A Review on Design and Evaluation of Niosomes for Transdermal Drug Delivery

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***Abstract*—Transdermal drug delivery devices, or TDDS, are a good alternative to taking medicine by mouth or through injections. These devices work by delivering medication through the skin in a controlled way. Niosomes, which are special types of tiny bubble-like structures made from nonionic surfactants, have become one of the best choices for carrying drugs through the skin. They can hold both water-soluble and oil-soluble medicines, help them pass through the skin more easily, and release the medicine slowly over time. This paper focuses on the design, methods for making niosomes, and how to test them for use in transdermal drug delivery. It also examines different factors that influence how well niosomes work, such as the type of surfactant used, the amount of cholesterol, the kind of liquid used in their preparation, and techniques to make them smaller. The paper also covers recent research, studies on how well drugs pass through the skin, and tests done in labs as well as on living animals.**

***Index Terms*—Cholesterol, Niosomes, Non-ionic surfactant vesicles, Transdermal Drug Delivery system.**

I. INTRODUCTION

A number of benefits, including avoiding hepatic first pass metabolism, preserving constant medication plasma levels, and enhancing patient compliance, have made transdermal drug delivery systems (TDDS) a viable substitute for oral and injectable methods. [1] However, the stratum corneum of the skin serves as a robust barrier that prevents many therapeutic substances from penetrating.[2] table routes, which have a number of benefits such avoiding hepatic first pass metabolism, preserving consistent medication plasma levels, and enhancing patient adherence.[3] However, the stratum corneum of the skin serves as a robust barrier that prevents many therapeutic substances from penetrating.[4]

Non-ionic surfactant-based vesicles called niosomes have drawn interest as efficient delivery systems for improving medication absorption through the skin. [5]. Both hydrophilic and lipophilic medications can be encapsulated in these tiny, bilayered structures, which shield them from deterioration and enable precise and regulated distribution. Niosomes are more stable, less expensive, and simpler to handle and store than liposomes, which makes them appropriate for use in medicinal applications.[6]

II. TRANSDERMAL DRUG DELIVERY SYSTEM (TDDS)

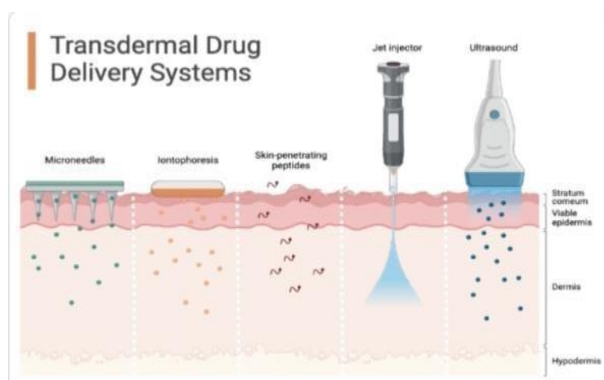

FIG.1: - TRANSDERMAL DRUG DELIVERY SYSTEM (TDDS).

DEFINE

To have a therapeutic effect, medicines can be slowly and steadily delivered through the skin into the bloodstream using a transdermal drug delivery system (TDDS).[7]

SIGNIFICANCE

The importance of TDDS comes from its unique advantages compared to traditional drug delivery methods like injections and oral tablets. It is a patient friendly, safe, and effective way to give medicine through the skin to achieve a systemic effect.[8].

1.Avoids the First-Pass Metabolism Process.
2.Consistent and Regulated Release.
3.Better Patient Adherence.
4.Minimizes Gastrointestinal Side Effects.
5.Convenient for Drugs with Short Half-Lives.
6.Beneficial for Patients Having Trouble Swallowing.

FACTORS AFFECTING TRANSDERMAL DELIVERY: -

-The size and weight of the medicine patch.
-The quantum of drug demanded.
-The attention of the medicine
-The pH position of the medicine expression.
-Skin temperature.
-How doused the skin.

III. NIOSOMES: -

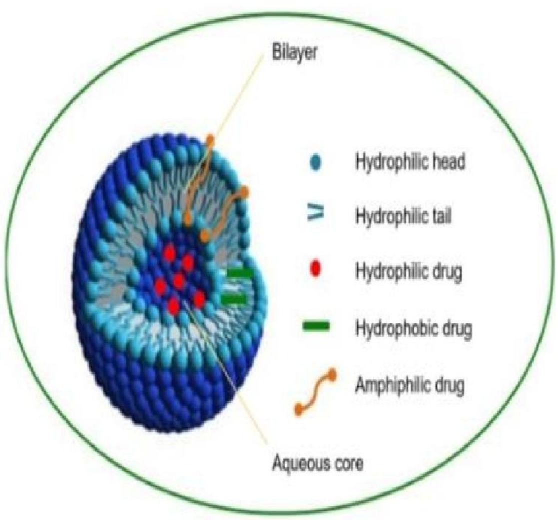

FIG.2: - NIOSOMES.

DEFINE

Therapeutic compounds can be encapsulated and delivered to specific locations within the body using niosomes, which are self-assembled vesicular systems made of cholesterol and non-ionic surfactants.[9]. Niosomes are vesicles based on nonionic surfactants that are employed as a new method of medication administration. These tiny, spherical structures, which are composed of a bilayer of cholesterol and non-ionic surfactants, can contain both lipophilic (fat-soluble) and hydrophilic (water-soluble) medications.[10].

KEY FEATURES OF NIOSOMES: -

- Composed of non-ionic surfactants, such as Tween or Span.
- With cholesterol, stabilized.
- Both biodegradable and biocompatible. - It can be used for parenteral, transdermal, topical, and oral medication administration.
- Enhance targeted delivery, bioavailability, and medication stability.[11].

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TYPES OF NIOSOMES: -

A. modest Unilamellar Vesicles (SUV): These are single-layered, 10–100 nm vesicles that are ideal for delivering modest doses of medication.
B. Large Unilamellar Vesicles (LUV): These are single-layered, but larger, and have a higher drug loading capacity than SUVs.
C. Often created using the thin film hydration process, multilamellar vesicles (MLV) are larger than 500 nm and comprise several concentric bilayers that resemble onions.

ADVANTAGES: -

- Non-toxic and biocompatible
- Enhanced Stability of Drugs
- Improved Skin Infiltration
- Consistent and Regulated Release
- Focused Medication Administration. - Simple to Set Up and Expand.
- Stable Compared to Liposomes.[12]

MECHANISM OF DRUG DELIVERY VIA NIOSOMES: -

vesicles based on non-ionic surfactants that are employed as medication delivery vehicles. Both hydrophilic and lipophilic medications can be encapsulated by them, improving bioavailability and enabling regulated release. The precise mechanism by which niosomes distribute medications is as follows.

The watery core of the niosome contains hydrophilic medicines. The bilayer membrane composed of cholesterol and non-ionic surfactants incorporates lipophilic medications.

*ADMINISTRATION AND INTERACTION WITH BIOLOGICAL

MEMBRANES: -
Niosomes can be applied topically, trans dermally, orally, and in other ways. They interact with biological membranes (such as skin, mucosa, or cell membranes) once they arrive at their intended location.[13].

*FUSION OR ADSORPTION: -
-Niosomes distribute medications into cells via three primary mechanisms: -

a. FUSION WITH CELL MEMBRANE: -
-The lipid bilayer of the cell membrane fuses with the niosomal bilayer.
-This allows the medication to enter the cytoplasm of the cell directly.

b. ENDOCYTOSIS (CELL ENGULFMENT): - -cell uses endocytosis to absorb the complete niosome.

IV. COMPOSITION OF NIOSOMES

Drug delivery techniques employ vesicles called niosomes, which are based on non-ionic surfactants. Although they share structural similarities with liposomes, they are more affordable and stable.
1. Surfactants without ions.2. Cholesterol.
3.Optional Charge Inducers.
4.The hydrophilic medication.[14].

V. METHOD OF PREPARATION OF NIOSOMES

1) THIN FILM HYDRATION METHOD: -
PROCEDURE: -Cholesterol and surfactant are dissolved in an organic solvent, like chloroform.
The solvent is removed using a rotary evaporator to form a thin film on the flask.
A slightly stirred aqueous drug solution is used to hydrate the film.
Niosomes can be sonicated to reduce their size and form naturally.

2) ETHER INJECTION METHOD: -
Procedure: -Cholesterol and surfactant are dissolved in diethyl ether.
- The heated aqueous drug solution is slowly mixed with this solution.
- When ether comes in contact with water, it evaporates and forms niosomes.

3) REVERSE PHASE EVAPORATION METHOD: -
Procedure: -
- Cholesterol and surfactant are dissolved in an organic solvent.
- A water-in-oil emulsion is created by gradually adding an aqueous drug solution. - A gel forms when the organic solvent evaporates under lower pressure.
- Niosomes form when the gel is hydrated.

4) SONICATION METHOD: -
Procedure: -
- Probe sonication is applied to the prepared niosomal dispersion.
- This results in smaller, more uniform vesicles.

5) Micro fluidization Method: -
Procedure: -
- - Aqueous and surfactant phases are mixed under high pressure through microchannels. - This creates small, uniformly sized vesicles.[15].

VI. FACTORS AFFECTING NIOSOME FORMULATION

1)Surfactant Type.
2) Cholesterol Content.
3) Surfactant to Cholesterol Ratio.
4) Hydration Medium.
5) Preparation Method.

VII. EVALUATION PARAMETERS OF NIOSOMES

1) Size Distribution and Vesicle Size.
2) Zeta Potential.
3) Entrapment Efficiency (%EE).
4) Morphology Study.
5) In Vitro Drug Release.

VIII. APPLICATION OF THE NIOSOMAL TRANSDERMAL SYSTEM

- Pain Management.
- Hormone Replacement Therapy.
- Antifungal and Antibacterial Therapy. - Anti-Hypertensive Therapy.
- Anticancer Drug Delivery.
- Dermatological Treatments.

IX. RESULT

When discussing "Design and Evaluation of Niosomes for Transdermal Drug Delivery Systems," some possible outcomes to consider include:

1) BETTER DRUG PENETRATION

- Niosomes can improve transdermal drug delivery by increasing skin penetration and retention.

2) IMPROVED STABILITY

- Niosomes can provide a steady and controlled release of drugs.

3) TARGETED DELIVERY

- Niosomes can be designed to specifically target certain cells or skin layers.

4) ENHANCED BIOAVAILABILITY

Niosome-based transdermal administration can avoid first-pass metabolism.

X. CONCLUSION

Because niosomes can encapsulate both hydrophilic and lipophilic drugs, enhance skin permeability, and enable prolonged drug release, they are becoming a reliable vesicular drug delivery technology for transdermal applications. The size of the vesicles, the entrapment efficiency, and the overall performance of the noisome system are heavily influenced by surfactant selection, cholesterol ratio, preparation methods, and formulation conditions.

Niosomal formulations have been shown in various studies to improve the bioavailability of drugs delivered through the skin and reduce the frequency of doses, which improves patient compliance Niosomes offer better stability, tailored distribution, and a more effective therapeutic impact with fewer side effects compared to traditional transdermal formulations.

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