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A Review on Methods for Preparation of Niosomes and Applications of Niosomal Gel.

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ABSTRACT:

Paul Ehrlich envisioned a medicine delivery system and launched the development of targeted delivery in 1909. A niosome is made of a nonionic surfactant and cholesterol. The range of niosome sizes is 10 nm to 100 nm. Niosomes have many advantages over conventional drug delivery system. Various methods are them to prepare niosomes and explained here some are like ether injection method, thin film hydration method, reverse phase evaporation method and sonication method. Also discussed here about some applications of niosomes prepared formulations over conventional applications.

Keywords: Niosomes, Cholesterol, Poloxamers, Surfactant.

INTRODUCTION:

When Paul Ehrlich envisioned a medicine delivery system that would target specifically damaged cells, he launched the development of targeted delivery in 1909. The capacity to direct a therapeutic agent specifically to a desired site of action with little to no contact with non-target tissue is known as drug targeting.[1]

A niosome is a liposome made of a nonionic surfactant. Cholesterol inclusion as an excipient is the primary method of niosome formation. You can also utilise different excipients. Compared to earlier emulsion formulations, niosomes are more capable of penetrating. Niosomes are architecturally similar to liposomes in that they contain a bilayer, however because of the materials employed in their creation, niosomes are more stable and hence have a number of advantages over liposomes.[1,2]

Niosome sizes are tiny and fall into the nanometric range. The range of particle sizes is 10 nm to 100 nm.

A typical niosome vesicle would be made up of a vesicle-forming amphiphile, such as Span-60, which is a non-ionic surfactant that is typically stabilised by the addition of cholesterol and a little amount of dicetyl phosphate, an anionic surfactant that also aids in stabilising the vesicle.[3,4]

ADVANTAGES:

- Drug release in sustained and controlled manner.
- Enhances permeation of drug through skin.[5]
- The niosome can be utilised for a range of pharmaceuticals since its structure allows room for hydrophilic, lipophilic, and amphiphilic chemical moieties.[6]
- Depending on the need, the vesicle's attributes, such as size and lamellarity, can be changed.[7]
- The vesicles can function as a depot, providing a regulated release of the medicine while releasing it gradually.[8]

DISADVANTAGES:

- The preparation of multilamellar vesicles via the extrusion and sonication approach takes time and requires specialised equipment.
- Niosomes in aqueous suspension have a short shelf life because to drug entrapment fusion, aggregation, and leakage.[9]

COMPOSITION OF NIOSOMES:

The two main components used for the preparation of niosomes are:

a. Nonionic surfactants

b. Cholesterol

a) Nonionic surfactants:

Due to their greater stability, biocompatibility, and lower toxicity as compared to anionic and cationic surfactants, nonionic surfactants are the surface-active agents employed in the synthesis of niosomes.[10]

- Ethers: Brij, Lauryl glucoside, Decyl glucoside, Nonoxynol-9
- Block polymers: Poloxamers
- Esters: Glyceryl laurate, Spans, Polysorbates
- Fatty alcohol: Stearyl alcohol, Cetyl alcohol, Oleyl alcohol

b) Cholesterol:

Cholesterol is utilised to give niosome preparations stiffness, correct shape, and conformation.[11] Niosomes prepared with cholesterols are also less permeable to the harmful effects of plasma and serum components, reducing the leakage fraction.[12]

PREPARATION OF NIOSOMES:

Since the preparation methods affect the number of bilayers, size, size distribution, and entrapment efficiency of the aqueous phase as well as the membrane permeability of the vesicles, the preparation procedures should be chosen in accordance with the use of the niosomes;

1) Ether injection method:

A 14-gauge needle is used to introduce the medication and lipid to the diethyl ether, which is kept at 60 ° C, before gradually introducing them into the aqueous phase. Large unilamellar niosomes are created when an organic solvent is heated past its boiling point; they can then be processed to make smaller niosomes.[13]

2) Thin film hydration method (hand shaking):

The most popular, reproducible, and researched approach for creating multilayer vesicles (MLV) is thin-film hydration. Thin layer hydration is used to dissolve the niosomes after a volatile solvent such as diethyl ether, chloroform, or methanol has been used to dissolve the surfactant and cholesterol. At room temperature (20°C), a rotary evaporator is then used to extract the organic solvent. As a result, the wall of the flask develops a thin coating of solid mixture. The dried surfactant can be hydrated with the drug-containing aqueous phase at 0 to 60 ℃ while gently stirring. Using this method, conventional multilamellar niosomes are created.[14,15]

3) Reverse phase evaporation method:

Chloroform and ether are used to dissolve surfactant and cholesterol. After adding an aqueous phase containing the medication to the combination, ultrasound is applied at 4-5 °C. The chemical is then mixed with a little amount of buffer salt to create a more sonic gel. The organic solvent is removed at a low pressure and 40 °C. We formed big monolayers by heating the mixture in a water bath at 60 ° C for 10 minutes after diluting the resulting suspension with phosphate-buffered saline (PBS).[16]

4) Sonication method:

The ultrasonic approach is a common way to create vesicles. In a mixture (cholesterol/surfactant) in a 10 ml glass vial, there is an aqueous phase containing the active agent in the buffer. The mixture is subjected to three minutes of sonication in a titanium sonic probe, producing uniformly sized, tiny niosomes at 60°C. As a drug model for low-soluble medications, niosomes loaded with rifampicin were created utilising the probe sonication technique.[14,15,17]

Method of injecting lipids this method avoids using organic solvents, which are expensive and dangerous to utilise in vivo. Niosome production occurs when molten surfactant and cholesterol are introduced to a heated aqueous phase that also contains dissolved drug molecules.[18]

CHARACTERIZATION OF NIOSOMES:

Niosome characterizations are necessary to assess the standard of the generated vesicles and their uses. Investigations into size, size distribution, zeta potential, entrapment effectiveness, shape, and in vitro release are regular since they affect how stable and effective niosomes are in vivo;

- Zeta potential, particle size, and particle size distribution:

The physical characteristics, homogeneity, and stability of the manufactured niosomes are determined by the mean particle size, particle size distribution (polydispersity index, PDI), and zeta potential. Numerous methods can be used to gauge niosome size. Undoubtedly one of the most popular methods for quickly and non-destructively determining the size and size distribution of nanomaterials is dynamic light scattering (DLS). It is based on the randomly distributed Brownian motion of the particles. Prior to measurement, one mL of freshly generated sample is typically diluted with the proper solvent (such as distilled water or phosphate-buffered saline (PBS)) and Sonicated in a water bath. Measurements should be made for each formulation in triplicates to assure accuracy. Niosomal size distribution is shown by PDI: Lower PDI values (0.3) indicate a more homogeneous, uniform dispersion.[19]

-Morphology of niosomes:

Microscopic methods like transmission electron microscopy (TEM), scanning electron microscopy, and atomic force microscopy can be used to analyse the morphology of niosomal vesicles. For investigating the morphology of niosomes, TEM is frequently utilised. In this method, a drop of the samples (niosomal formulation) is applied to copper grids covered with carbon, dyed with, for instance, 2% phosphotungstic acid (w/v), and then left to dry before imaging. Cholesterol, Span 60, and Tween 40 (2:1:1 M ratio) make up niosomes.[20]

-Entrapment efficiency:

The amount of medication contained within niosomes is indicated by the entrapment efficiency. When the loaded niosomal solution is centrifuged, the amount of free drug in the supernatant is assessed (an indirect indicator of entrapment effectiveness), and this may be computed using equation (1).[21,22]

Entrapment efficiency (%) = Total amount of initially added drug – Unentrapped drug /Total amount of initially added drug × 100 …… equation (1)

-In vitro drug release:

In vitro drug release, which depends on a number of variables including drug concentration, hydration temperature, and membrane type, is one of the key aspects of niosome characterisation. In most cases, the dialysis membrane is employed to investigate the rate of release of active substances (drug molecules). A clean dialysis bag is cleansed and bathed in distilled water during this operation. The mixture is then placed inside a bag with a pipe and sealed. A magnetic stirrer is used to agitate the vesicle bag continuously at 37°C in a 200 ml glass of PBS. The samples are exposed to the same volume of freshly prepared media at predefined intervals. After that, we do the necessary analyses on the samples to determine how much of the medicine is released over time.[23,24]

APPLICATIONS OF NIOSOMAL GEL:

For the treatment of a wide range of disorders, niosomal drug delivery is suitable to numerous pharmacological agents;

a) Drug delivery for the eyes:

Due to tear formation, brief residence times, and corneal epithelial impermeability, the main disadvantage of ocular dose forms including ophthalmic solutions, suspensions, and ointments is that it is challenging to obtain excellent bioavailability. However, great bioavailability of the medicine can be achieved through niosomal drug delivery.[25]

b) Transdermal drug delivery:

Niosomes structural characteristics have a permeation enhancer effect and enable direct vesicle fusion with the stratum corneum (the skin's outer layer), which improves the penetration of loaded medications when applied transdermally.[26]

c) Nasal administration:

The medication's incorporation into niosomes improved direct transport percentage, brain bioavailability, drug targeting effectiveness, and brain absorption via the direct nose-to-brain channel, showing improved central nervous system targeting via the direct nasal pathway.[27]

CONCLUSIONS:

The structure of niosomes, a relatively new drug delivery method, is two layers of nonionic surfactants. Various medications can be put in niosomes by varying the experiment's parameters and the ratio of surfactant and cholesterol used. Additionally, hydrophobic and hydrophilic medicines can be loaded into niosomes due to their amphipathic nature. Additionally, niosomes improve medication stability, delay drug release, and lower drug toxicity. In contrast to other drug delivery methods, niosomes don't need to be prepared or stored under certain circumstances. In conclusion, it appears that additional research will lead to an optimistic market for niosomes in pharmaceutical biotechnology in the future.

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