for precise programs, which includes focused on or sustained relese o drug.

METHODS OF PRRREEPARATION: Niosomes are non-ionic surfactant-primarily based vesicular structures which might be used for drug delivery. They can encapsulate both hydrophilic and hydrophobic pills, improving their bioavailability and balance. Here's a detailed review of various methods for making ready niosomes:

1. **Thin Film Hydration Method**

Overview: This is one of the most common methods for niosome preparation.

Procedure:

Step 1: Dissolve the non-ionic surfactant (e.G., Span, Tween) along with ldl cholesterol in an organic solvent (like chloroform or methanol) to create a thin movie.

Step 2: Remove the solvent below decreased stress the usage of a rotary evaporator, forming a thin lipid film at the flask's wall.

Step three: Hydrate the thin movie by way of adding an aqueous segment (commonly buffer or distilled water) at a temperature above the transition temperature of the surfactants.

Step four: Vortex or sonicate the combination to facilitate the formation of niosomes.

Step 5: Size the niosomes if vital, using extrusion or sonication.

2. **Microfluidization**

Overview: This technique uses excessive shear to create uniform niosomes.

Procedure:

Step 1: Prepare a dispersion of the surfactant and cholesterol in an aqueous medium.

Step 2: Pass this dispersion thru a microfluidizer at high pressures.

Step 3: The intense shear forces and turbulence result in the formation of niosomes with managed length and uniformity.

3 Reverse Phase Evaporation Method (REV)

Overview: This method is useful for encapsulating hydrophobic drugs.

Procedure:

Step 1: Dissolve the surfactants and ldl cholesterol in a water-immiscible organic solvent (e.G., dichloromethane).

Step 2: Add an aqueous solution containing the drug to this aggregate.Step three: Evaporate the solvent under reduced strain, forming a gel-like segmeStep four: Add a buffer to hydrate the film, res

NIOSOME are more stable ta liposososmes

4. Ether Injection Method

Overview: This method is powerful for encapsulating both hydrophilic and hydrophobic pills.

Procedure:

Step 1: Dissolve the surfactants and cholesterol in an organic solvent (like diethyl ether).

Step 2: Inject this solution hastily into an aqueous phase below steady stirring.

Step three: The natural solvent evaporates quickly, main to the formation of niosomes as the surfactant assembles around the aqueous segment.

5. Solvent Injection Method

Overview: Similar to the ether injection approach however makes use of distinctive solvents.

Procedure:

Step 1: Dissolve the surfactants in a water-miscible natural solvent (like ethanol).

Step 2: Inject this solution into an aqueous segment at the same time as stirring vigorously.

Step three: This induces the formation of niosomes as the solvent disperses.

6. Coacervation Method

Overview: This method is based on the segment separation of surfactants.

Procedure:

Step 1: Mix non-ionic surfactants in an aqueous section.

Step 2: Adjust the pH or ionic energy to induce coacervation.

Step three: The surfactants aggregate to shape niosomes, which may be harvested and purified.

7. High-Pressure Homogenization

Overview: This method makes use of excessive-strain homogenization for niosome formation.

Procedure:

Step 1: Disperse the surfactants and pills in an aqueous medium.

Step 2: Subject the combination to excessive-pressure homogenization.

Step three: The mechanical forces result in the formation of niosomes with controlled length.

8. Supercritical Fluid Technology

Overview: This emerging method utilizes supercritical fluids for niosome coaching.

Procedure:

Step 1: Dissolve surfactants and capsules in a supercritical fluid (like CO2).

Step 2: Rapidly make bigger the answer into an aqueous medium.

Step 3: The surprising exchange in strain effects inside the formation of niosomes.

. Niosomalformulation:: The efficacy of a drug delivery system is strictly dependent on its components, that should be characterized in terms of physical–chemical and clinical properties needed for the formation of niosomal systems with specific characteristics, together with biocompatibility and relevance in clinics. The basic components of niosomes include non-ionic surfactants, hydration medium and lipids such as cholesterol.

. **Non-ionic surfactants**:: Just as ionic surfactants, non-ionic surfactants are amphiphilic (or amphipathic) molecules that have two distinct regions in their chemical structure, one of which is water-liking or hydrophilic and the other is water-hating or hydrophobic. The two portions of such molecules may be linked

by ether, amide or ester bonds. Non-ionic surfactant vesicles can be prepared from different types of molecules, such as: amino acids, fatty acids, amides, alkyl esters and alkyl ether surfactants, the last one being mostly employed for such purposes . Alkyl ether surfactants can be broadly divided into two classes based on the nature of the hydrophilic head group: alkyl ethers in which the hydrophilic head group consists of repeating glycerol subunits, related isomers or larger sugar molecules and those in which the hydrophilic head group consists of repeating ethylene oxide subunits.

Ether linked surfactant: These are surfactants contain hydrophilic and hydrophobic moieties which are linked by ether, polyoxyethylene alkyl ethers with the general formula (CnEOm), where n; i.e. number of carbon atoms varies between 12 and 18 and m; i.e. number of oxyethylene unit varies between 3 and 7.

Di -alkyl chain surfactant: Surfactant was used as a principal component of niosomal preparation of stibogluconate and its potential in delivering sodium stibogluconate in experimental marine visceral leishmaniasis has been explored.

C16H33CH-O[-CH2 -CH-O]7 -H

‖

CH2 CH2 OH

|

C12H25-O

(mol. Wt. 972)

Ester linked: These surfactants have ester linkage between hydrophilic and hydrophobic groups; hence it is also called as Ester linked surfactants.

C15H31CO[O-CH2 -CH-CH2]2 -OH | OH (mol. Wt. 393)

This surfactant was also studied for its use in the preparation of stibogluconate bearing niosomes and in delivery of sodium stibogluconate to the experimental marine visceral leishmaniasis

. **Sorbitan esters:** These are the ester linked surfactants. The commercial sorbitan esters are mixtures of the partial esters of sorbital and its mono and di-anhydrides with oleic acid CH2 | H-C-OH | RCOO- C-H | H-C-OH | H-C-OOC-R | CH2 OOC-R Where, R is H or an alkyl chain. These have been used to entrap wide range of drugs viz doxorubicin.

Fatty acid and amino acid compound: Long chain fatty acids and amino acid moieties have also been used in some niosomespreparation which form "Ufasomes" vesicles.

Cholesterol :It is well known that cholesterol (CHOL) influences the physical properties and structure of niosomes because of its interaction with non-ionic surfactants. Several surfactants form vesicles only after CHOL addition (up to 30–50 mol%). The amount of CHOL to be added depends on the HLB value of the surfactants. As the HLB value increases above 10, it is necessary to increase the CHOL concentration in order to compensate the effect of the larger head

groups on the critical packing parameter (CPP). Niosomal formulation The efficacy of a drug delivery system is strictly dependent on its components, that should be characterized in terms of physical–chemical and clinical properties needed for the formation of niosomal systems with specific characteristics, together with biocompatibility and relevance in clinics.

Classificationof niosomes:

The niosomes are classified as a function of the number of bilayer (e.g. MLV, SUV) or as a function of size. (e.g. LUV, SUV) or as a function the method of preparation. The various types of niosomes are described below:

1. Multi lamellar vesicles (MLV, Size=●>0.05 um)

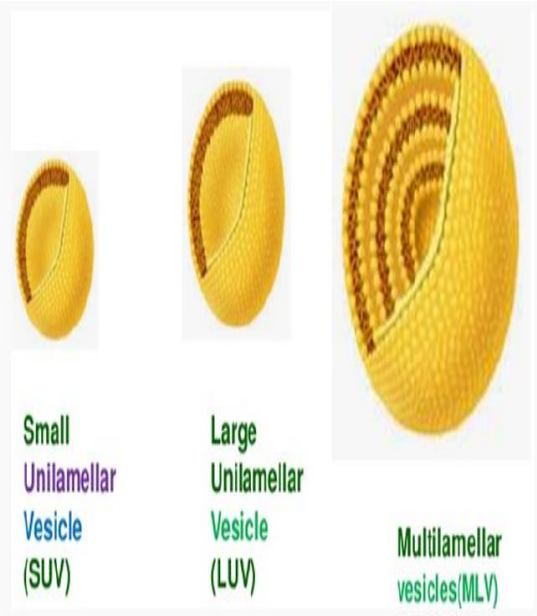
2.Large unilamellar vesicles (LUV, Size=●>0.10 um)

3. Small unilamellar vesicles (SUV, Size=0.025-0.05 um)

- **Multilamellar vesicles (MLV):** It consists of multiple bilayers surrounding aqueous lipid compartments. The diameter of these vesicles is approximately 0.5-10 microns. Multilayer vesicles are the most commonly used vesicles. These vesicles are well-suited as drug carriers for lipophilic drugs.

Large unilamellar vesicles (LUV): This type of vesicle has a balanced water/lipid compartment and therefore allows the capture of large amounts of bioactive substances through the economical use of lipids. GSC Biological and Pharmaceutical Sciences, 2024, 26(01), 048–062 **51**

. Small unilamellar vesicles (SUV): Most small monolayer vesicles are prepared from multilayer vesicles by ultrasonic treatment, French press extrusion, and electrostatic stabilization with such hexadecyl phosphate in charged carboxyluciferin. (CF) .



EVALUATION OF NIOSOMES: (Chauhan et al., 1999)

1 Entrapment efficiency: After preparing niosomal dispersion, unentrapped drug is separated by dialysis, centrifugation, or gel filtration as described above and the drug remained entrapped in niosomes is determined by complete vesicle disruption using 50% n-propanol or 0.1% Triton X-100 and analysing the resultant solution by appropriate assay method for the drug. Where, Entrapment efficiency (EF) = (Amount entrapped total amount) x 100

4] Vesicle diameter: Niosomes, similar to liposomes, assume spherical shape and so

their diameter can be determined using light microscopy, photon correlation microscopy and freeze fracture electron microscopy. Freeze thawing(keeping vesicles suspension at –20°C for 24 hrs and then heating to ambient temperature) of niosomes increases the vesicle diameter, which might be attributed to fusion of vesicles during the cycle (Mayer et al., 1985).

3) In-vitro release: A method of in-vitro release rate study includes the use of dialysis tubing. A dialysis sac is washed and soaked in distilled water. The vesicle suspension is pipetted into a bag made up of the tubing and sealed. The bag containing the vesicles is placed in 200 ml of buffer solution in a 250 ml beaker with constant shaking at 25°C or 37°C. At various time intervals, the buffer is analyzed for the drug content by an appropriate assay method (Parthasarthy et al., 1994). Methods for the evaluation of niosomes:

FACTORS AFFECTING NIOSOMES FORMULATION:

a) Drug :Entrapment of drug in niosomes increases vesicle size, probably by interaction of solute with surfactant head groups, increasing the charge and mutual repulsion of the surfactant bilayers, thereby increasing vesicle size. In polyoxyethylene glycol (PEG) coated vesicles, some drug is entrapped in the long PEG chains, thus reducing the tendency to increase the size. The hydrophilic lipophilic balance of the drug affects degree of entrapment (Raja et al., 1994)

. **b) Amount and type of surfactant:** The mean size of niosomes increases proportionally with increase in the HLB of surfactants like Span 85 (HLB 1.8) to Span 20 (HLB 8.6) 52 Pranshu Tangri et al. / International Journal of Biopharmaceutics. 2011; 2(1): 47-53. because the surface free energy decreases with an increase in hydrophobicity of surfactant (Raja et al., 1994; Khandare et al.,1994). The bilayers of the vesicles are either in the so-called liquid state or in gel state, depending on the temperature, the type of lipid or surfactant and the presence of other components such as cholesterol. In the gel state, alkyl chains are present in a well-ordered structure, and in the liquid state, the structure of the bilayers is more disordered. The surfactants and lipids are characterized by the gel-liquid phase transition temperature (TC). Phase transition temperature (TC) of surfactant also effects entrapment efficiency i.e. Span 60 having higher TC, provides better entrapment (Khandare et al., 1994).

c) Cholesterolcontent and charge ::Inclusion of cholesterol in niosomes increases its hydrodynamic diameter and entrapment efficiency. In general, the action of cholesterol is two folds; on one hand, cholesterol increases the chain order of liquid-state bilayers and on the other, cholesterol decreases the chain order of gel state bilayers. At a high cholesterol concentration, the gel state is transformed to a liquidordered phase (Hunter et al., 1988). An increase in cholesterol content of the bilayers resulted in a decrease in the release rate of encapsulated material and therefore an increase of the rigidity of the bilayers obtained. Presence of charge tends to increase the interlamellar distance

between successive bilayers in multilamellar vesicle structure and leads to greater overall entrapped volume**.**

d) Resistance to osmotic: stress Addition of a hypertonic salt solution to a suspension of niosomes brings about reduction in diameter. In hypotonic salt solution, there is initial slow release with slight swelling of vesicles probably due to inhibition of eluting fluid from vesicles, followed by faster release, which may be due to mechanical loosening of vesicles structure under osmotic stress (Malhotra et al., 1994).

e) Membrane Composition: The stable niosomes can be prepared with addition of different additives along with surfactants and drugs. Niosomes formed have a number of morphologies and their permeability and stability properties can be altered by manipulating membrane characteristics by different additives. In case of polyhedral niosomes formed from C16G2, the shape of these polyhedral niosome remains unaffected by adding low amount of solulan C24 (cholesteryl poly-24- oxyethylene ether), which prevents aggregation due to development of steric hindrance. In contrast spherical Niosomes are formed by C16G2: cholesterol:solulan (49:49:2). The mean size of niosomes is influenced by membrane composition such as Polyhedral niosomes formed by C16G2: solulan C24 in ratio (91:9) having bigger size (8.0 ± 0.03mm) than spherical/tubular niosomes formed by C16G2: cholesterol:solulan C24 in ratio (49:49:2) (6.6±0.2mm). Addition of cholesterol molecule to niosomal system provides rigidity to the membrane and reduces the leakage of drug from noisome (Chauhan et al., 1989)

Types of niosomes:

. 1 Proniosomes: Proniosomes are niosomal formulations containing a carrier and surfactant that require hydration before use. Hydration results in the formation of an aqueous dispersion of noisome. Proniosomes reduce the aggregation, leakage, and fusion problems associated with niosomal formulations.

[13] Carrier + surfactant = proniosomes•Proniosomes + water = niosomes•**.2Bola–surfactant**niosomes Bola surfactant niosomes were prepared from omega-hexadecyl-bis-(1-aza-18-crown-6): span-80: cholesterol in a 2:3:1 molar ratio. Among them, omega-hexadecyl-bis-(1-aza-18-crown-6) is a surfactant.

3. Aspasomes Aspasomes The combination of ascorbyl palmitate, cholesterol, and the highly charged lipid diethyl phosphate leads to the formation of vesicles called aspasomes. Aspasomes are first hydrated with water/aqueous solution and then subjected to sonication to obtain niosomes. Aspasomes can be used to increase the transdermal permeability of drugs. Aspasome is also used to reduce diseases caused by reactive oxygen species due to its antioxidant properties. [15] 5.3.1. Procedure .

4.Discomes: Discomes are large disc-shaped vesicles. The phase diagram of non-ionic surfactants exists only under certain conditions. When previously spherical vesicles were incubated for 1 h in a shaking bath at 24 and 74 °C, with different rates of respiration, discs of 11-60 μm in size were formed. Discoms are used as vehicles to deliver drugs to the eyes. Abdelkader et al. Ocular delivery formulations of naltrexone were prepared using a modified reverse phase evaporation technique. The temperature used for preparation is 60 °C, which is lower than the previously mentioned temperature and will therefore be beneficial for electrical equipment. [16,17]

5**. Elastic niosome:** They are made using nonionic surfactants, ethanol, and water. They can pass through pores that are larger than the vesicles found in the stratum corneum. They can be used to deliver low and high molecular weight drugs. Their effects last longer than vesicles and their penetration is weaker but depends on trans-epidermal hydration. Manosroi et al., 2013 prepared elastase niosome for scar treatment using Tween 61 and cholesterol in a chloroform/methanol (1:1) mixture. [19]

6. Polyhedral niosomes Polyhedral vesicles are spherical vesicles but are not homogeneous. Polyhedral vesicles have approximately 4 to 12 equal sides. niosomes were prepared by mixing cetyl diglyceryl ether (C16G2) and inhaled C24 by Uchegbu and Florence, 1995; Uchegbu et al., 1997; and Uchegbu and Vyas, 1998. These can be prepared by adding small amounts of cholesterol to the mixture. Polyhedral niosomes can also be prepared by adding mixtures of C16EO5 and solan-C24 into low concentrations of ethanol. [19]

7. Vesicles in water and oil system These vesicles are formed by emulsifying aqueous vesicles in an oily system. If cooled to room temperature, the vesicle system turns into a gel.

***In vitro* Release Study**

A method of *in vitro* release rate study was reported with the help of dialysis tubing. A dialysis sac was washed and soaked in distilled water. The vesicle suspension was pipetted into a bag made up of the tubing and sealed. The bag containing the vesicles was then placed in 200 ml buffer solution in a 250 ml beaker with constant shaking

at 25°C or 37°C. At various time intervals, the buffer was analysed for the drug content by an appropriate assay method. In another method, isoniazid-encapsulated niosomes were separated by gel filtration on Sephadex G- 50 powder kept in double distilled water for 48 h for swelling. At first, 1 ml of prepared niosome suspension was placed on the top of the column and elution was carried out using normal saline. Niosomes encapsulated isoniazid elutes out first as a slightly dense, white opalescent suspension followed by free drug. Separated niosomes were filled in a dialysis tube to which a sigma dialysis sac was attached to one end. The dialysis tube was suspended in phosphate buffer of pH (7.4), stirred with a magnetic stirrer, and samples were withdrawn at specific time intervals and analysed using high-performance liquid chromatography (HPLC) method.

***In vivo* Release Study:**

Albino rats were used for this study. These rats were subdivided with groups. Niosomal suspension used for *in vivo* study was injected intravenously (through tail vein) using appropriate disposal syringe.

Separation of Un entrapped Drug : The removal of unentrapped solute from the vesicles can be accomplished by various techniques, which include:

Dialysis: The aqueous niosomal dispersion is dialyzed in dialysis tubing against phosphate buffer or normal saline or glucose solution .

Gel Filtration: The unentrapped drug is removed by gel filtration of niosomal dispersion through a Sephadex-G-50 column and elution with phosphate buffered saline or normal saline .

Centrifugation: The niosomal suspension is centrifuged and the supernatant is separated. The pellet is washed and then resuspended to obtain a niosomal suspension free from unentrapped drug

Future Prospects: Niosomes represent a promising medication delivery module. Researched in noisome field are extensed to encapsulate toxic anticancer drugs, anti infective medications, anti AIDS medications, anti-inflammatory medications, anti viral medications, etc. Also, to utilize niosomes as promising medication transporters to accomplish better bioavailability, targeting properties, decreasing the toxicity, lethality and side effects of the medications. The ionic medications transporters are generally poisonous and inadmissible while niosomal carriers are more secure.

Characterization

Physicochemical characterization and analyses of niosomescontainvesicle size, morphology, size distribution, charge and zeta potential,entrapment efficiency, curve of drug release, lamellarity, rigidity, stability, viscosity, conductivity and homogeneity.

1 Average vesicle size, morphology and size distribution

Niosomes are assumed to be spherical in shape and their size can bedetermined using several techniques such as light microscopy and coulter counter (for particles with diameter over 1 μm), photon correlationspectroscopy, electron

microscopic analysis (scanning electron microscopy (SEM), transmission electron microscopy (TEM), freeze fracturereplication-electron microscopy (FF-TEM)), light scattering techniques(spectrometer — dynamic light scattering (DLS) instrument), zetasizerandmastersizer. Also, niosomes size distribution and polydispersityindex (PdI) can be measured by using dynamic light scattering particlesizeanalyzer. Vesicle size can range from around 20 nm to around50 μm .

2. **Charge of vesicle and zeta potential**

The zeta potential of vesicles can play an important role in the behavior of niosomes. In general, charged niosomes are more stableagainst aggregation and fusion than uncharged vesicles [40]. Also, negative zeta potential values ranging between −41.7 and −58.4 mV aresufficiently high for electrostatic stabilization and both surfactant typeor encapsulation efficiencies might affect the zeta potential values. Surface zeta potential can be determined using zetasizer,mastersizer, microelectrophoresis, pH-sensitive fluorophores, high performance capillary electrophoresis and DLS instruments .

3 **Stability study**

Storage feasibility of niosomal drug is investigated in stability study. Stability of vesicles is an important factor in successful development of a dosage form [40]. Stability of niosome is influenced by the entrappeddrug, its concentration, type of surfactant and cholesterol content Stability studies are carried out to investigate the drug leaching fromniosomes during storage and while in the general circulation. Usingconditions that simulate both situations, this leaching can be evaluatedby determining mean vesicle size, size distribution and entrapment efficiency over several month periods.

The stabilization strategies must be optimized depending on theagent to be entrapped to provide chemical stability of both the surfactant and drug components .

4. **Entrapment efficiency**

For the use of therapeutic vesicles in pharmaceutical application, themost important parameter of niosome is entrapment efficiency (EE%). After preparation of niosomes suspension, unencapsulated drug(free drug) can be subtracted from the total amount of drug by dialysis,centrifugation, gel chromatography or filtration. For the, encapsulation of the drug in niosomes, some parametersmust be determined. First, the amount of total drug (loaded and freedrug) (μg/ml) in constant amount of suspension is determined by aspectrophotometer instrument, high-performance liquid chromatography (HPLC), enzyme-linked immunosorbent assay (Elisa) and soon. Theconcentration of drug in μg/ml is found using a standard curve of absorbance values. After one or more separation step/s (depending on theseparation methods), the total concentration of free drugs can be obtained. The concentration of loaded drug.

.route ofAdministrations

Depending on the types of drugs, surfactants, diseases or locations ofdefects,

various routes of administration exist for niosomal drugs whichhave been listed below:

Intravenous (IV): Intravenous administration of drugs can directlyput drugs into the circulation system and drug loaded niosomes

compared to free drugs can enhance stability of the drugs and prolong the circulation time. Loaded drug can be released into thebloodstream or into target tissue under certain condition or intothe targeted cells.

Intramuscular (IM): After IM injection of the drugs, a gentle drugpenetration from tissues to capillaries has been observed.

Transdermal: The specific characteristic of transdermal route is slowpenetration of the drug through the skin.

Oral: The oral route is the most preferred route for delivering a therapeutically active substance. But acids and digestive enzymes in thestomach and small intestine can degrade some active substances. However, niosomes have been reported as conceivable vesiclesto deliver drug molecules to the desired mucous membrane or skinlayers .

Ocular: Topical ocular drug delivery is one of the commonly usedand preferred routes for treating conditions that affect the anteriorsegment of the eye. However, there are many anatomical and physiological barriers such as exclusive tight junctions of corneal epithelium and precorneal tear film that prevent absorption of theadministered particles from residing on the eye surface for deepersites. Therefore, the bioavailability of drugs administrated by ocularroute from simple solutions is typically less than 5% and often lessthan 1% .

Subcutaneous (SC): After SC injection, drugs transit to capillaries andthis route of administration is used for several drugs such as insulin,hydroxycamptothecin and so on . However, IV, IM and SC injections are more invasive routes than others which generally arenot an ideal method for the administration of drugs.

Pulmonary: Pulmonary administration, through inhalation ofdrugs, is one of appropriate routes used for glucocorticoidssuch as beclomethasonedipropionate (BDP) for patients withasthma. Pulmonary delivery of BDP through polysorbate

20 niosomes offers the advantages of sustained delivery, an improved mucus permeation, targeted drug delivery and amplifiedtherapeutic effect .

Several other routes of administration of niosomal drugs have beenreported such as intraperitoneal route, brain and vaginal deliverieswhereniosomes enhanced brain uptake. Also, it has been reportedthatniosomes might be a good carrier for vaginal delivery of proteindrugs.

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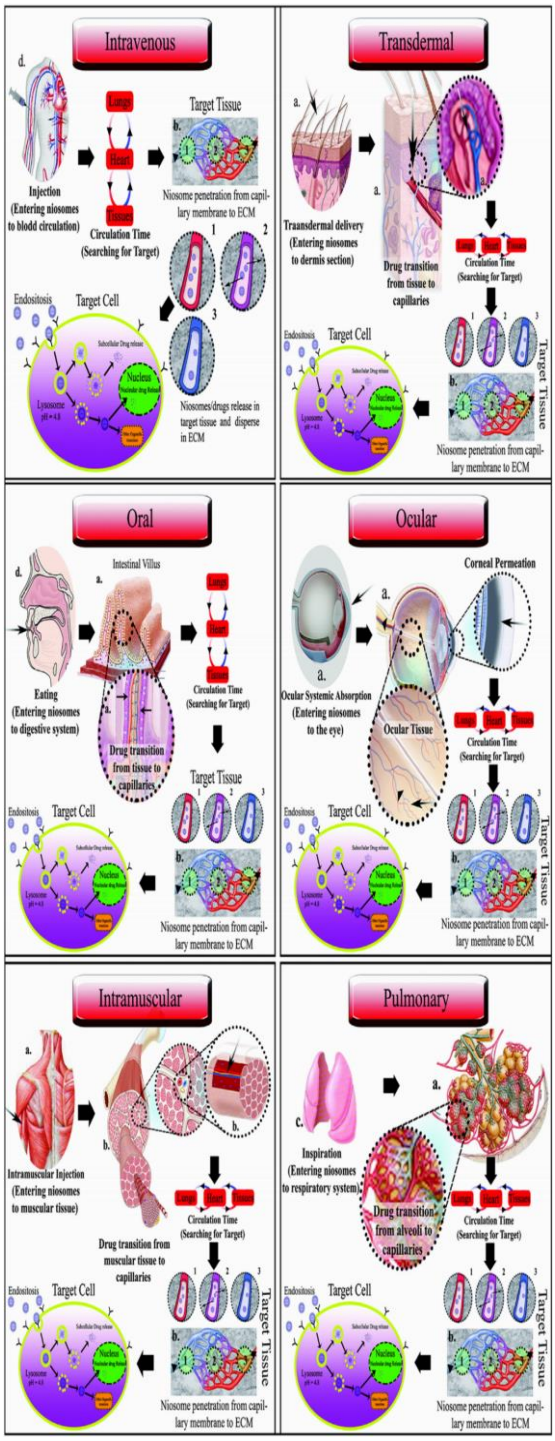

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Salient Features of Niosomes;:

Niosomes can entrap solute in a manner analogous to Liposome.

Niosomesosmoticaly active and stable.

Niosomes possess an infra structure consisting ofhydrophobic and hydrophilic mostly together and so alsoaccommodate the drug molecule with a wide range of solubility.

Niosomes exhibit flexibility in their structuralcharecterestics (composition, fluidity and size) and can be designed according to their desired situation

Niosomes can improve the performance of drug molecule.

Better availability to the particular site, just by protectingthe drug from biological environment.Niosomes surfactants are biodegradable, biocompatibleandnonimmunogenic. molecule.

Separation of unentrapped drug molecules.

The removal of unentrapped solute from thevesicles can be accomplished by various techniques, whichinclude: -

Dialysis

The aqueous niosomal dispersion is dialyzed in adialysis tubing against phosphate buffer or normal saline orglucose solution.

Gel Filtration

The unentrapped drug is removed by gel filtrationofniosomal dispersion through a Sephadex-G-50 columnand elution with phosphate buffered saline or normalsaline.

Centrifugation

The niosomal suspension is centrifuged and thesupernatant is separated. The pellet is washed and thenresuspended to obtain a niosomal suspension free fromunentrapped drug

Drug use in niosomes:

Niosomes are non-ionic surfactant-based vesicles used for drug delivery. They can encapsulate various types of drugs, including:

1. **Anticancer Agents**: Such as doxorubicin and paclitaxel, which

can benefit from enhanced delivery and reduced side effects.

2. **Antibiotics**: Drugs like rifampicin and vancomycin can be encapsulated for targeted delivery, improving efficacy.
3. **Anti-inflammatory Drugs**: Such as diclofenac, which can be delivered more effectively to target sites.
4. **Antiviral Drugs**: For instance, acyclovir can be used in niosomal formulations for better absorption and reduced toxicity.
5. **Vitamins and Nutraceuticals**: Such as vitamin C or curcumin, which can be stabilized and delivered more effectively.

Merits of niosomes:

1 Niosomes are less economic compared to liposomes. They have

More chemical stability due to absence of phospholipidswhich are inclined to oxidative degradation.

2. Niosomes prolong the circulation of entrapped drug. Theycan be relied upon to target the drug to its wanted site of actionand to control its discharge.

3. The use of niosomes in cosmetics preparation has thefollowing advantages:

i. The vesicle suspension being water based offers morepatient compliance over oil based systems.

ii. Since the structure of the niosome offers place to suit

hydrophilic, lipophilic and in addition ampiphilic drug moieties, they can be utilized for an assortment of drugs.

iii. Niosome characteristics such as size, lamellarity etc. of

the vesicle can be fluctuated relying upon the requirement.

iv. The vesicles can act as a depot to release the medication

gradually and offer a controlled release.

4 They are osmotically active and stable.

5. They increase the stability of the entrapped drug

6. Handling and storage of surfactants do not require any special

conditions

7. Can increase the oral bioavailability of drugs

8. Can enhance the skin penetration of drugs

9. They can be utilized for oral, parenteral and topical use

10. The surfactants are biodegradable, biocompatible, and nonimmunogenic

11. Improve the therapeutic action of the drug by shielding itfrom the biological environment and restrictions to target cells,in this manner diminishing the clearance of the drug

Demerits:

1. Physical instability

2. Aggregation

3. Fusion

4. Leaking of entrapped drug

5. Hydrolysis of encapsulated drugs which limiting the shelf life of the dispersion.

. Conclusion

It is obvious that niosome appears to be a wellpreferred drug delivery system over liposome as noisome being stable and economic. Alsoniosomes have great drugdelivery potential for targeted delivery of anti-cancer,antiinfectiveagents. Drug delivery potential of niosome canenhance by using novel concepts like proniosomes,discomes and aspasome. Niosomes also serve better aid indiagnostic imaging and as a vaccine adjuvant. Thus theseareas need further exploration and research so as to bringout commercially available niosomal preparation. Theconcept of incorporating the drug into liposomes orniosomes for a better targeting of the drug at appropriatetissue destination is widely accepted by researchers andacademicians. Niosomes represent a promising drugdelivery module. They present a structure similar toliposome and hence they can represent alternative vesicularsystems with respect to liposomes, due to the noisome ability to encapsulate different type of drugs within theirmultienvironmental structure. Niosomes are thoughts to bebetter candidate drug delivery as compared to liposomesdue to various factors like cost, stability etc. Various type ofdrug deliveries can be possible using niosomes like targeting, ophthalmic, topical, parenteral

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