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TRANSETHOSOMES AS DRUG CARRIER AND ITS EFFICIENCY

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ABSTRACT

The development of efficient drug delivery systems remains a major focus of modern pharmaceutical research to overcome the limitations associated with conventional dosage forms, such as poor bioavailability, inadequate skin permeation, frequent dosing, and systemic adverse effects. Among the various nanocarrier-based approaches, transethosomes have emerged as an advanced generation of ultra-deformable lipid vesicles with significant potential for topical and transdermal drug delivery. Transethosomes are composed of phospholipids, ethanol, edge activators (surfactants), and water, integrating the advantages of both ethosomes and transferosomes. The synergistic interaction of ethanol and edge activators enhances vesicular flexibility, allowing these carriers to efficiently penetrate the highly resistant stratum corneum and deliver drugs into deeper layers of the skin or systemic circulation.Transethosomes exhibit excellent encapsulation efficiency for hydrophilic, lipophilic, and amphiphilic drugs, providing improved physicochemical stability, controlled and sustained drug release, enhanced skin retention, targeted drug delivery, and increased bioavailability. Their unique structural characteristics minimize drug degradation and reduce systemic toxicity while improving therapeutic efficacy and patient compliance.

1. INTRODUCTION

Transethosomes are advanced **ultra-deformable lipid vesicular nanocarriers** developed by combining important characteristics of **ethosomes and transferosomes**. Ethosomes are characterized by the presence of a relatively high concentration of ethanol, whereas transferosomes contain edge activators that impart high membrane deformability. Transethosomes incorporate these features into a single vesicular system and are therefore investigated as carriers for enhanced drug delivery through biological barriers, particularly the skin.

A typical transethosomal formulation contains **phospholipids, ethanol, an edge activator, and an aqueous phase**. Depending on the formulation and intended application, additional components such as cholesterol, penetration enhancers, stabilizers, polymers, or targeting ligands may also be incorporated. The combined effects of ethanol and edge activators increase membrane flexibility and facilitate interaction with the stratum corneum, thereby improving drug deposition and permeation.

Transethosomes can accommodate a broad range of therapeutic molecules. Hydrophilic drugs may preferentially associate with the aqueous compartment, whereas lipophilic drugs can partition into the phospholipid bilayer. Amphiphilic molecules may distribute between both regions depending on their physicochemical properties.

The transethosome concept was introduced as an extension of ultra-deformable vesicular systems and has subsequently been investigated for transdermal, dermal, ocular, pulmonary, and other specialized drug-delivery applications. However, many of these applications remain at the research and preclinical-development stage rather than being established clinical applications [1].

2. SOURCE AND COMPONENTS OF TRANSETHOSOMES

The term **source of transethosomes** refers primarily to the origin and nature of the materials used to construct the vesicular system and to the scientific development of the carrier from ethosomes and transferosomes.

2.1 Phospholipids

Phospholipids constitute the principal structural component of transethosomes. Commonly used phospholipids include **phosphatidylcholine, soya lecithin, egg phosphatidylcholine, and other phosphatidylcholine-rich materials**.
Natural phospholipids may be obtained from sources such as:

- Soybean lecithin
- Egg-yolk lecithin
- Sunflower-derived phospholipids

Synthetic phospholipids may also be used when greater batch-to-batch reproducibility, controlled composition, or improved stability is required. The type and concentration of phospholipid can influence vesicle size, encapsulation efficiency, deformability, stability, and skin permeation.

2.2 Ethanol

Ethanol is an important functional component of transethosomes. It contributes to membrane fluidization and deformability and can act as a skin-permeation enhancer. Ethanol also interacts with the lipid domains of the stratum corneum, facilitating disruption or fluidization of the skin lipid structure.
The concentration of ethanol is formulation-dependent. Published studies have used a broad range of concentrations, and therefore a single concentration should not be considered universally optimal. A recent review reports ethanol concentrations commonly ranging from approximately **10–50%**, while some formulations use approximately 30–40%. Excessive ethanol may destabilize vesicles or increase the possibility of skin irritation [2].

2.3 Edge Activators

Edge activators are surfactants or membrane-fluidizing agents incorporated to increase the flexibility and deformability of the phospholipid vesicles.
Examples include:

- Tween 20
- Tween 80
- Span 20
- Span 80
- Sodium cholate
- Sodium deoxycholate
- Other bile salts and suitable surfactants

The type and concentration of edge activator strongly influence vesicle deformability, particle size, drug encapsulation, membrane integrity, and drug permeation. Excessive amounts may destabilize the vesicular membrane and increase drug leakage.

2.4 Aqueous Phase

Purified water, distilled water, or an appropriate aqueous buffer serves as the hydration medium and forms the aqueous environment of the vesicular system. Hydrophilic drugs can be incorporated into the aqueous compartment, depending on the preparation method and formulation characteristics.

Important Points

- Transethosomes combine important characteristics of ethosomes and transferosomes.
- The basic components are phospholipids, ethanol, an edge activator, and an aqueous phase.
- Phospholipids may be obtained from natural or synthetic sources.
- Ethanol contributes to membrane fluidization and enhanced skin permeation.
- Edge activators increase vesicle deformability and flexibility.
- Transethosomes can potentially carry hydrophilic, lipophilic, and amphiphilic drugs.
- Their principal area of investigation is enhanced dermal and transdermal drug delivery.
- Their ability to improve bioavailability depends on the drug, formulation, route, and experimental conditions.

Table 01: Source Components of Transethosomes

Category	Component	Major Function	Main Advantage
Structural component	Natural phospholipids	Vesicle formation	Biocompatibility and biodegradability
Structural component	Synthetic phospholipids	Formation of reproducible lipid membranes	Better compositional control
Functional component	Ethanol	Membrane fluidization and permeation enhancement	Improved deformability and skin permeation

Functional component	Edge activators	Increase membrane flexibility	Enhanced vesicle deformability
Aqueous phase	Purified water/buffer	Hydration and vesicle formation	Provides an aqueous environment
Optional stabilizer	Cholesterol	Membrane stabilization	Improved physical stability

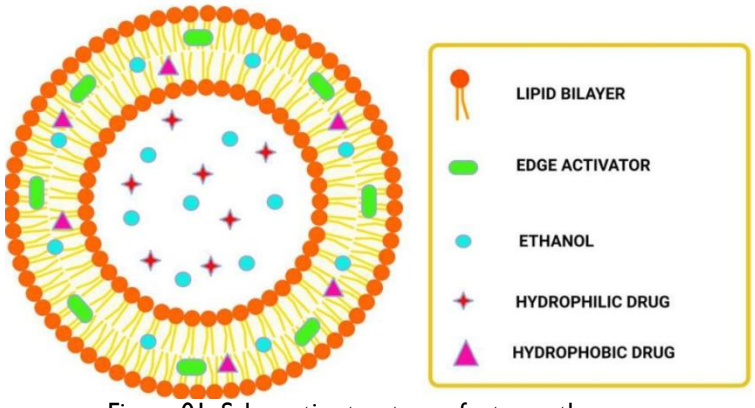

Figure 01: Schematic structure of a transethosome

A suitable schematic should illustrate the phospholipid bilayer, ethanol-containing environment, edge activator molecules, aqueous compartment, and entrapped drug [3].

3. NOVEL FORMS OF TRANSETHOSOMES

Continuous research has resulted in several modified or multifunctional transethosomal systems. These modifications are intended to improve stability, targeting, residence time, controlled release, or therapeutic performance.

3.1 Surface-Modified Transethosomes

Surface modification involves coating or functionalizing transethosomes with polymers, carbohydrates, peptides, or other molecules.

Examples include:

- Chitosan
- Polyethylene glycol (PEG)
- Carbohydrate-based coatings
- Other biocompatible polymers

Surface modification may improve physical stability, mucoadhesion, cellular interaction, or site-specific delivery. The actual benefit depends on the modifying material and intended route of administration.

3.2 Ligand-Targeted Transethosomes

Specific ligands can be attached to the surface of transethosomes to promote interaction with receptors expressed on particular cells or tissues.

Potential targeting ligands include:

- Peptides
- Antibodies
- Folic acid
- Hyaluronic acid
- Carbohydrate ligands

Such systems are being investigated for targeted drug delivery, including cancer and inflammatory diseases. However, ligand-targeted transethosomes should be considered an **emerging research approach**, and their clinical applicability requires further validation.

3.3 Stimuli-Responsive Transethosomes

Stimuli-responsive systems are designed to release their drug payload in response to specific environmental or externally applied stimuli.

Possible stimuli include:

- pH
- Temperature

- Enzymes
- Light
- Ultrasound

These systems may provide more controlled drug release and are being explored as advanced drug-delivery platforms.

3.4 Mucoadhesive Transethosomes

Incorporation of mucoadhesive materials, such as chitosan or carbomer-based polymers, can increase residence time at mucosal surfaces.

Potential applications include:

- Nasal delivery
- Buccal delivery
- Ocular delivery
- Vaginal delivery

The suitability of these systems depends on the physicochemical characteristics of the drug and the intended biological barrier.

3.5 Gel-Based Transethosomes

Transethosomal dispersions can be incorporated into hydrogels, emulgels, or other semisolid vehicles.

Advantages may include:

- Improved residence time
- Convenient topical application
- Reduced spreading or leakage
- Sustained drug release
- Improved patient acceptability

Gel-based transethosomes have been investigated particularly for topical and dermatological applications.

3.6 Hybrid Transethosomal Systems

Transethosomes can be combined with other drug-delivery technologies, including:

- Polymeric nanoparticles
- Hydrogels
- Microneedles
- Other nanocarriers

Such hybrid systems are intended to overcome specific delivery barriers and may provide controlled release or enhanced tissue penetration.

Important Points

- Surface modification can improve stability or biological interaction.
- Ligand functionalization may provide targeted delivery.
- Stimuli-responsive systems can provide controlled or triggered release.
- Mucoadhesive systems can increase residence time on mucosal surfaces.
- Gel-based formulations can improve topical application.
- Hybrid systems can combine the advantages of transethosomes with other delivery technologies.
- Most advanced modifications remain under experimental or preclinical investigation.

Table 02: Novel Forms of Transethosomes

Novel Form	Modification	Major Advantage	Potential Application
Surface-modified transethosomes	PEG, chitosan, carbohydrates or other polymers	Improved stability or biological interaction	Dermal and targeted delivery
Ligand-targeted transethosomes	Peptides, antibodies, folic acid, hyaluronic acid	Potential site-specific delivery	Cancer and inflammatory disorders
Stimuli-responsive transethosomes	pH-, temperature-, enzyme-, light- or ultrasound-responsive components	Controlled drug release	Precision drug delivery
Mucoadhesive transethosomes	Chitosan, carbomer and other mucoadhesive polymers	Increased residence time	Nasal, buccal and ocular research
Gel-based transethosomes	Incorporation into hydrogel/emulgel	Improved topical application and sustained release	Dermatology and wound-care research
Hybrid	Combination with nanoparticles,	Synergistic delivery	Advanced transdermal

transethosomes	hydrogels or microneedles	performance	therapy

4. FORMULATION MODELS AND DESIGN

Successful transethosomal formulation requires optimization of the composition and processing parameters. Important formulation variables include the type and concentration of phospholipid, ethanol, edge activator, drug concentration, aqueous phase, cholesterol or other stabilizers, and preparation conditions [1,2,4].

The objective of formulation optimization is to obtain a system with suitable:

- Vesicle size
- Size distribution
- Encapsulation efficiency
- Deformability
- Physical stability
- Drug-release characteristics
- Skin permeation
- Drug deposition

4.1 Key Formulation Components

Table 03: Key components of Models and Design

Component	Common Examples	Role	Effect on Performance
Phospholipid	Soya lecithin, egg phosphatidylcholine, phosphatidylcholine	Forms the vesicular membrane	Influences size, encapsulation, stability and permeability
Ethanol	Ethanol	Fluidizes the membrane and enhances permeation	Influences size, deformability and skin penetration
Edge activator	Tween 20/80, Span 20/80, sodium cholate, sodium deoxycholate	Increases membrane flexibility	Improves deformability and permeation
Cholesterol	Cholesterol	Optional membrane stabilizer	Can improve membrane stability and reduce leakage
Aqueous phase	Purified water or buffer	Hydration medium	Supports vesicle formation
Additional enhancer	Oleic acid, terpenes, propylene glycol	Modifies skin-barrier properties	May increase drug flux
Drug	Hydrophilic, lipophilic or amphiphilic API	Therapeutic agent	Determines loading and release behavior

The concentration of each component should be optimized experimentally because increasing the concentration of one component can have different effects depending on the drug and other formulation variables.

5. Critical Quality Attributes and Characterization Parameters

There is **no single universal specification** for all transethosomal formulations. The acceptable range for each parameter depends on the drug, composition, preparation method, intended route, and target product profile [5].

5.1 Vesicle Size

Vesicle size is commonly determined using dynamic light scattering (DLS).

Nanometer-sized vesicles are generally desirable for topical and transdermal delivery, but reported transethosomal formulations show considerable variation. Therefore, a rigid range such as 50–250 nm or 100–300 nm should not be treated as a universal requirement.

5.2 Polydispersity Index

The polydispersity index (PDI) indicates the breadth of the particle-size distribution.

A lower PDI generally indicates a more uniform population of vesicles. A PDI below approximately **0.3** is often considered desirable for a relatively homogeneous nanosuspension, although the appropriate acceptance criterion should be established for the individual formulation.

5.3 Zeta Potential

Zeta potential provides information about the surface electrical characteristics and contributes to the assessment of colloidal stability.

Highly positive or highly negative zeta-potential values may provide greater electrostatic repulsion and therefore improved dispersion stability. However, zeta potential alone does not determine the stability of transethosomes because steric stabilization, ethanol, surfactants, lipid composition, viscosity, and other factors also contribute.

Therefore, values such as **−15 to −40 mV** or **±30 mV** should be regarded as commonly cited experimental benchmarks rather than universal specifications.

5.4 Entrapment Efficiency

Entrapment efficiency (EE%) represents the percentage of drug associated with the vesicular system relative to the total amount of drug used.

High entrapment efficiency is generally desirable, but the achievable value depends strongly on:

- Drug solubility
- Drug–lipid interactions
- Lipid concentration
- Ethanol concentration
- Edge-activator concentration
- Preparation technique

Reported values can vary substantially; therefore, a fixed value such as 65–95% or 70–90% should not be considered mandatory for all transethosomal formulations.

5.5 Deformability Index

The deformability index evaluates the ability of vesicles to deform under applied stress without losing their structural integrity.

High deformability is one of the most important characteristics distinguishing transethosomes from conventional rigid vesicles.

5.6 Morphology

Morphological characteristics can be investigated using techniques such as:

- Transmission electron microscopy (TEM)
- Scanning electron microscopy (SEM)
- Atomic force microscopy (AFM), where appropriate

Transethosomes are generally described as spherical or approximately spherical/irregularly spherical vesicles depending on their composition and imaging conditions.

5.7 In Vitro Drug Release

In vitro release studies determine the rate and extent of drug release from the transethosomal formulation.

Depending on the formulation, release may demonstrate:

- Initial drug release
- Sustained release
- Diffusion-controlled release
- Combination mechanisms

Release data can be analyzed using appropriate kinetic models.

5.8 In Vitro and Ex Vivo Skin Permeation

Franz diffusion cells are commonly used to investigate drug permeation across excised skin or synthetic membranes.

Important parameters include:

- Cumulative drug permeation
- Steady-state flux (Jss)
- Permeability coefficient (Kp)
- Lag time
- Enhancement ratio
- Drug deposition within different skin layers

The results should be compared with an appropriate control formulation, such as a drug solution, conventional liposome, ethosome, or transferosome.

5.9 Stability

Stability studies evaluate changes in:

- Vesicle size
- PDI
- Zeta potential
- Drug content

- Entrapment efficiency
- Appearance
- Drug leakage
- pH

Storage conditions should be selected according to the intended product and relevant stability-testing guidelines.

6. EFFICACY IN FORMULATION AND DRUG DESIGN

Transethosomes are investigated as a strategy for addressing several limitations of conventional transdermal drug delivery.

A. Improved Skin Permeation

The combination of ethanol and edge activators can increase membrane fluidity and vesicle deformability. These effects can facilitate interaction with and passage through the stratum corneum.

However, the statement that:

Transethosomes > Ethosomes ≈ Transferosomes > Conventional liposomes

should not be presented as a universal ranking. Comparative performance varies with drug, formulation composition, experimental conditions, and study design.

B. Versatility in Drug Loading

Transethosomes can accommodate different classes of drugs:

Lipophilic Drugs

Lipophilic drugs can preferentially associate with the hydrophobic region of the phospholipid membrane.

Hydrophilic Drugs

Hydrophilic drugs can be incorporated into the aqueous compartment or associated with the vesicle depending on their physicochemical properties and preparation method.

Amphiphilic Drugs

Amphiphilic drugs may partition between the aqueous and lipid phases.

Macromolecules

Research has explored lipid-vesicular systems for peptides, proteins, and other macromolecules. However, successful transdermal delivery of large biologics remains challenging because molecular size and physicochemical properties strongly affect skin penetration.

C. Reduction of First-Pass Metabolism

When a drug is successfully delivered transdermally into systemic circulation, the gastrointestinal tract and hepatic first-pass metabolism can be avoided.

This may potentially:

- Improve systemic bioavailability
- Reduce fluctuations in plasma drug concentration
- Reduce gastrointestinal exposure
- Permit lower doses in some cases

However, these benefits are **drug- and formulation-dependent** and should not be assumed for every transethosomal system [4, 5,6].

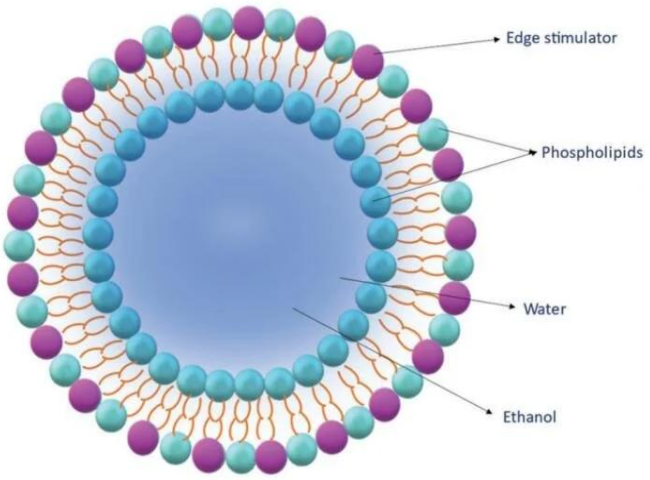

Figure 02: Schematic Representation of the Structure of aTransethosomes

7. STRATEGIC APPROACHES FOR TRANSETHOSOMAL DRUG DELIVERY

When considering transethosomes from a drug-delivery perspective, their utility can be categorized according to the intended site and therapeutic objective.

7.1 Transdermal Systemic Delivery

Strategy:

Transethosomes are applied to the skin with the objective of enhancing drug permeation across the stratum corneum and, where appropriate, enabling systemic absorption.

Therapeutic objective:

Maintenance of systemic drug concentrations for drugs suitable for transdermal administration.

Potential advantages:

- Avoidance of gastrointestinal degradation
- Avoidance of hepatic first-pass metabolism
- Potential reduction in dosing frequency
- Potential improvement in patient adherence

7.2 Localized Dermal Delivery

Strategy:

The formulation is designed to increase drug deposition in the skin rather than necessarily maximizing systemic absorption.

Therapeutic objective:

High local drug concentration at the site of dermatological disease.

Potential applications:

- Psoriasis
- Atopic dermatitis
- Inflammatory skin disorders
- Fungal infections
- Certain localized skin infections
- Skin-cancer research

Potential advantage:

Localized delivery may increase drug concentration at the target tissue while potentially reducing unnecessary systemic exposure.

7.3 Mucosal Delivery

Transethosomes have also been investigated for mucosal routes, including ocular, vaginal, nasal, and buccal delivery.

The scientific rationale is based on the deformability and permeation-enhancing characteristics of the vesicles. Nevertheless, evidence for each route varies, and these applications should be regarded as **research and development areas rather than universally established clinical applications**.

7.4 Physical-Enhancement and Hybrid Approaches

Transethosomes may be combined with physical permeation-enhancement technologies such as:

- Microneedles
- Sonophoresis
- Iontophoresis
- Other barrier-modifying techniques

The objective is to provide additional pathways for difficult-to-deliver drugs. Such combinations require careful assessment of safety, irritation, dose control, and manufacturing complexity.

Table 03: Strategic Approaches for Transethosomal Drug Delivery

Strategic Approach	Mechanism/Objective	Potential Drug Classes
Sustained systemic delivery	Enhanced transdermal permeation and systemic absorption	Suitable small-molecule drugs
Localized dermal delivery	Increased drug deposition in target skin layers	Anti-inflammatory, antifungal and other dermatological drugs
Mucosal delivery	Enhanced interaction with mucosal barriers	Selected small molecules and macromolecules under investigation
Targeted delivery	Surface functionalization to improve interaction with specific cells	Drugs requiring site-specific delivery

Hybrid physical enhancement	Combination with microneedles or other techniques	Difficult-to-deliver drugs and selected macromolecules

8. OPERATIONAL AND DELIVERY-VECTOR APPROACHES

Depending on the intended application, transethosomes can be incorporated into secondary dosage forms.

8.1 Hydrogel/Emulgel Incorporation

Transethosomal dispersions may be incorporated into hydrogels or emulgels prepared using polymers such as carbomers or chitosan.

Advantages:

- Increased formulation viscosity
- Improved residence time
- Convenient topical administration
- Reduced spreading
- Potentially sustained drug release

8.2 Transdermal Patch Systems

Transethosomal formulations may be incorporated into matrix or reservoir-type transdermal systems.

The objective is to combine the enhanced permeation characteristics of transethosomes with the controlled-release and convenience characteristics of patch systems.

However, the actual duration of drug release depends on the drug, patch design, polymer matrix, membrane characteristics, and transethosomal formulation.

8.3 Spray and Aerosol Systems

Transethosomal formulations can potentially be adapted for spray or aerosol administration where appropriate.

These systems may facilitate:

- Uniform application
- Convenient administration
- Large-area coverage
- Mucosal delivery in selected applications

Device compatibility and formulation stability must be established before practical use.

9. Detailed Specifications of Transethosomes

Transethosomal specifications can be divided into two major categories:

1. **Formulation specifications**
2. **Characterization and quality specifications**

9.1 Formulation Specifications

Phospholipids-Structural Backbone

Phospholipids form the primary structural membrane of transethosomes. Common materials include phosphatidylcholine, soya lecithin, and egg phosphatidylcholine.

Their concentration and chemical characteristics affect:

- Vesicle size
- Encapsulation efficiency
- Membrane stability
- Deformability
- Drug release
- Skin permeation

Ethanol-Permeation and Fluidization Component

Ethanol contributes to the fluidity and deformability of the vesicular membrane and enhances interaction with the stratum corneum.

Ethanol concentration must be optimized because insufficient ethanol may provide inadequate permeation enhancement, whereas excessive ethanol may compromise membrane integrity or increase irritation potential. Published formulations use a broad range of concentrations rather than one universal concentration.

Edge Activators-Deformability Agents

Edge activators modify membrane packing and increase vesicular flexibility.

Common examples include:

- Tween 20
- Tween 80
- Span 20
- Span 80
- Sodium cholate
- Sodium deoxycholate

Their concentration must be optimized to achieve high deformability without causing excessive membrane disruption.

Aqueous Phase

Water or an appropriate buffer provides the hydration medium and contributes to formation of the aqueous compartment.

10. CHARACTERIZATION SPECIFICATIONS

10.1 Vesicle Size and Size Distribution

Vesicle size is commonly determined by dynamic light scattering.

General expectation: nanoscale vesicles with an acceptable and reproducible size distribution.

A universal size specification should not be assigned because reported transethosome sizes vary according to formulation composition and preparation method.

10.2 Polydispersity Index

A lower PDI indicates a more uniform vesicle population.

Common development target: PDI < 0.3 may be desirable for a relatively homogeneous dispersion, although formulation-specific acceptance criteria should be established.

10.3 Zeta Potential

Zeta potential is used as an indicator of surface charge and dispersion stability.

Highly charged systems may exhibit greater electrostatic repulsion; however, zeta potential should always be interpreted together with other stability parameters.

10.4 Entrapment Efficiency

Entrapment efficiency is determined using:

EE (%) = (Amount of drug entrapped / Total amount of drug added) × 100

High EE is generally desirable, but there is no universal value applicable to every transethosomal formulation.

10.5 Deformability Index

Deformability is a key quality attribute of transethosomes.

A high deformability index indicates that the vesicles can undergo substantial deformation under mechanical stress while retaining their integrity. This property contributes to their ability to interact with and traverse the skin barrier.

10.6 In Vitro Permeation

In vitro permeation studies commonly use Franz diffusion cells.

Important parameters include:

- Steady-state flux
- Permeability coefficient
- Cumulative amount permeated
- Lag time
- Enhancement ratio
- Drug deposition in skin

10.7 Vesicle Morphology

Morphological evaluation is generally performed using TEM, SEM, or related microscopic techniques.

The desired morphology should be evaluated together with particle-size data and formulation stability rather than used as an isolated acceptance criterion.

11. ADVANTAGES OF TRANSETHOSOMES

The major potential advantages of transethosomes include:

- High membrane deformability
- Enhanced interaction with the stratum corneum
- Improved dermal and transdermal drug permeation
- Ability to accommodate drugs with different physicochemical properties
- Potential for localized or systemic drug delivery
- Potential reduction of first-pass hepatic metabolism for successfully transdermally absorbed drugs

- Potential for sustained or controlled drug release
- Non-invasive administration for suitable topical/transdermal applications
- Possibility of incorporation into gels, patches, and other dosage forms
- Potential for surface functionalization and targeted delivery

12. LIMITATIONS AND CHALLENGES

Despite their promising characteristics, transethosomes also have several limitations.

12.1 Ethanol-Related Irritation

The relatively high ethanol content may cause skin dryness or irritation in susceptible individuals.

12.2 Physical and Chemical Stability

Vesicle aggregation, drug leakage, lipid oxidation, and changes in particle size may occur during storage.

12.3 Formulation Optimization

Small changes in phospholipid, ethanol, or edge-activator concentration can substantially alter vesicle characteristics.

12.4 Reproducibility

Natural phospholipids may exhibit variability in composition, making synthetic or highly purified phospholipids attractive when reproducibility is critical.

12.5 Scale-Up

Laboratory-scale preparation may not directly translate to industrial manufacturing. Process control, sterilization where required, stability, and batch-to-batch reproducibility remain important development challenges.

12.6 Limited Clinical Evidence

Although numerous laboratory and animal studies demonstrate promising results, additional well-designed clinical studies are required to establish the safety, efficacy, and long-term performance of transethosomal products.

Current reviews emphasize that transethosomes remain a promising but developing drug-delivery technology, with formulation stability, safety, standardization, and translation to clinical use requiring further investigation [3,4,6,7].

13. CONCLUSION

Transethosomes are advanced ultra-deformable lipid vesicular carriers that combine the major characteristics of ethosomes and transferosomes. Their basic composition consists of phospholipids, ethanol, edge activators, and an aqueous phase. Ethanol contributes to membrane fluidization and skin-permeation enhancement, whereas edge activators increase membrane flexibility and deformability.

Because of these properties, transethosomes have attracted considerable interest for dermal and transdermal delivery of a wide variety of therapeutic agents. Their formulation can be further modified using polymers, targeting ligands, mucoadhesive materials, stimuli-responsive components, hydrogels, patches, microneedles, and other technologies.

However, transethosomes should not be considered universally superior to all other vesicular systems. Their performance is strongly dependent on drug properties, formulation composition, preparation method, and experimental conditions. Important quality attributes include vesicle size, PDI, zeta potential, encapsulation efficiency, deformability, morphology, drug release, permeation, and stability.

Overall, transethosomes represent a promising platform for advanced drug delivery, particularly where overcoming the skin barrier is the primary formulation challenge. Continued optimization, standardization, toxicological assessment, scale-up studies, and clinical evaluation are required before their broader therapeutic translation.

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