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INVASOMES IN COSMETICS: ENHANCING SKIN PENETRATION AND ACTIVE INGREDIENT DELIVERY

Nituporna Bora [*] and Apurba Talukdar

NETES Institute of Pharmaceutical Science, Santipur, Mirza, Guwahati - 781125, Assam, India.

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Correspondence to Author:
Nituporna Bora

PG Scholar,
NETES Institute of Pharmaceutical Science, Santipur, Mirza, Guwahati - 781125, Assam, India.

E-mail: bnituporna@gmail.com

ABSTRACT: Invasomes, within the scope of transdermal medication delivery and cosmetic formulations, nowadays have emerged as impressive technology and are described in comprehensive detail in this review paper. Essentially, invasomes are built from a unique substance, techniques, and processes that can enable active compounds to penetrate easier into the skin than standard liposomes, with the help of phospholipids, ethanol, and terpenes while remaining within the skin boundaries and decreasing systemic absorption. This paper discusses the advantages of invasomes over the conventional delivery systems, including enhanced bioavailability and targeted delivery of therapeutic agents. Other aspects discussed include advancements in nanotechnology and process automation to reduce the production cost and enhance the scalability without any compromise on quality. Review of applications of invasomes in dermo-cosmetic products focuses on their role in treating skin dysfunctions. In summary, it is underscored in this paper that invasomes can revolutionize skincare formulations and hence help overcome multiple dermatological issues.

INTRODUCTION:

Overview of Invasome: Better penetration across the transdermal barrier is exhibited by invasomes, which are new vesicular structures compared to conventional liposomes. The improved penetration capability of these vesicles results from their composition, including phospholipids, ethanol, and terpenes. The ability of these nanovesicles to enhance the skin's penetration of drugs while limiting systemic absorption constraining the medication's effects only to the layers of the skin [1-4]. This is one of its key advantages.

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Their ability to penetrate epidermal layers improves the effectiveness of invasomes, which work by disrupting lipid and intracellular protein contacts and fluidizing SC lipid bilayer structure [5].

Importance of Invasomes in Cosmetic:

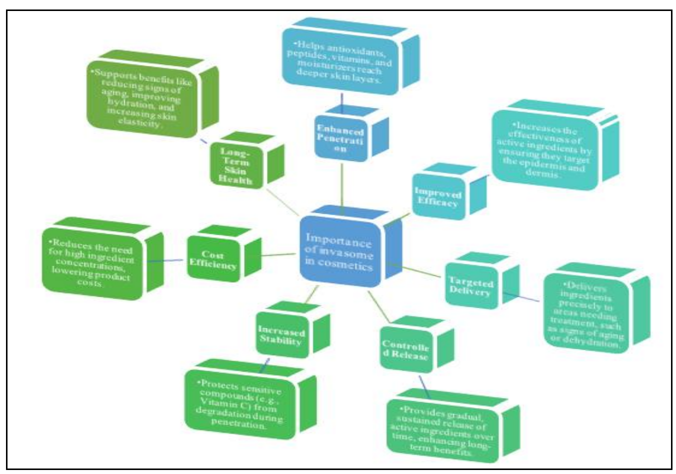

FIG. 1: IMPORTANCE OF INVASOME IN COSMETICS

Difference between Different Somes:

TABLE 1: DIFFERENCE BETWEEN DIFFERENT SOMES

Characteristics	Invasome	Liposome	Niosome	Phytosome	Transferosomes	Flexosome
Composition	Phospholopids with penetration enhancers (e.g., ethanol, terpene)	Phospholipid usually lecithin and cholesterol	Non-ionic and cholesterol	Phospholipids with plant derived active ingredients	Phospholipids with edge activators	Phospholipids with flexible membrane enhancer
Active ingredient delivery	Targets deeper skin layer s for enhanced penetration	Mainly for hydrophilic and lipophilic drugs	Primarily for hydrophilic drugs	Delivers plant derived compounds to target organs	Delivers drugs across skin using elastic properties	Target deeper skin layer with enhanced flexibility
Key feature	Enhanced skin penetration using ethanol/surfactants	Bi layer vesicles for both hydrophilic and lipophilic compounds	Non-ionic surfactant-based vesicles for hydrophillic drugs	Improves bioavailability of plant based active ingredients	Flexible and elastic vesicle for deeper skin penetration	Highly flexible vesicle efficient drug delivery across skin
Penetration mechanism	Increased permeability through skin due to penetration enhancers	Limited skin penetration due to hydrophillic outer layer	Skin penetration via surfactant-induced disruption of skin barrier	Improves skin penetration of plant-based actives through lipid interections	Elastic deformation through the skin barrier for transdermal delivery	Flexible vesicle that can deform and penetrate the skin more effectively
Stability	High stability for sensitive cosmetic ingredients	Moderate stability, prone to leakage over time	Relatively stable but can be affected by environmental factors	High stability for plant extract	Very stable effective for transdermal delivery	Highly stable with aprolong release profile
Application	Cosmetic, transdermal drug delivery	Cosmetics, pharmaceuticals and vaccines	Cosmetic pharmaceuticals	Cosmetics, nutraceuticals, phytotherapeutic products	Transdermal drug delivery (pain management and hormone)	Anti-aging and transdermal
Example	Anti-aging cream, moisturizing lotion	Liposomal sunscreens, anticancer treatnents	Niosomal moisturizers wound healing	Phytosome-based anti-aging and anti-inflamatory products	Transferosome based pain relief patches	Anti agimg serums
Market availability	Widely used in advanced cosmetics and dermatology	Commonly used in pharmaceuticals and cosmetics	Gaining popularity in cosmetic formulation	Increasing use in nutraceuticals and cosmetics	Used in clinical dermato;ogy and pharmaceuticals	Emerging technology used in high-and cosmetics
Reference	49, 50, 51,52	53, 54, 55	56, 57, 58	59, 60, 61, 62	63, 64, 65	66, 67, 68

Skin Structure and Penetration Barriers: There are multiple layers in the anatomy of skin, and each one serves a particular purpose.

The key ones that influence the delivery of active ingredients are mostly confined to the epidermis, which consists of stratum corneum as the outermost layer of the skin. This section is going to discuss the anatomy of skin, specifically focusing on the role these layers, in particular stratum corneum, play as barriers in active ingredient delivery.

Layers of the Skin: There are basically three layers of the skin:

Epidermis:

Stratum Corneum (SC): Epidermis It is an oily matrix mainly made of skin cells that have died called corneocytes and serves as the outermost cover of the epidermis. It forms the most major barrier protecting the skin against toxins, harmful infections, and dehydration [6].

Other Epidermal Layers: These are located underneath the stratum corneum, including stratum lucidum, stratum granulosum, stratum spinosum, and stratum basale. They enable the conservation of integrity in the structure of skin, thus making the process easier for skin restoration [6, 7].

Dermis: The dermis, immediately under the epidermis, is where collagen, elastin, blood vessel components, and nerve endings that contribute to the strength and suppleness of the skin can be found [6].

Hypodermis: The hypodermis, or subcutaneous tissue, is the deepest layer, mainly composed of connective tissue and fat, which cushions and insulates the body.

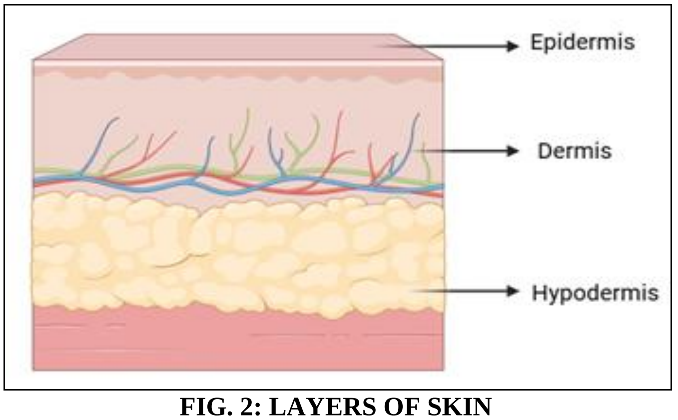

FIG. 2: LAYERS OF SKIN

The Stratum Corneum and its Barrier Function: Since it is the most critical layer acting as the first line of defence against the permeation of active substances, perhaps the stratum corneum is the most important layer. This is composed of layers of dead skin cells known as corneocytes embedded within the lipid matrix, forming a semi-permeable barrier. The integrity of this structure is critical for maintaining skin homeostasis; it is the first and foremost line of security in which the body protects itself against environmental damage and water loss [6, 8].

The Keratin and Lipid Matrix: Keratin is a fibrous protein that gives skin its strength and shape, so it is abundant in the corneocytes. The lipid matrix, which is made up of ceramides, cholesterol, and free fatty acids, surrounds the corneocytes in a hydrophobic barrier. This lipid-rich matrix, which is crucial for the skin's protective barrier, prevents the majority of water-soluble compounds from passing through the skin [7].

Barrier Function: Trans epidermal water loss, or TEWL, is excessive water loss that is prevented by the stratum corneum, which also serves as a barrier against toxins, diseases, and environmental pollutants. At the same time, this same barrier significantly hinders the delivery of active compounds in pharmaceuticals and cosmetics. This is particularly true for large molecules such as proteins and peptides, which have a difficult time penetrating the stratum corneum [8].

Stratum Corneum as a Barrier in Active Ingredient Delivery: Even though the stratum corneum plays an important role in the body by forming an effective barrier against substances penetrating the outer skin layer, it inhibits the entry of active chemicals.

Physical Barrier: A physical barrier in the shape of size and structure of corneocytes and lipid layers prohibits large or polar compounds, such as vitamins, peptides, and antioxidants, to cross the stratum corneum [9].

Molecules with high molecular weight or those that are water-soluble often struggle to diffuse through the lipid matrix, which is more permeable to lipophilic compounds [6].

Chemical Barrier: The barrier function is further supported by the stratum corneum's enzymes and acidic pH [7]. Certain active substances, including vitamin C or ascorbic acid, may become less effective or disintegrate before reaching their target location due to changes in their stability and activity caused by this environment.

Challenges in Cosmetic Ingredient Penetration: The hydrophobicity of components, molecular size, and stability of active compounds are some of the aspects that make it difficult for cosmetic formulations to achieve effective deep skin penetration. To guarantee that active chemicals can reach skin levels where they can provide the desired effects, these aspects must be carefully taken into consideration during the product development process.

Hydrophobicity: It is tough for many of the active agents such as vitamins and antioxidants to penetrate into the lipid rich skin barrier. In order to improve their penetration emulsions and liposomal delivery techniques are used [10].

Molecular Size: Large molecules typically cannot enter the skin completely due to the size restriction. Less than 500 Daltons is the ideal size for penetration [13]. Enhanced delivery nanoparticles are larger than normal molecules, like nanoparticles [11].

The Stability of the Active Ingredient: Most active compounds, among which is vitamin C, become unstable and degradable in the presence of air or light. Liposomes and microencapsulation techniques that stabilize the ingredients and give an efficient delivery protect them from degradation [12].

Comprising the stratum corneum, it is actually the outermost barrier, keeping out the exterior substances. Alcohols and fatty acids are examples of penetration enhancers that can dissolve the outer layer and permit the substances to enter more deeply within the skin [10].

Formulation Challenges: Due to the pH and barrier properties of the skin, it is challenging to maintain the chemical equilibrium. Some modern drug delivery systems include liposomes, patches, and microneedles, which increase the efficacy and penetration of active ingredients [11].

Invasomes: Mechanism of Action:

Lipid-Based Structure of Invasomes: Invasomes are novel lipid-based vesicular systems that are designed to improve active ingredient delivery into the skin. They have a lipid bilayer structure specially designed to resemble that of the natural barrier skin, thereby allowing better interaction and deeper penetration of pharmaceutical or cosmetic ingredients.

Composition of Invasomes:

Lipid Bilayer: The majority of invasomes consist of phospholipids, which self-assemble to form a bilayer structure that is analogous to the lipid barrier of the skin. This stable barrier can encapsulate both hydrophilic and hydrophobic molecules and is composed of water loving heads, which attract water, and water hating tails, which repel water. These lipids' structure facilitates the regulated release of active ingredients and improves skin penetration [15].

Skin Mimicry: The lipid structure of invasomes is so designed to mimic the ceramides, lipids, and fatty acids that form the stratum corneum of the skin. When the invasomes can more easily mimic these natural structures and bond with the skin barrier, encapsulated medication molecules can penetrate the lipid-rich layers of the skin more easily. This design makes invasomes more skin-friendly by improving the stability of the compounds they enclose and their capacity to distribute active molecules [13].

Encapsulation and Penetration: There are several excipients such as surfactants or penetration enhancement factors, which can be incorporated into the lipid bilayers of invasomes. These excipients act to temporarily break down the barrier of the skin so that the API can penetrate into the dermal layers. These systems are generally thinner than traditional liposomes and create [14].

Penetration Mechanisms:

Skin Lipid Fusion: The lipid bilayers within invasomes are structurally equivalent to those found in the natural layers of skin lipids, specifically the stratum corneum, that is composed of fatty (oily) acids, cholesterol, and ceramides. Interaction between the vesicle membrane and the lipid bilayer of the skin allows unification by phospholipids within the invasome that are involved in a type of interaction with the skin's lipids. This type of fusion mechanism improves penetration through direct inclusion within layers of the skin of active substance molecules. Because of their structural similarity to the natural barrier of the skin, invasomes can be more easily incorporated and penetrate through the skin's defence mechanisms against exogenous substances [16].

Permeation Enhancement through the Stratum Corneum: The stratum corneum is the outermost skin layer, and this layer is essentially the primary barrier to molecular entry. Invasomes can cross this barrier because it causes a temporary disruption of the integrity of the stratum corneum. Owing to their small size and flexibility, invasomes can penetrate deeper into the skin. Because of their lipid composition, invasomes are able to travel through the lipid-rich layers of the stratum corneum. In addition, invasomes can carry surfactants or other penetration enhancers that help make the skin's protective barrier even more disrupted and active substances to penetrate to deeper levels of the dermal layer [17].

The Ability to Carry both Hydrophilic and Lipophilic Active Ingredients: One of its unique advantages is that an invasome can carry out hydrophilic (water loving) as well as lipophilic (fat loving) substances. Hydrophilic substances may be transported inside the coe of aqueous or on the surface of the vesicle; however, the hydrophobic molecules will be encapsulated inside the lipid bilayer's hydrophobic core. Because of their bimodal function, invasomes can deliver a higher diversity of active substances, which makes them fit for a variety of medicinal and cosmetic applications. This aspect is critical for developing treatments that treat a range of skin conditions since the two types of substances have to be delivered together to achieve maximum effect [18].

Formulation Strategies for Invasome-Based Cosmetics: To optimize the skin permeability through better absorption of active materials, improved lipid-based vesicular systems, called invasomes, are produced. Invasome technology allows for encapsulation with both lipophilic as well as hydrophilic material for improved delivery with the help of various processes in its production. Significant to invasome production with the help of cosmetic formulation is thin-film hydration, reverse-phase evaporation, mechanical dispersion, and sonication. Regarding its stability, control of size, and efficiency of vesicle encapsulation, a number of techniques present relative benefits and disadvantages [19, 20, 24].

Thin Film Hydration: It is among the most commonly employed techniques in order to prepare invasomes thin-film hydration. First of all, lipids and surfactants are dissolved into a solvent that is organic like ethanol or chloroform in order to initiate the process. Once the pressure reduces, the solvent evaporates and leaves behind a thin layer of lipid. After hydrating the mixture by introducing the aqueous phase containing the active component, vesicles develop.

Advantages: This method provides excellent encapsulation efficiency for both hydrophilic and lipophilic molecules and is relatively easy and cost-effective. It is very useful for preparing stable vesicles with controlled sizes [22, 23].

Problems: Hydration parameters such as temperature and volume of the aqueous phase affect vesicle quality and require careful management to avoid aggregation formation [27].

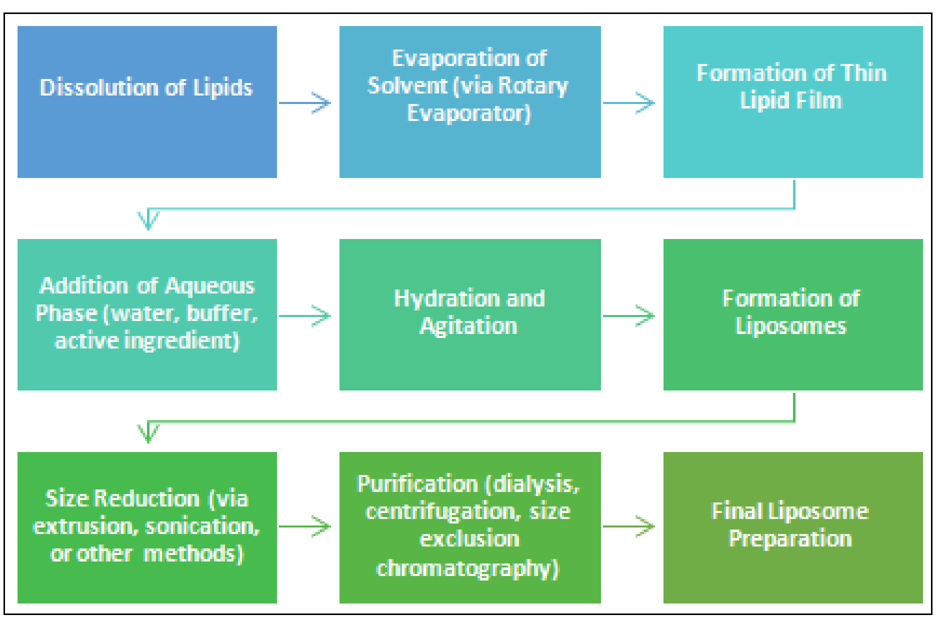

FIG. 3: THIN FILM HYDRATION METHOD

Reverse-Phase Evaporation: The primary application of reverse-phase evaporation is the formulation of vesicles that consist of hydrophobic substances. By mixing lipids with an organic solvent and aqueous solution of the active principle, this technique yields a reverse-phase emulsion. The mixture is emulsified, and the pressure in the apparatus is reduced to remove the organic solvent, thus forming vesicles.

Advantages: It has tight control over the size and stability of the vesicle and is useful for the encapsulation of lipophilic compounds [19, 20].

Problems: This process may be more cumbersome than thin-film hydration to avoid instability and require careful emulsification and solvent removal

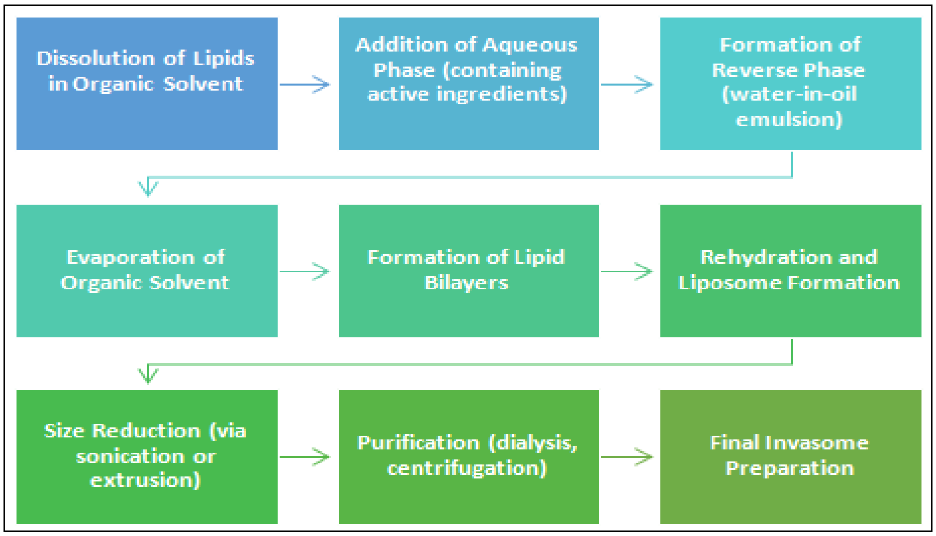

FIG. 4: REVERSE-PHASE EVAPORATION METHOD

Mechanical Dispersion Method: For forming vesicles, a combination of lipids with water-based phases using a strong shear force is involved in mechanical dispersion. This process may apply to fast-speed homogenizers or rotor-stator devices that involve the breaking down of lipid phases into small-sized particles by applying mechanical energy. Advantages the process is scalable and effective for mass production. It allows one to prepare vesicles with a relatively uniform size distribution [25, 26].

Problems: Mechanical dispersion can cause overheating, which may degradation sensitive active compounds. Besides, it could not always produce the high encapsulation efficiency that other methods do [26].

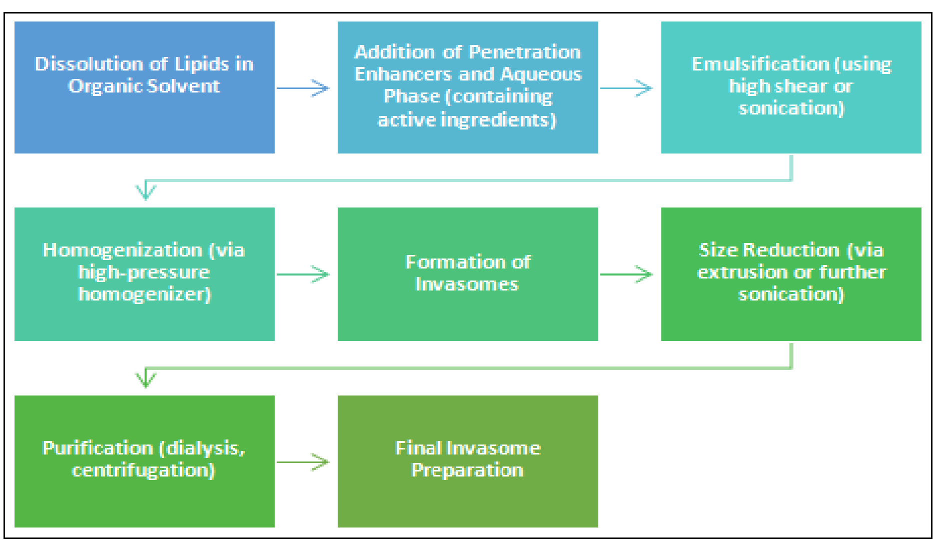

FIG. 5: MECHANICAL DISPERSION METHOD

Sonication: It works on lipid aggregates to break them into smaller vesicles through cavitation bubbles created using high-frequency sound waves in a lipid mixture. Once the cavitation bubbles have formed, they collapse, applying shear stresses. The technique has proven effective especially in forming smaller and uniform-sized vesicles.

Advantages: Sonication is very fast and efficient in forming small vesicles that enhance penetration through the skin. It also provides excellent control over the size of the vesicles [21, 22].

Problems: The ultrasonic-generated heat can break down the sensitive components. To avoid unwanted aggregation and degradation of the active ingredient, the process requires critical control of the sonication power and time [25, 28].

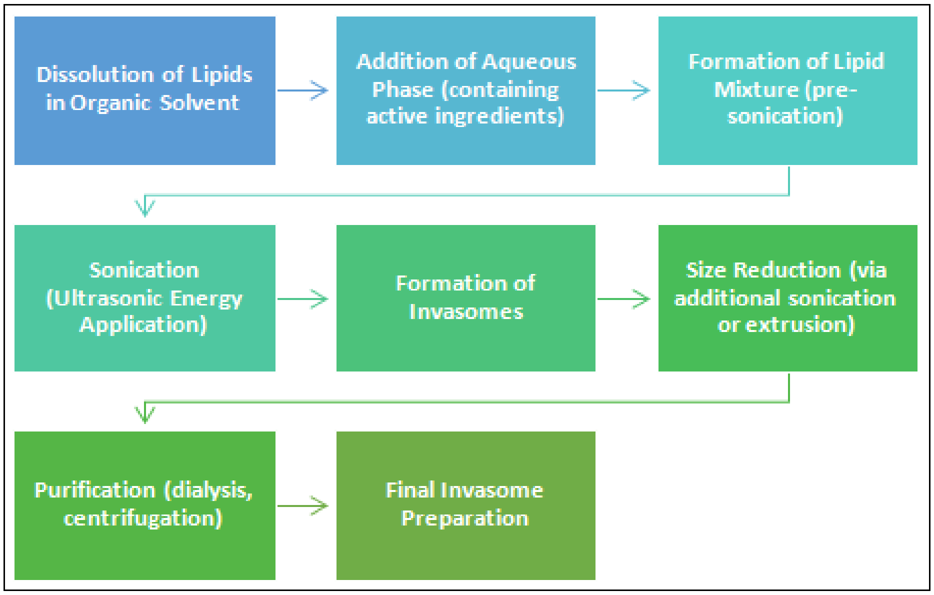

FIG. 6: SONICATION METHOD

Clinical Trials and Case Studies on Invasomes:

Skin Penetration Research Study: Godin and Touitou (2003) undertook one of the landmark studies reported in the Journal of Controlled Release. Their research was part of the pioneering works on the invasion technology. Invasomes were shown to significantly increase skin penetration of drugs compared with that of conventional liposomal formulation preparations [29]. Some results involved:

- ○ A 3-4 fold increased penetration across the skin
- ○ Effective delivery across the skin
- ○ Intercourse with lipid layers of skin improved

- Study on Improvement of Skin Condition Abdulbaqi *et al.* (2016) conducted an extensive study in the International Journal of Nanomedicine about the cosmetic uses of invasomes [30].

- ○ o\Improved delivery of active ingredients
- ○ o\Improved skin hydration
- ○ o\Reduced resistance to the skin barrier
- ○ o\Significant improvement in skin texture and appearance

- Study on Consumer Satisfaction and Efficacy Elsayed *et al.* (2007) conducted a clinical study on invasome-based cosmetic formulations [31]:

- ○ 86% of participants showed improvement in skin appearance
- ○ o\tSubstantially decreased fine lines and wrinkles
- ○ o\tSignificantly increased hydration
- ○ o\tOverall skin elasticity improved

Case Examples that use Invasome Technology: Invasome technology is the use of enhanced delivery systems that increase active ingredient/drug penetration in the skin or other biobarriers. It often relies on liposomal, nano, or other encapsulation strategies for enhancing bioavailability and effect of products. Here are case examples of products that implement invasome technology.

TABLE 2: CASE EXAMPLES THAT USE INVASOME TECHNOLOGY

Product Name	Purpose	Active Ingredients	Invasomal Formulation Features	Reference
Eucerin Hyaluron-Filler + Elasticity Night Cream	Anti-aging, skin elasticity improvement	Hyaluronic acid, Elasticity complex	Invasomal formulation for deeper skin penetration of active ingredients	Eucerin product information
Nivea Q10 Plus Anti-Wrinkle Night Cream	Wrinkle reduction, skin rejuvenation	Coenzyme Q10, Creatine	Invasomal technology to enhance delivery of active	Nivea product information
Olay Regenerist Micro-Sculpting Cream	Anti-aging, skin firming	Peptides, Niacinamide	Invasomes enhance penetration of peptides and niacinamide for effective anti-aging	Olay product details
L'Oréal Revitalift Bright Reveal Brightening Peel Pads	Skin brightening, exfoliation	Glycolic acid, Vitamin C	Invasomal technology for enhanced penetration of glycolic acid and vitamin C	L'Oréal product information
La Roche-Posay Anthelios SX SPF 50+	Sunscreen, high UV protection	UV Filters (Mexoryl SX)	Invasomal technology improves absorption of UV filters	La Roche-Posay product leaflet
Vichy Liftactiv Supreme Night Cream	Anti-aging, wrinkle reduction	Rhamnose, Vichy volcanic water	Invasomal delivery system for effective active ingredient penetration	Vichy product brochure
L’Oréal Paris Revitalift Laser X3	Anti-aging, skin resurfacing	Retinol, Glycolic acid	Invasomal liposomes enhance penetration of retinol and glycolic acid	L’Oréal Paris product details
Clarins Extra-Firming Night Cream	Skin firming, regeneration	Plant extracts (e.g., Centella Asiatica, Hibiscus)	Invasomal formulation for better absorption of plant-based extracts	Clarins product leaflet
BiodermaAtoderm Ultra-Nourishing Anti-Irritation Cream	Skin hydration, barrier repair	Glycerin, Ceramides	Invasomal technology improves delivery of moisturizing agents	Bioderma product information
Eucerin Even Brighter Pigment Reducing Day Cream	Skin brightening, even skin tone	Glycyrrhetinic acid, Vitamin C	Invasomal formulation enhances penetration of brightening agents	Eucerin product details

Future Trends and Challenges in Invasome-Based Delivery Systems:

Emerging Technologies: The Next Generation of Invasome-Based Delivery Systems:

Multi-Functional Invasomes: The future generations of the invasome systems will hence be developed as multi-functional delivery systems that combine in one formulation several active ingredients into one. That is to say, the multi-functional invasomes may deliver concurrently several actives such as anti-aging agents and antioxidants and peptides, aimed at different skin concerns.

Advantages: This approach benefits the treatments better because a single product can offer a whole range of benefits to a wider array of consumers and thereby reduces the number of products that have to be made separately.

Examples of Future Products: The invasomes may carry antioxidants like Vitamin C, anti-aging peptides and hyaluronic acid for hydration in one formula. These would likely attract the consumer searching for a comprehensive skincare solution [32].

Stimuli-Responsive Invasomes: Stimuli-responsive systems form a rapidly emerging frontier within nanotechnology. These are systems that will respond to specific environmental or physiological conditions like pH, temperature, or UV radiation. In relation to invasomes, such stimuli-responsive delivery will allow for active agents to be released only when there is a need, such as the skin experiencing a temperature change or even responding to UV exposure by releasing additional protective and repair agents [33].

Advantages: Such systems would offer even higher control over the release of active ingredients in terms of when and how. The skincare approach would be highly individualized, thus more effective with fewer side effects.

Examples of Future Products: A sunscreen with a stimuli-responsive invasome may become more active in higher UV conditions, providing enhanced protection when exposed to sun, or a moisturizer may release anti-aging agents only when the skin is dry or stressed [34].

Hybrid Invasomes (Combination Systems): Hybrid formulations are a combination of different delivery systems. For example, liposomes to protect ingredients from degradation along with SLNs or NLCs. Hybrid invasomes might provide more favorable release profiles, stability, and penetration than single component systems [35].

Advantages: Hybrid systems may be capable of combining the best of both worlds to provide deeper skin penetration similar to liposomal systems while prolonging the controlled release to the benefit of SLNs or NLCs. This will lead to increased efficacy over time, enhanced stability of sensitive ingredients, and increased consumer satisfaction by the prolonged action.

Examples of Future Products: an Anti-aging Serum with Hybrid Invasome System which incorporates peptides and antioxidants, can exhibit long-term antipersistent wrinkle effectiveness while maintaining the protection from oxidative stress [36].

Challenges in Commercialization of Invasome Technology: While the potential of invasome-based delivery systems in cosmetics is immense, several challenges hinder their widespread adoption in the industry:

Manufacturing Costs and Scalability:
Problem: Invasome technology involves advanced production processes including special equipment to formulate nanoparticles and encapsulate liposomes and to synthesize the hybrid system. They are very expensive for bulk production [37].

Impact on Commercialization: Commercialization Impact In this aspect, small companies or new manufacturers are hindered by well-established businesses, which can well afford these systems. High costs of manufacturing also mean expensive products and out of reach for an average consumer [38].

Possible Solutions: The development of nanotechnology and automation processes might be reducing the production cost of formulations based on the invasome in the future. Production techniques will also be optimized and less expensive for raw materials; hence, large-scale systems would be possible without compromising quality.

Regulatory Obstacles:
Challenge: Cosmetics are regulated differently in various geographies, and any new delivery system, for example, invasomes typically falls into a grey area about approval. All agencies including FDA, U.S.; EMA, EU and several more are very stringent in ensuring that the products possess absolute safety, efficacy and have ingredients' transparencies [39, 40].

Commercialization Impact: Even if the active ingredients themselves are approved for cosmetic use, delivery systems, such as nanoformulations, may require additional safety testing and regulatory review. Lack of regulatory approvals could delay new product launches.

Potential Solutions: The cosmetics industry may need to establish clearer guidelines specifically addressing the safety and efficacy of nano- and invasome-based systems. Regulatory agencies are gradually adapting to the increasing use of advanced technologies, and as more data on the safety and benefits of these systems becomes available, regulations may become more streamlined.

Consumer Acceptance and Education:
Challenge: People just do not know anything about terms like "invasomes" and "nanotechnology," and possibly shun products containing delivery systems that are so modernly advanced, if it can't be sure in respect of safety or the working.

Influence on Commercialization: Consumer scepticism would delay the acceptance of new technologies.

There's a requirement for proper public communication of the benefits and advantages of invasome technology to deliver more potent effective skincare solutions.

Potential Solutions: Brand education and transparency will become key to consumer trust. Such clinical studies, before-and-after results, and details about the technology should work to demystify the systems of invasome and increase consumer confidence [41, 42, 43].

Stability and Shelf Life:

Challenge: Another persistent issue with invasome-based systems is the instability of these extremely active delivery mechanisms over time. Some of these systems may deteriorate or lose their efficacy if not formulated or stored appropriately [44].

Impact on Commercialization: Since consumers expect that products will continue to work for longer periods of time, any decline in the delivery system may lead to lower product performance, which can cause dissatisfaction and potentially harm the brand.

Potential Solutions: Further research on stabilizing chemicals and better packing along with efficient encapsulation methods will help maintain the stability of the invasome systems. All these problems can be solved by the use of better formulation technologies and advancements in storage conditions [45].

Environmental Impact:

Challenge: Like most of the high technologies, environmental footprint to create and dispose of nano and invasome systems has now emerged as a concern. The amount of nanoparticles that can accumulate in the environment or human body is still an issue under debate [46].

Impact on Commercialization: Environmental considerations may provoke resistance from either regulations or consumers. The industry of beauty has become quite green-sensitized and any fears with the environmental impact of invasome formulations could delay the latter's market entry.

Potential Solutions: Eco-friendly alternatives, biodegradable delivery systems, and sustainability in sourcing raw materials will prove highly crucial in solving the issues related to the environment. A further advantage of invasome technologies is their suitability with the global aims on sustainability, if they are done according to green chemistry concepts [47].

CONCLUSION: An invasome is just another name for a new vehicle that might enhance penetration and maximize the delivery of drugs or active agents in cosmetic products. Their ability to effectively permeate the barrier of the skin and to penetrate into the layers for proper action is guaranteed by a specific structure integrating liposomal technology with elastic membranes. This will, hence, lead to significantly enhanced skin care results, making invasomes inherently highly effective in transferring anti-aging chemicals, moisturizers, antioxidants, and more therapeutic agents. Invasomes can enjoy a bright future in cosmetics. As technology and the scope of research continue developing, the role of these functions of invasomes will be more significant, while developing more efficient targeted skincare products. With the potential of achieving improved delivery of ingredients and overall skin health, the invasomes are pretty close to revolutionizing the formulation and use of cosmetic products, with consumers receiving the advantage of more high-performance and effective products for multiple concerns that most concern them within skincare.

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REFERENCES:

1. Chen M, Liu X and Fahr A: Skin penetration and deposition of carboxyfluorescein and temoporfin from di erent lipid vesicular systems: *In-vitro* study with finite and

infinite dosage application. Int J Pharm 2011; 408: 223–234.

2. Ota Y, Hamada A, Nakano M and Saito H: Evaluation of percutaneous absorption of midazolam by terpenes. Drug Metab Pharmacokinet 2003; 18: 261–266.
3. Puglia C, Bonina F, Trapani G, Franco M and Ricci M: Evaluation of *in-vitro* percutaneous absorption of lorazepam and clonazepamfromhydro-alcoholic gel formulations. Int J Pharm 2001; 228: 79–87.
4. Vaddi H, Ho P, Chan Y and Chan S: Terpenes in ethanol: Haloperidol permeation and partition through humanskin and stratum corneum changes. J Control Release 2002; 81: 121–133.
5. Verma DD, Verma S, McElwee KJ, Freyschmidt-Paul P, Hoffman R and Fahr A: Treatment of Alopecia areata in the DEBR model using Cyclosporin A lipid vesicles. European Journal of Dermatology 2004; 14(5): 332-338.
6. Ashfaq R, Rasul A, Asghar S, Kovács A, Berkó S and Budai-Szűcs M: Lipid Nanoparticles: An Effective Tool to Improve the Bioavailability of Nutraceuticals. International J of Molecular Sciences 2023; 24(21): 15764.
7. Madison KC: Barrier function of the skin: "la raison d'etre" of the epidermis. Journal of Investigative Dermatology 2003; 121(2): 231-241.
8. Sagrafena I, Morin M, Paraskevopoulos G, Nilsson EJ, Hrdinová I, Kováčik A, Björklund S and Vávrová K: Structure and function of skin barrier lipids: Effects of hydration and natural moisturizers *in-vitro*. Biophysical Journal 2024; 123(22): 3951-3963.
9. Musakhanian J, Osborne DW and Rodier JD: Skin penetration and permeation properties of Transcutol® in complex formulations. AAPSPST 2024; 25(7): 201.
10. Tambunlertchai S, Geary SM and Salem AK: Skin penetration enhancement strategies used in the development of melanoma topical treatments. The AAPS Journal 2024; 23(1): 19.
11. Tambunlertchai S, Geary SM and Salem AK: Skin penetration enhancement strategies used in the development of melanoma topical treatments. The AAPS Journal 2021; 23(1): 19.
12. Gorzelanny C, Mess C, Schneider SW, Huck V and Brandner JM: Skin barriers in dermal drug delivery: which barriers have to be overcome and how can we measure them? Pharmaceutics 2020; 12(7): 684.
13. El-Kayal M and Hatem S: A comparative study between nanostructured lipid carriers and invasomes for the topical delivery of luteolin: Design, optimization and pre-clinical investigations for psoriasis treatment. Journal of Drug Delivery Science and Technology 2024; 97: 105740.
14. Preeti, Puri D and Singh S: Invasomes: An Artificial Vesicle Nanocarrier to Enhance Transdermal Drug Delivery. Current Nanomedicine 2024.
15. El-Kayal M and Hatem S: A comparative study between nanostructured lipid carriers and invasomes for the topical delivery of luteolin: Design, optimization and pre-clinical investigations for psoriasis treatment. Journal of Drug Delivery Science and Technology 2024; 97: 105740.
16. Raszewska-Famielec M and Flieger J: Nanoparticles for topical application in the treatment of skin dysfunctions an overview of dermo-cosmetic and dermatological products. International J of Molecular Sciences 2022; 23(24): 15980.
17. Jain S, Tripathi S and Tripathi PK: Invasomes: Potential vesicular systems for transdermal delivery of drug molecules. Journal of Drug Delivery Science and Technology 2021; 61: 102166.
18. Subramaniyan G, Rubina S, Ramana BV, Stanley AM and Srinivasan D: Nano-Revolution in transdermal drug delivery: a bibliographic compilation of vesicular system. International Journal of Pharmaceutical Investigation 2024; 14(2).
19. Brahmankar DM & Jaiswal SB: Biopharmaceutics and Pharmacokinetics: A Treatise. Vallabh Prakashan 2016.
20. Jabbar TL: Elastic vesicles for enhancing the transdermal delivery of Olmesartan Medoxomil. Bulletin of Pharmaceutical Sciences Assiut University 2024.
21. Preeti, Puri D and Singh S: Invasomes: An Artificial Vesicle Nanocarrier to Enhance Transdermal Drug Delivery. Current Nanomedicine 2024.
22. Patil G, Baokar S, Bhujbal A, Pharande S, Mane K, Tour D, Patil R and Gupta V: Invasomes-novel vesicular carriers for transdermal drug delivery systems. Tuijin Jishu/Journal of Propulsion Technology 2023; 44(5).
23. Tonge MR, Pimpalshende PM and Kosalge SB: Advancements in invasomes for enhanced drug delivery: A comprehensive review. AJPER 2024; 13(1): 15-26.
24. Mounika N, Ramya MG, Meghana S and Rajesh A: Invasomes: A Comprehensive Overview of their Design And Applications 2024.
25. Dragićević N and Maibach HI: Lipid-Based vesicles (liposomes) and their combination with physical methods for dermal and transdermal drug delivery. Percutaneous Absorption 2021; 519-542.
26. Filipczak N, Pan J, Yalamarty SSK and Torchilin VP: Recent advancements in liposome technology. Advanced Drug Delivery Reviews 2020; 156: 4-22.
27. Verma S and Utreja P: Exploring therapeutic potential of invasomes, transfersomes, transethosomes, oleic acid vesicles and cubosomes adopting topical/transdermal route. Micro and Nanosystems 2022; 14(1): 3-20.
28. Gupta V, Mohapatra S, Mishra H, Farooq U, Kumar K, Ansari MJ, Aldawsari MF, Alalaiwe AS, Mirza MA and Iqbal Z: Nanotechnology in cosmetics and cosmeceuticals a review of latest advancements. Gels 2022; 8(3): 173.
29. Godin B and Touitou E: Ethosomes: new prospects in transdermal delivery. Critical Reviews™ in Therapeutic Drug Carrier Systems 2003; 20(1).
30. Abdulbaqi IM, Darwis Y, Khan NAK, Assi RA and Khan AA: Ethosomal nanocarriers: the impact of constituents and formulation techniques on ethosomal properties, *in-vivo* studies, and clinical trials. International Journal of Nanomedicine 2016; 2279-2304.
31. Elsayed MM, Abdallah OY, Naggar VF and Khalafallah NM: Lipid vesicles for skin delivery of drugs: reviewing three decades of research. International Journal of Pharmaceutics 2007; 332(1-2): 1-16.
32. Stefanov SR and Andonova VY: Lipid nanoparticulate drug delivery systems: recent advances in the treatment of skin disorders. Pharmaceuticals 2021; 14(11): 1083.
33. Liu R, Li A, Lang Y, Cai H, Tang X, Li D, Liu X and Liu J: Stimuli-responsive polymer microneedles: a rising transdermal drug delivery system and Its applications in biomedical. Journal of Drug Delivery Science and Technology 2023; 104922.
34. Das SS, Bharadwaj P, Bilal M, Barani M, Rahdar A, Taboada P, Bungau S and Kyzas GZ: Stimuli-responsive polymeric nanocarriers for drug delivery, imaging, and theragnosis. Polymers 2020; 12(6): 1397.
35. Musacchio T and Torchilin VP: Lipid-based delivery systems: liposomes and lipid-core micelles properties and applications. Drugs and the Pharmaceutical Sciences 2010; 194: 260-292.
36. De Brum TL, Fiel LA, Contri RV, Guterres SS and Pohlmann AR: Polymeric nanocapsules and lipid-core

nanocapsules have diverse skin penetration. Journal of Nanoscience and Nanotechnology 2015; 15(1): 773-780.

37. Souto EB, Fernandes AR, Martins-Gomes C, Coutinho TE, Durazzo A, Lucarini M, Souto SB, Silva AM and Santini A: Nanomaterials for skin delivery of cosmeceuticals and pharmaceuticals. Applied Sciences, 2015; 10(5): 1594.
38. Bodnár K, Fehér P, Ujhelyi Z, Bácskay I and Józsa L: Recent approaches for the topical treatment of psoriasis using nanoparticles. Pharmaceutics 2024; 16(4): 449.
39. Dahiya R, Dubey S and Dahiya S: Current global regulations for nanocosmeceuticals. In Nanocosmeceuticals 2022; 483-510. Academic Press.
40. Saleem S, Mushtaq NU, Rasool A, Padder SA, Shajar F, Shah WH and Tahir L: Regulatory and Ethical Issues Raised by the Utilization of Nanomaterials. Interaction of Nanomaterials with Living Cells 2023; 899.
41. Mihranyan A, Ferraz N and Strømme M: Current status and future prospects of nanotechnology in cosmetics. Progress in Materials Science 2012; 57(5): 875-910.
42. Salvioni L, Morelli L, Ochoa E, Labra M, Fiandra L, Palugan L, Prosperi D and Colombo M: The emerging role of nanotechnology in skincare. Advances in Colloid and Interface Science 2021; 293: 102437.
43. Raszewska-Famielec M and Flieger J: Nanoparticles for topical application in the treatment of skin dysfunctions an overview of dermo-cosmetic and dermatological products. International J of Molecular Sciences 2022; 23(24): 15980.
44. Abbasi BH, Fazal H, Ahmad N, Ali M, Giglioli-Guivarch N and Hano C: Nanomaterials for cosmeceuticals: nanomaterials-induced advancement in cosmetics, challenges, and opportunities. Nanocosmetics 2020; 79-108.
45. Ferraris C, Rimicci C, Garelli S, Ugazio E and Battaglia L: Nanosystems in cosmetic products: A brief overview of functional, market, regulatory and safety concerns. Pharmaceutics 2021; 13(9): 1408.
46. Włodarczyk R and Kwarciak-Kozłowska A: Nanoparticles from the cosmetics and medical industries in legal and environmental aspects. Sustainability 2021; 13(11): 5805.
47. Yadwade R, Gharpure S and Ankamwar B: Nanotechnology in cosmetics pros and cons. Nano Express 2021; 2(2): 022003.
48. Gupta V, Mohapatra S, Mishra H, Farooq U, Kumar K, Ansari MJ, Aldawsari MF, Alalaiwe AS, Mirza MA and Iqbal Z: Nanotechnology in cosmetics and cosmeceuticals a review of latest advancements. Gels 2022; 8(3): 173.
49. Mounika N, Ramya MG, Meghana S and Rajesh A: Invasomes: a comprehensive overview of their design and applications 2024.
50. Cunha IVN, Campos AM, Gerola AP and Caon T: Effect of invasome composition on membrane fluidity, vesicle stability and skin interactions. International Journal of Pharmaceutics 2023; 646: 123472.
51. Arabhavi A, Mane M, Mali NDS and Sawant A: Invasome: a novel vesicular drug delivery system. International Journal of Research in Pharmacy and Allied Science 2024; 3(3): 96-110.
52. Pande S: Liposomes for drug delivery: review of vesicular composition, factors affecting drug release and drug loading in liposomes. Artificial Cells, Nanomedicine and Biotechnology 2023; 51(1): 428-440.
53. Jiang Y, Li W, Wang Z and Lu J: Lipid-based nanotechnology: Liposome. Pharmaceutic 2023; 16(1): 34.
54. Filipczak N, Pan J, Yalamarty SSK and Torchilin VP: Recent advancements in liposome technology. Advanced Drug Delivery Reviews 2020; 156: 4-22.
55. Large DE, Abdelmessih RG, Fink EA and Auguste DT: Liposome composition in drug delivery design, synthesis, characterization, and clinical application. Advanced Drug Delivery Reviews 2021; 176: 113851.
56. Arshad N, Shaheen F, Khan IN, Naeem S, Riaz M, Siddique MI, Ayesha M and Waqar MA: A comprehensive review on niosomes: novel manufacturing techniques, factors influencing formation, applications and recent advances. International Journal of Polymeric Materials and Polymeric Biomaterials 2024; 1-18.
57. Mawazi SM, Ann TJ and Widodo RT: Exploring the Evolution of Niosomes: from Past Techniques to Future Advances in Preparation Methods a Comprehensive Review. Bio Nano Science 2024; 1-22.
58. Izhar MP, Hafeez A, Kushwaha P and Simrah: Drug delivery through niosomes: a comprehensive review with therapeutic applications. Journal of Cluster Science 2023; 34(5): 2257-2273.
59. Bhakat SP, Modak A, Debnath B, Rahaman R, Mitra H and Roy S: Phytosome an advancement technology in Herbal Drug Delivery, a review. Circulation 2024; 4(5): 23.
60. Alam T: A Review on Phytosome as Therapeutic Agents 2024; 15(84).
61. Danish I: Phytosome: Recent investigation for a new drug delivery system. International Journal of Newgen Research in Pharmacy & Healthcare 2024; 163-175.
62. Priya VMH and Kumaran A: Recent trends in phytosome nanocarriers for improved bioavailability and uptake of herbal drugs. Pharmaceutical Sciences 2023; 29(3): 298-319.
63. Opatha SAT, Titapiwatanakun V and Chutoprapat R: Transfersomes: A promising nanoencapsulation technique for transdermal drug delivery. Pharmaceutics 2022; 12(9): 855.
64. Firdos L, Haranath C, Yasaswini S, Sai RN and Satish T: Exploring transferosomes: a comprehensive review of novel strategies and applications in drug delivery. Journal of Young Pharmacists 2024; 16(3): 410-415.
65. Riccardi D, Baldino L and Reverchon E: Liposomes, transfersomes and niosomes: production methods and their applications in the vaccinal field. Journal of Translational Medicine 2024; 22(1): 339.
66. Kaur P, Verma S, Tomar B, Vyas M, Kakoty V, Saha P and Kalarikkal Chandran S: Exploring applications of flexible vesicular systems as transdermal drug delivery. Current Drug Delivery 2024; 21(8): 1062-1072.
67. Zhang ZJ and Michniak-Kohn B: Flavosomes, novel deformable liposomes for the co-delivery of anti-inflammatory compounds to skin. International Journal of Pharmaceutics 2020; 585: 119500.
68. Kaur P: Flexible vesicular systems: a mini review on the explored areas for transdermal delivery. Systematic Reviews in Pharmacy 2023; 14(11).
69. Santos AC, Marto J, Chá-Chá R, Martins AM, Pereira-Silva M, Ribeiro HM and Veiga F: Nanotechnology-based sunscreens a review. Materials Today Chemistry 2022; 23: 100709.
70. Jain S, Kale DP, Swami R and Katiyar SS: Codelivery of benzoyl peroxide & adapalene using modified liposomal gel for improved acne therapy. Nanomedicine 2018; 13(12): 1481-1493.
71. Dragicevic N and Maibach HI: Liposomes and other nanocarriers for the treatment of acne vulgaris: improved therapeutic efficacy and skin tolerability. Pharmaceutics 2024; 16(3): 309.

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