

Nanoemulgel-Based Topical Drug Delivery For Management of Psoriasis: Recent Literature Survey And Patents

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Abstract

Background

Psoriasis is an immune-mediated inflammatory disease of the skin that involves excessive keratinocyte proliferation, epidermal hyperplasia, scaling and erythema. The topical treatments that are used traditionally work well with localized disease but are not without their limitations, such as low solubility, inadequate penetration, instability, greasiness, and lack of patient adherence. Nanoemulgel has a potential to be an ideal vehicle for localized topical therapy since it is both drug loading capacity of emulsion and favourable application properties of gel.

Objective

This review will highlight the pharmaceutical rationale behind the use of nanoemulgels, its formulation constituents, preparation methods, characterization parameters, therapeutic applications and future perspective of nanoemulgels with an emphasis on topical drug delivery in psoriasis.

Methodology

The topical treatment, emulgels, nanoemulsions and nanoemulgels, skin permeation, formulation development and evaluation of psoriasis were reviewed in relevant literature. Topics covered include formulation strategies, gelling and emulsifying agents, penetration enhancement, drug release, skin retention, stability and therapeutic benefits. Considering the potential for application of the nanoemulgel systems in the improvement of the solubilization, permeation, localized and sustained release of a drug was also taken into consideration.

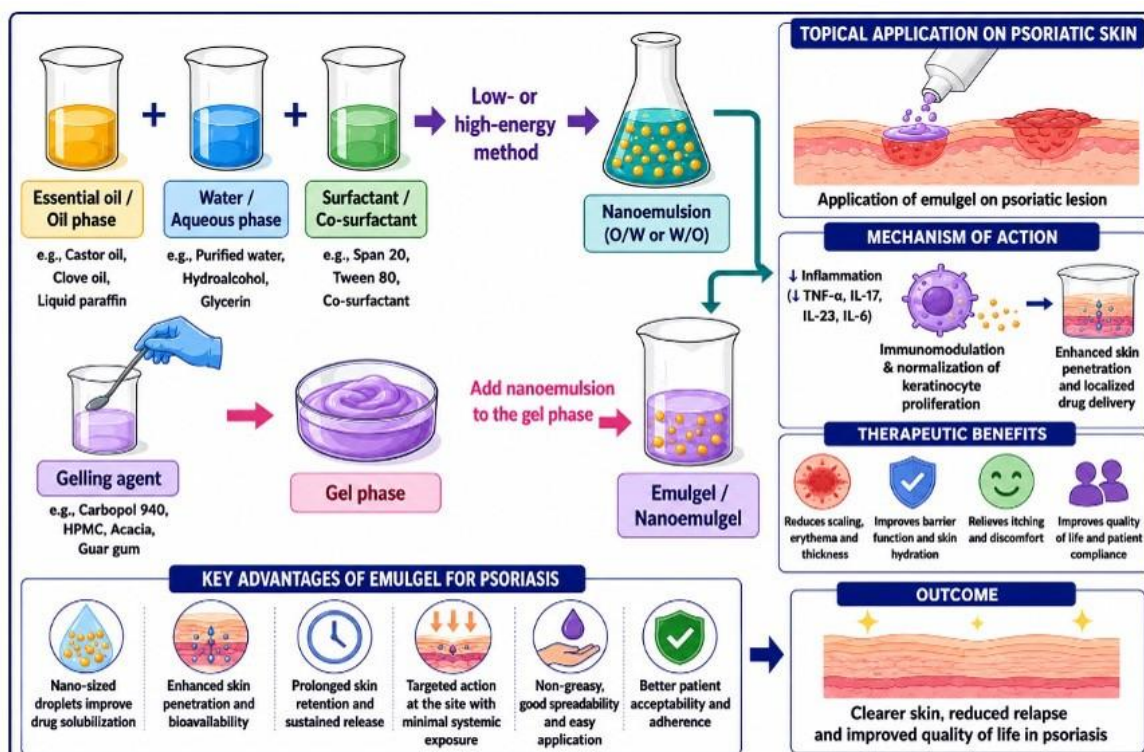
Conclusion

Nanoemulgels are a versatile patient-friendly topical delivery system which can be used for poorly water-soluble drugs, with drug release controlled, improved spreadability and stability, and can be formulated to improve skin retention. The improvement in drug solubilisation and penetration through psoriatic skin of nanoemulgel systems can also help to enhance the efficiency of the therapeutic action at the site, while reducing absorption into the systemic circulation. They will need further optimization in terms of pharmacokinetics, excipient selection, safety of surfactants and stability for their successful translation into advanced psoriasis therapies.

Keywords: Emulgel, Psoriasis, Topical drug delivery, Nanoemulgel, Skin permeation, Nanoemulsion, Controlled release, Drug delivery system.

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Graphical Abstract :



Introduction

The application of a pharmacological formulation directly onto the skin with a therapeutic effect at the application site is known as topical medication delivery. It is useful for certain dermatological diseases as it allows targeted delivery of drugs to affected skin areas without exposing other tissues to non-essential drug concentrations¹. The drug release and the skin barrier penetration will be determined by the physicochemical properties of the drug, the formulation vehicle, and the characteristics of skin barrier. In particular, the reduction of gastrointestinal exposure and bypassing hepatic first-pass metabolism are important benefits of topical administration, and it is an appropriate treatment method for localized treatment of several skin disorders².

Psoriasis is an ongoing inflammatory condition of the skin that is caused by abnormalities in the immune system, and is treated over time and optimally. Sustained disease control, minimizing the extent and severity of the lesions, enhancing quality of life, maintaining functional capacity and prevention of disease related complications are the key goals of psoriasis management. The choice of therapy is mostly determined by the degree of skin involvement and the severity of the disease, with concomitant conditions, contraindications, treatment safety and patient specific factors also taken into account³.

Topical therapy is an important therapeutic approach, but conventional topical pharmaceuticals could have low bioavailability, poor retention in the skin, high frequency of application and cosmetic

properties that are not desired, which could impact patient adherence. The dispersed droplets in microemulsions are very small, and they can enhance drug solubilization, as well as skin penetration of the drug. Their relatively low viscosity, however, could reduce the time they spend at the application site⁴. Ensuring incorporation of a microemulsion in an appropriate gel matrix can enhance its viscosity, and may extend the skin contact time, thus contributing to the continued release of the drug. This idea resulted in the formulation of emulgel systems, as a combination of the good properties of emulsions and gels⁵.

Nanoemulgels are semi-solid topical preparations which consist of an oil in water (O/W) or water in oil (W/O) emulsion in an appropriate gel base. The emulsion phase will allow the incorporation and solubilisation of a lipophilic drug, while the gel matrix will confer the required viscosity, spreadability, skin residence and ease of application. The presence of both phases (aqueous and oil) also allows the formulation of drugs with different solubility properties. Moreover, the use of an appropriate emulsifier and penetration enhancers could facilitate the transport of drug into the stratum corneum and increase the amount of drug in target site^{6,7}. The synergistic effect of these properties renders the emulgels appropriate drug carriers for topical management of psoriasis at a local level, especially when there is a need for better absorption/penetration, extended skin contact and better patient acceptance and a minimum of systemic distribution. Therefore, the creation of emulgel-based systems is a pharmaceutical solution

to some of the limitations of conventional topical dosage forms and to increase the efficacy of topical psoriasis therapy^{8,9}.

Physiology of Skin

Treatment is applied to the skin with creams. Thus a simple knowledge of the physiology and function of the skin may be necessary when designing topical

formulations of dosages¹⁰. The skin has a total area of approximately 2 m² and is associated with one-third of the blood flow in the entire body. There are roughly 200–300 sweat ducts and 40–50 hair follicles per square centimeter in human skin. Human skin can have a pH between 4.7 and 5.7 (Figure 1)¹¹.

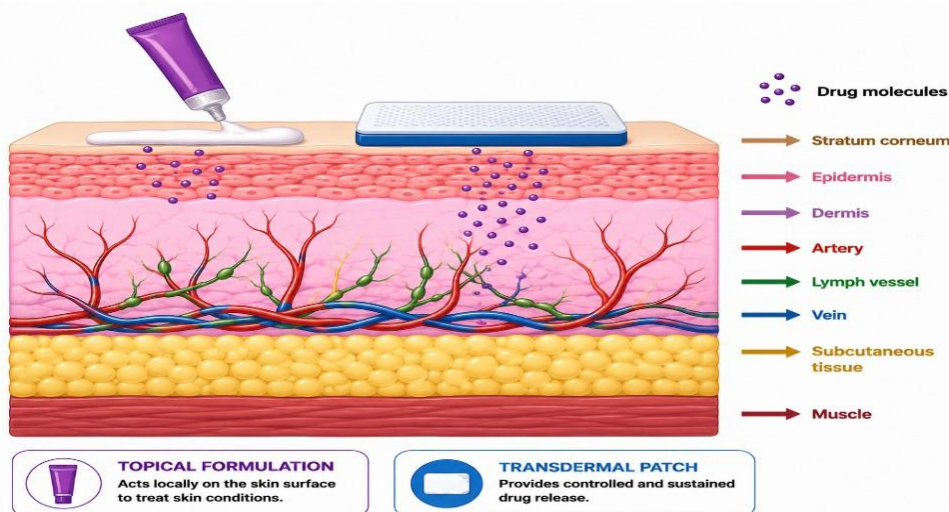


Figure 1: Anatomy of human skin with mechanism of topical formulation

Physiological Factors^{12,13}

Hydration of Skin: Boost the drug's uptake.

Skin Temperature: The skin permeates more quickly at higher temperatures.

Skin Inflammation: Permeability rises when the stratum corneum is damaged.

The pH of Skin: The pH of the skin rises as a result of increased sweat and fatty acid release.

Skin Thickness: The thickness of the skin varies from the epidermis to the subcutis. The epidermal layer is about 100 and 150 µm thick.

Hair Follicle Density: The storage capacity of a hair follicle's infundibulum is roughly ten times more than that of the stratum corneum.

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Lipid Content: Despite the skin's vital role as a water barrier, percutaneous penetration increases when the stratum corneum of the skin has some lipid weight.

Nanoemulgel: Pharmaceutical Concept

The preparation of gels is characterised by an increase in the viscosity of a liquid system, by the addition of appropriate polymers without altering

Types of Nanoemulgel

It will be classified into 3 types: (summarized in Table 1)

Table 1: Types of Nanoemulgel

some of the essential physicochemical properties. An emulsion incorporated in a polymeric gel matrix is known as a nanoemulgel, and is a hybrid of both. The polymeric network imparts the desired consistency and structural integrity, and the emulsion phase helps to incorporate drugs with varying solubility properties¹⁴.

Nanoemulgels are especially effective in the delivery of poorly water-soluble or lipophilic drugs, that are difficult to deliver through conventional hydrogels. The presence of both aqueous and non-aqueous phases allows the system to be used for carrying both hydrophilic and lipophilic therapeutic agents. Moreover, the biphasic structure can be beneficial for both drug loading and formulation stability and can be also used for controlled drug release¹⁵. Nanoemulgels provide a number of pharmaceutical benefits when compared with conventional topical preparations such as easy application, good spreadability, non-greasy nature, thixotropic properties, prolonged residence time, acceptable appearance and patient acceptability. The emulsion and gel phases, therefore, impart beneficial characteristics to emulgel that make it a useful topical delivery system for the effective and controlled delivery of drugs¹⁶.

Type of Nanoemulgel	Typical drop let size	Key characteristics	Pharmaceutical significance /	Limitations	Reference

			advan tages		
Macroemulsion gel (Macroemulgel)	Generally >400 nm	Contains relatively large emulsion droplets dispersed within a gel matrix. The droplets are generally not visible to the naked eye but can be observed microscopically.	Simple formulation approach; suitable for incorporating lipophilic drugs and oils into a topical gel system; provides better viscosity and application characteristics than a conventional emulsion.	Relatively larger droplets may provide less efficient skin penetration than micro- or nano-sized systems; physical stability can be affected by temperature and storage conditions.	[17]
Microemulsion gel (Microemulgel)	Approximately 10–100 nm	Transparent or translucent, isotropic system containing oil, water, surfactant, and usually a	Can improve drug solubilization and facilitate penetration through the stratum corneum. Incorporation	Microemulsions alone have low viscosity and may have inadequate skin retention; relatively	[18]

Structure of Nanoemulgel

Nanoemulgel is a bi-phasic topical delivery systems that is an oil in water emulsion (O/W) or a water in

		co-surfactant. It has low interfacial tension and a large interfacial area.	into a gel increases viscosity and improves skin residence compared with a liquid microemulsion.	high surfactant/co-surfactant concentrations may cause irritation in some formulations.	
Nanoemulsion gel (Nanoemulgel)	Approximately 1–100 nm*	Contains nanosized oil droplets dispersed in an aqueous phase and incorporated into a gel matrix. Provides a combination of nanoemulsion characteristics and gel properties.	Enhanced drug solubilization, increased surface area, improved contact with the skin, potential enhancement of dermal/transdermal drug delivery, and improved patient acceptability due to suitable viscosity and spreadability.	Requires careful optimization of surfactant/co-surfactant concentration, droplet size, viscosity, and physical stability; excessive surfactant levels may produce irritation.	[19]

oil emulsion (W/O) dispersed in a 3-D gel matrix. The active pharmaceutical ingredient, oil phase, aqueous phase, emulsifier and gelling agent are the

major ingredients. The oil phase assists in solubilizing lipophilic drugs, and the gel base accounts for the viscosity, spreadability, stability and prolonged skin residence of the drug²⁰. The emulsifier is used to stabilize the oil and water phase interface, the gelling agent is used to make the water phase more viscous, and form the semi-solid structure of the formulation. Other ingredients, including penetration enhancers, preservatives, humectants and pH adjusters may be added as needed for therapy and formulation. Physicochemical characteristics of these components affect release of drugs, formulation stability, and skin permeation²¹.

Following topical application the gel matrix keeps the formulation on the skin surface where the drug is released from the emulsion droplets and then partitions into the stratum corneum. The drug molecules can pass through the transcellular, intercellular and follicular pathways depending on the physicochemical property and formulation properties. This e.g. system may then allow for a

more efficient local drug delivery and enable easy application and sufficient skin retention (as illustrated in Figure 2)^{22,23}.

Figure2: Structure of Nanoemulgel

In the field of psoriasis treatment, the ability of the nanoemulgel-based delivery has been proven with the optimized formulation of calcipotriol emulgel which was found to have improved drug permeation compared to a commercial calcipotriol ointment, with acceptable viscosity, spreadability and tolerability to skin²⁴.

Nanoemulgel'S Pros AND Cons

Nanoemulgels have the best of both world of emulsion and gel, they offer additional drug solubilisation, better skin permeation, good spreadability and good formulation stability (summarized in Table 2). But they may also encounter optimization of the concentration of both the surfactant and gelling agents, potential skin irritation and formulation instability if they are not carefully chosen²⁵.

Table 2: Pros AND Cons

S. N o.	Advantages	Disadvantages / Limitations	References
1	Combines the advantageous qualities of gels and emulsions to create a flexible topical administration mechanism.	Formulation development is comparatively complex because both the emulsion and gel phases require optimization.	[26]
2	Suitable for incorporation of poorly water-soluble/hydrophobic drugs by solubilizing them in the oil phase.	Drug loading may be limited by the solubility and compatibility of the drug with formulation components.	[26]
3	Provides good spreadability, allowing easy and uniform application to the skin.	Changes in viscosity during storage may adversely affect	[27]

		spreadability and application properties.	
4	Improves drug solubilization and can facilitate drug availability at the skin surface.	Increased solubilization does not always result in adequate drug penetration through the stratum corneum.	[27]
5	Provides prolonged skin contact/residence time, which may support localized drug delivery.	Excessive viscosity or gel strength may retard drug release and skin permeation.	[28]
6	Enables localized topical drug delivery, potentially reducing unnecessary systemic exposure.	Some drugs may still undergo systemic absorption through the skin.	[28]
7	Generally offers good patient acceptability due to its smooth texture and ease of application.	Certain surfactants, preservatives, oils, or penetration enhancers may cause skin	[29]

		irritation or allergic reactions.	
8	Can provide desirable physical stability when properly formulated and optimized.	Improper formulation may result in phase separation, creaming, cracking, or other physical instability.	[29]
9	Allows incorporation of different oils, emulsifiers,	Incompatible or excessive excipients	[30]

Rationale for Nanoemulgel in Topical Drug Delivery

Nanoemulgels have become of great topical importance as semisolid formulations since 1980s. They are formulated by adding an appropriate gelling agent to an emulsion of the (O/W) or (W/O) type, and thus the properties of emulsion and gel are combined. The emulsion phase may serve as a source of the drug and release it out slowly towards the skin, and polymeric gel network gives viscosity, stability and controlled drug release. The system can also enhance skin residence due to its adhesive qualities³¹. The high water content of gels and their ability to promote drug diffusion through the vehicle result in their generally giving rapid release of a drug. Their capacity of incorporating drugs with hydrophobic properties is however limited. Nanoemulgels are the solution to this problem, because they are able to encapsulate lipophilic drugs in the oil phase and still maintain the desirable characteristics of a gel matrix. Generally, O/W systems can be used for lipophilic drugs while W/O systems can be used for hydrophilic drugs³². Adding

Table 3: Key Components of Nanoemulgels

S. No.	Components	Examples	References
1	Oil Phase	Mineral and olive oils are examples of lipophilic solvents.	[36]
2	Aqueous Phase	Water, glycols, hydrophilic solvents, humectants (glycerin, propylene glycol), and polymers (carbomer,	[37]

		gelling agents, and penetration enhancers according to drug requirements.	may adversely affect drug release, stability, or skin safety.	
10		Can provide controlled or sustained drug release and improve the performance of topical formulations.	Drug release and permeation are strongly influenced by formulation composition, viscosity, and skin properties.	[30]

emulsion to a gel may result in better physical stability and decrease creaming, phase separation and other issues, but could be problematic for larger particles which will not be absorbed by the skin and for air trapping. These limitations are overcome by using smaller dispersed droplets in the gel matrix in so-called advanced microemulgel and nanoemulgel systems³³. Nanoemulgels are also relatively easy and inexpensive to prepare, as most nanoemulgels only need to be readily available materials and do not necessarily require special equipment³⁴.

Components of Nanoemulgel

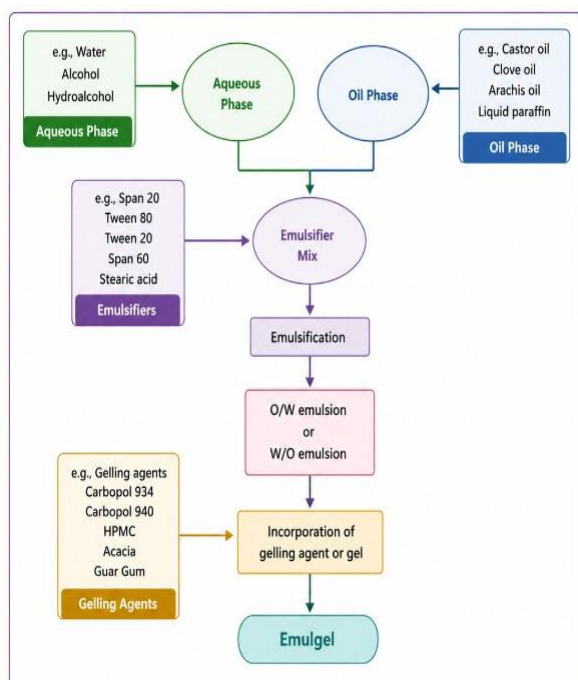
The components of nanoemulgel are the oil phase, the water phase, emulsifying agents, gelling agents, penetration enhancers, preservatives, and the active pharmaceutical ingredient (API) (summarized in Table 3). The emulsion will serve as a proper vehicle to encapsulate lipophilic drugs and the gel matrix will increase its viscosity, spreadability, stability and skin residence time. Careful selection and concentration of each ingredient is crucial in achieving a stable and effective topical formulation³⁵.

		hydroxypropyl cellulose)	
3	Emulsifiers	Sodium lauryl sulfate is an anionic example; cetostearyl alcohol and cetearyl macromonium chloride are non-ionic examples; cetrimonium bromide is a cationic example.	[38]
4	Surfactants	Polysorbates, Tween 80,	[39]

		Span 80, Fluorosurfactants	
5	Gelling Agents	Synthetic examples include carbomer, acrylates, and C10-30 alkyl acrylate crosspolymer; natural examples include gelatin, starch, and carbomer.	[40]

Preparation techniques of Nanoemulgel

Several techniques are available for preparing emulgel formulations, and the appropriate method is selected according to the type of nanoemulgel,



properties of the drug and excipients, desired droplet size, and formulation objective (as illustrated in Figure 3)⁴⁴.

Figure 3 : Schematic representation of the components and general preparation pathway of an nanoemulgel.

6	Penetration Enhancers	Ex. Propylene glycol, urea, Azone	[41]
7	Preservatives	Formaldehyde, Parabens	[42]
8	pH Modifiers	Sodium hydroxide, Citric acid	[43]

1. Low-Energy Emulsification

This method is known as low-energy emulsification, or the solubilization–dispersion method, which requires gentle agitation and proper surfactant to create finely dispersed emulsions. Relatively low mechanical energy is needed, and it is often used with microemulsion-based systems. The method can generate the small droplets with the minimum excessive mechanical stress and heat generation^{45,46}.

2. High-Pressure Homogenization

High pressure homogenization utilizes high pressure homogenizers or microfluidizers to create intense shear, turbulence and forces in the formulation. This process will decrease droplet size and create a fairly even dispersion. The increased interfacial area needs to be stabilized using appropriate emulsifiers. But, it may be limited in terms of energy consumption and high temperatures, especially with heat-sensitive ingredients^{47,48}.

3. Microemulsion Technique

In the microemulsion method, the use of an appropriate combination of oil, surfactant and co-surfactant produces an isotropic and thermodynamically stable system containing very small droplets. But it requires careful optimization due to the fact that the type and concentration of the surfactant, oils, co-surfactants and active pharmaceutical ingredients can affect the formulation properties^{49,50}.

4. Hot–Cold Method

The hot-cold method involves the separating oil and aqueous phases and performs a separation at controlled temperatures and the subsequent mixing with stirring. The emulsion is then cooled and further homogenized to achieve the desired droplet properties. This method can yield fairly uniform dispersions and is helpful when the temperature of the dispersion during formulation is critical. In general, the chosen method affects the droplet size, rheological properties, physical stability, drug distribution and potential of the final emulgel. Emulsion is then added to the mix of the gel base under controlled mixing to prepare the final topical formulation⁵¹.

Limitations of Nanoemulgel^{52,53}

Nanoemulgel formation and stability are influenced by several factors, including:

Solubility: For stable emulsification, emulsifiers must effectively solubilize the water and oil phases.

Agitation: The interfacial tension between the water and oil phases must be sufficiently agitated. Smaller droplets are produced by high agitation.

Additives: Emulsion stability can be enhanced by adding surfactant, co-emulsifiers, electrolytes, gels and polymers which will increase the charge, reduce the surface curvature and add viscosity.

Table 4: Significance and methods of various parameters used in nanoemulgel evaluation.

S. No.	Parameter	Significance	Technique	References
1	Particle Size	Shows dispersion and stability. Higher stability is found in smaller sizes.	Determined using scanning electron microscopy, laser diffraction, and photon correlation spectroscopy.	[55]
2	Viscosity	Stronger gel with reduced spreadability is indicated by higher viscosity.	Evaluated using rotational viscometers, Brookfield viscometer	[56]
3	pH	Important for stability, drug compatibility and skin	Determined using pH meters, pH strips or indicators	[57]

HLB Value: Emulsion formation and stability depend on emulsifiers having the right HLB. O/W emulsions are produced by HLB 12-18 and W/O emulsions by HLB 4-6.

Emulsifier Concentration: The ideal quantity required to cover the droplets and stop them from coalescing. The emulsion may become unstable if it is too high or too low.

Temperature: W/O emulsions are preferred at low temperatures, whereas O/W emulsions are preferred at higher temperatures. Molecules' kinetic energy, viscosity, and solubility are all impacted by temperature.

Evaluations of Nanoemulgel

Nanoemulgels are evaluated for their physical appearance, homogeneity, pH, viscosity, spreadability, drug content, rheological properties, in vitro drug release, and skin permeation to ensure formulation quality and therapeutic performance. Stability studies are also performed to assess changes in physical and chemical characteristics during storage. These parameters collectively determine the stability, safety, patient acceptability, and effectiveness of the topical nanoemulgel (summarized in Table 4)⁵⁴.

		irritation . For topical usage, a range of 4 to 8 is typically suitable.		
4	Spreadability	Demonstrates the acceptability of patients and flow behavior .	Assessed using slips and slides method or cone penetration method.	[58]
5	Drug release	Emulgels should spread easily and retain form Reflects sustained release ability and effectiveness.	Studied using diffusion cells, dialysis bags, Franz diffusion cells.	[59]
6	Drug content	Determines the amount	A known quantity of emulgel is	[60]

		and uniformity of drug present in the formulation and confirms appropriate drug incorporation during preparation.	dissolved in a suitable solvent, filtered, and analyzed using UV–Visible spectrophotometry or HPLC.	
7	Zeta potential	Provides details on stability and surface charge. Acceptable stability is indicated by values about ± 30 mV.	Measured utilizing electrophoretic light scattering and laser doppler electrophoresis.	[61]
8	Rheological behaviour	Gives profiles of viscosity in both static and dynamic environments.	Assessed under increasing shear rates using tube viscometers, plate viscometers, or concentric cylinders.	[62]
9	Drug penetration	Determines the efficacy and skin penetration of actives. Improved activity results from increased	Evaluated utilizing synthetic membranes or ex-vivo or in-vivo skin studies.	[63]

		permeability.		
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Topical Therapy Drug used in Psoriasis Treatment

Topical therapy is the first-line treatment for mild-to-moderate localized psoriasis, particularly plaque psoriasis. Common agents include topical corticosteroids, vitamin D analogues, keratolytics, retinoids, and calcineurin inhibitors, which reduce inflammation, scaling, and abnormal keratinocyte proliferation. The choice of drug depends on lesion severity, anatomical site, patient preference, and treatment tolerability (summarized in Table 5)⁶⁴.

Table 5: Topical therapeutic agents used in the management of psoriasis

S. No.	Topical therapy / Approach	Drug / Active agent	Drug category	Work / Mechanism	Major topical application	References
1	Keratolytic therapy	Salicylic acid (5–30%)	Keratolytic agent	Softens and removes hyperkeratotic scales and enhances penetration of other topical drugs.	Useful for thick, scaly and hyperkeratotic psoriatic plaques.	[65]
2	Keratolytic and moisturizing therapy	Urea (10–20%)	Keratolytic / humectant	Hydrates the stratum corneum, softens scales and facilitates their removal.	Used for dry, scaly and hyperkeratotic lesions.	[66]
3	Anti-inflammation	Topical	Corticosteroid	Suppress	Widely	[67]

	mma tory thera py	corti cost eroi ds	id anti- infla mmat ory agent	infla mmat ory cytoki ne activit y, immu ne respo nses and exces sive kerati nocyt e prolif eratio n.	used for local ized psori asis; pote ncy depe nds on lesio n site and sever ity.	
4	Investigational herbal topical therapy	<i>Rubia cordifolia</i> extract	Plant-derived / phytotherapeutic agent	May inhibit keratinocyte proliferation and promote epidermal differentiation.	Investigated as a potential topical antipsoriatic agent.	[68]
5	Investigational phytochemical therapy	Quercetin from <i>Smilax china</i>	Flavonoid / phytoconstituent	Products reported antiproliferative and anti-inflammatory effects in experimental studies.	Investigated for potential topical antipsoriatic activity.	[69]
6	Combination topical	Vitamin D analog	Antiproliferative + anti-	Provides complementary	Frequently used for	[70]

	thera py	e + corti cost eroi d	infla mmat ory combi nation	effects by controlling keratinocyte proliferation and cutaneous inflammation.	localized plaque psoriasis and improves overall treatment response.	
7	Retinoid therapy	Tazarotene (0.05–1%)	Topical retinoid	Modulates keratinocyte differentiation and reduces inflammatory changes.	Useful for localized plaque psoriasis.	[71]
8	Anti proliferative therapy	Calcipotriol	Vitamin D ₃ analog	Exerts immunomodulatory effects and controls keratinocyte differentiation and proliferation.	Commonly used for localized plaque psoriasis.	[72]
9	Tar therapy	Pine, beech and juniper	Tar / keratoplastic agent	Reduces epidermal hyperproliferation.	Used topically in plaque	[73]

		per tars (5– 20%)		eratio n and helps suppr ess infla mmat ory activit y.	and scalp psori asis.	
1 0 .	Adv ance d / inves tigati onal topical thera py	Met hotr exat e (MT X)	Anti metab olite; folate antag onist; immu nosup pressi ve agent	Inhibi ts dihyd rofolate reduct ase, reduci ng folate - depend ent DNA synth esis and suppr essing activa ted immu ne cells and exces sive kerati nocyt e prolif eratio n. This can help reduc e the infla mmat ory and hyper prolif erativ e proces ses associ ated	Inves tigat ed for local ized topical treat ment using crea ms, niosomes, nano struc tured lipid carri ers, nano emul sions and nano emul gels to enha nce skin depo sition and local drug reten tion whil e pote ntially limiti ng syste mic expo sure.	[74]

				with psoria sis.		
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Marketed and Patented Nanoemulgel Formulation

A few examples of emulgel and NEG formulations that contain multiple medications for transdermal delivery of different diseases are shown in Table 6. Medical Union Pharmaceutical's Miconaz-H emulgel contains these as its Active Pharmaceutical Ingredients (APIs): Miconazole nitrate and hydrocortisone. It is primarily used to treat skin rash, inflammation and aches, as well as bacterial and fungal infections. Also, it is recommended in the treatment of immunological disorders, hormonal disorders, and arthritis⁷⁵. Diclomax emulgel containing diclofenac sodium is used in the treatment of various diseases such as peripheral joints, rheumatism and spiny osteoarthritis. Kleraderm Gaia 480 emulgel is vaginal antiseptic. Isofen emulgel also contains ibuprofen, which belongs to a group of drugs called nonsteroidal anti-inflammatory drugs (NSAIDs). It has been shown to be helpful in treating rheumatic and other muscular discomfort (summarized in Table 6). Diclofenac diethyl ammonium makes up Novartis Alcon's Cataflam emulgel, which is used to treat osteoarthritis, pain, and joint and muscle swelling and inflammation⁷⁶.

Table 6: Patented Nanoemulgel Formulations

S . N o .	Pate nt No.	AP I / Act ive Ing red ient	Titl e	Dise ase Indi cati on	Cu rre nt Ass ign ee / Inv ent ors	Gr an te d / Pu bli cat ion Ye ar	Re fer en ce s
1 .	WO 2012 0530 07A 1	Clo beta sol pro pio nate , Sali cylic acid	Top ical Pha rma ceu tica l Co mp osit ion s Co ntai nin g Na nod	Psor iasis	Cad ila Hea lthc are Ltd .; Sun ilen du B. Ro y, Jay S. Kot hari	20 12 (P ubl ish ed)	[7 7]

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2 .	US2 0160 2431 33A 1	Clo beta sol pro pio nate	Top ical Pha rma ceu tica l Co mp osit ion s Co ntai nin g Na nod ropl ets for the Tre atm ent of Pso rias is	Pla que Pso riasis	Cad ila Hea lthc are Ltd .	20 16 (P ubl ish ed)	[7 8]
3 .	US2 0093 2472 7A1	5- Am inol evu lini c Aci d (AL A) Nan oe mul sion Gel	Na noe mul sion	Psor iasis and Hyp erpr olife rativ e Skin Diso rders	Bio fro nter a Bio scie nce Gm bH; Mo ntse rrat Fog uet Roc a	20 09 (P ubl ish ed)	[7 9]
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8	IN20 2121 0481 08A	Her bal Mic roe mul sion Gel	Mic roe mul sion Gel Pre par atio n for Pso rias is The rap y	Psor iasis , Dry Skin Diso rders	Vai bha v R. Vai dya , Kir an S. Bhi se	20 23 (P ubl ish ed)	[8 4]
9	CN1 0730 3263 B	Tri pter ygi um gly cosi des	Tri pter ygi um gly cosi des nan oe mul sion gel	Imm une disor ders, such as psori asis and clini cal rheu mato	Sec ond Mil itar y Me dic al Uni ver sity (S M	20 20	[8 5]

			and its pre par atio n tec hni que	id arthr itis.	MU)		
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Future Perspectives

Poor aqueous solubility poses a significant challenge for developing effective formulations for poorly soluble drugs, as it can impact drug delivery and bioavailability. A significant fraction of therapeutic compounds are hydrophobic, and the topical route is therefore a promising approach to circumventing the problems of solubility and bioavailability seen with conventional oral formulations⁸⁶. A new method that has been recognised is to make an emulsion of a hydrophobic drug and then disperse the drug in a gel matrix which is known as 'emulgel'. This will offer a dual-action release mechanism and may minimize formulation difficulties including phase separation and creaming and enhance physical stability⁸⁷.

However, there can be certain drawbacks in using conventional emulgels, such as drug permeation. A potential solution to these limitations is nanoemulgel (NEG) which is made up of a nanoemulsion in a gel base material. The type and concentration of oils, surfactants, co-surfactants and other added ingredients need to be carefully optimized as they have a significant effect on the characteristics and stability of the final formulation. The selection of surfactants is important especially if the concentration is not appropriate as this could lead to allergic reactions or irritation to the skin. Thus safer alternatives like biosurfactants should be explored further⁸⁸. They possess biodegradability, biocompatibility, relatively low toxicity, resistance to diverse conditions and economic benefits, making them desirable candidates for replacing the conventional synthetic surfactants⁸⁹. In future, emulgel and nanoemulgel systems could be investigated further for delivery of agents for bacterial, fungal, viral and other dermatological diseases. In-depth research and development into the absorption of these drugs, molecular interactions with the skin, skin permeation, and safety are necessary to determine their therapeutic value. In general, emulgel and NEG systems are promising systems for further topical drug delivery and treatment of diverse dermatological disorders (summarized in Table 7)⁹⁰.

Table 7: Various Marketed Nanoemulgel Formulation with Their Manufacturers

S .	Br an d	Ac tiv e	D os a	In di		R ef er
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o .	Na me	In gr edi en t(s)	g e F o r m	ca tio n	Manufacture r	en ce s
1	W yn zor a® Cr ea m*	Ca lci pot rio l + Be ta me tha so ne Di pr opi on ate	E m ul si o n- B as e d T o pi ca l S ys tem	Pla que Pso rias is	Almirall https://www.almirall.com/?utm_source=chatgpt.com	[9 1]
2	Ta clo ne x® Ge l	Ca lci pot rie ne + Be ta me tha so ne Di pr opi on ate	T o pi ca l Ge l	Pla que Pso rias is	LEO Pharma USA	[9 2]
3	Xa mi ol ® Ge l	Ca lci pot rio l + Be ta me tha so ne Di pr opi	T o pi ca l Ge l	Sca lp Pso rias is	LEO Pharma	[9 3]

4	D o v o b et ® Ge l	Ca lci pot rio l + Be ta me tha so ne Di pr opi on ate	E m ul gel - li ke Ge l	Pla que Pso rias is	LEO Pharma	[9 4]
5	Da ivo bet ® Ge l	Ca lci pot rio l + Be ta me tha so ne Di pr opi on ate	E m ul gel - li ke Ge l	Pso rias is Vul gari s	LEO Pharma	[9 5]
6	Ta zre t® Ge l	Ta zar ote ne 0.0 5 % / 0.1 %	Ge l	Pla que Pso rias is	Glenmark Pharmaceuticals	[9 6]
7	Ps ori d® Ge l	Co al Ta r + Sal icy lic Ac id	Ge l	Pso rias is and Hy per ker atot ic Dis ord ers	Various Regional Manufacturers	[9 7]

Conclusion

The literature available suggests that nanoemulgel is a promising topical drug delivery system for poorly

water-soluble drugs, as well as for plant-derived active ingredients in pharmaceutical and cosmetic preparations. An emulsion can be incorporated into

a three-dimensional gel matrix which can reduce the usual issues associated with emulsion formulations, such as cracking, coalescence, and creaming and offer a dual or combined drug delivery system⁹⁸. Many hydrophobic drugs are still difficult to formulate due to their poor aqueous solubility. To overcome this, nanoemulgel can contain the hydrophobic drugs in the oil phase of the emulsion and then disperse the emulsion into the gel base, making it easier to apply to the skin and increasing the amount available to the skin⁹⁹.

Carbopol 934, Carbopol 940, HPMC are frequently used gelling agents while Tween 40, Tween 20, Tween 80, Span 60, Span 20 and Span 80 are common emulsifying agents. Propylene glycol, polyethylene glycol, isopropyl alcohol, ethanol, azones, and sulfoxides may increase the barrier resistance to skin permeability in a reversible manner¹⁰⁰. Nanoemulgels are tested for drug release, physical parameters, stability, skin permeation and toxicity. Appearance, homogeneity, consistency, swelling index, extrudability, clarity, spreadability, viscosity, pH and rheological behavior are some of the characterization parameters¹⁰¹. The physical stability of emulgels has been found to be superior to that of conventional emulsions, and few incompatibility problems have been observed; some reported less systemic toxicity and adverse effects than oral or parenteral administration. Nanoemulgels in turn are the next generation as nanosized droplets can enhance drug solubilization, absorption, skin penetration and bioavailability, which are beneficial for their future use in advanced topical drug delivery¹⁰².

List of Abbreviations

API:-Active Pharmaceutical Ingredient
BSA:-Body Surface Area
HLB:-Hydrophilic-Lipophilic Balance
HPMC:-Hydroxypropyl Methylcellulose
ICH:-International Council for Harmonisation
IL:-Interleukin
NLC:-Nanostructured Lipid Carrier
NEG:-Nanoemulgel
O/W:-Oil-in-Water
PASI:-Psoriasis Area and Severity Index
PUVA:-Psoralen plus Ultraviolet A
SC:-Stratum Corneum
SLN:-Solid Lipid Nanoparticle
TNF:-Tumour Necrosis Factor
UVB:-Ultraviolet B
VDR:-Vitamin D Receptor
W/O:-Water-in-Oil
3D:-Three-Dimensional
HPLC:-High-Performance Liquid Chromatography
SEM:-Scanning Electron Microscopy
UV-Vis:-Ultraviolet-Visible Spectroscopy

Consent for Publication

Not applicable.

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Conflicts of Interest

The authors declare that they have no conflicts of interest related to the publication of this manuscript.

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References

1. Ghosh, P. K., Majithiya, R. J., Umrethia, M. L., & Murthy, R. S. R. (2006). Design and development of microemulsion drug delivery system of acyclovir for improvement of oral bioavailability. *AAPS PharmSciTech*, 7(3), E172–E177. <https://doi.org/10.1208/pt070377>
2. Kute, S. B., & Saudagar, R. B. (2013). Emulsified gel: A novel approach for delivery of hydrophobic drugs: An overview. *Journal of Advanced Pharmacy Education & Research*, 3(4), 368–376.
3. Kim, W. B., Jerome, D., & Yeung, J. (2017). Diagnosis and management of psoriasis. *Canadian Family Physician*, 63(4), 278–285.
4. Begum, S. G., Chetty, C. M., Voleti, V. K., Pavithra, B., Akhila, B., Gayathri, C., & Ruksar, S. (2019). A review on emulgels: A novel approach for topical drug delivery. *Asian Journal of Pharmaceutical Research and Development*, 7(2), 70–77. <https://doi.org/10.22270/ajprd.v7i2.477>
5. Sharma, S. (2008). Topical preparations are used for the localized effects at the site of their application by virtue of drug penetration into the underlying layers of skin or mucous membranes. *Pharmaceutical Reviews*, 6(1), 26–39.
6. Singh, R. P., Parpani, S., Narke, R., & Chavan, V. (2014). Emulgel: A recent approach for topical drug delivery system. *Asian Journal of Pharmaceutical Research and Development*, 2(2), 112–123.
7. Panwar, A. S., Upadhyay, N., Bairagi, M., Gujar, S., Darwhekar, G. N., & Jain, D. K. (2011). Emulgel: A review. *Asian Journal of Pharmacy and Life Science*, 1(3), 333–343.
8. Baibhav, J., Singh, G. S., Rana, A. C., Seema, S., & Singla, V. (2011). Emulgel: A comprehensive review on recent advancement on topical drug delivery. *International Research Journal of Pharmacy*, 2(11), 66–70.
9. Ramadan, D., McCrudden, M. T. C., Courtenay, A. J., & Donnelly, R. F. (2022). Enhancement strategies for transdermal drug delivery systems: Current trends and applications. *Drug Delivery and Translational Research*, 12, 758–791. <https://doi.org/10.1007/s13346-021-00909-6>
10. Jain, A., Deveda, P., Vyas, N., Chauhan, J., Khambete, H., & Jain, S. (2011). Development of antifungal emulsion based gel for topical fungal infection(s). *International Journal of Pharmaceutical Research and Development*, 2(12), 18–25.

11. Hussain, A., Singh, S. K., Baboota, S., Ali, J., Kumar, R., & Prasad, B. (2016). Formulation and optimization of nanoemulsion using antifungal lipid and surfactant for accentuated topical delivery of amphotericin B. *Drug Delivery*, 23(8), 3101–3110. <https://doi.org/10.3109/10717544.2016.1153747>
12. Emami, J., Rezazadeh, M., Sadeghi, H., & Varshosaz, J. (2016). Formulation of a topical antifungal emulgel containing sertaconazole nitrate. *Drug Development and Industrial Pharmacy*, 42(4), 544–551.
13. Bonacucina, G., Martelli, S., & Palmieri, G. F. (2004). Rheological, mechanical and functional properties of topical preparations containing the synthetic polymeric emulsifier Pemulen™ TR-2. *AAPS PharmSciTech*, 5(1), 48–59.
14. Bharadwaj, S., Jain, S., Choudhury, A., Jha, A., & Dey, A. (2015). Emulgel: A topical preparation for hydrophobic drugs. *International Journal of Pharmaceutical Innovation and Research*, 4(5), 13–16.
15. Pathan, I. B., & Setty, C. M. (2009). Chemical penetration enhancers for transdermal drug delivery systems. *Tropical Journal of Pharmaceutical Research*, 8(2), 173–179. <https://doi.org/10.4314/tjpr.v8i2.44527>
16. Agrawal, S. S., & Munjal, P. (2007). Permeation studies of atenolol and metoprolol tartrate from three different polymer matrices for transdermal delivery. *Indian Journal of Pharmaceutical Sciences*, 69(4), 535–539. <https://doi.org/10.4103/0250-474X.36940>
17. Attia, M. A., El-Gibaly, I., Shaltout, S. E., & Fetih, G. N. (2004). Transdermal permeation and anti-inflammatory effect of piroxicam formulated in different formulae. *Drug Development and Industrial Pharmacy*, 30(2), 245–256.
18. Chouksey, R., Jain, A. K., Pandey, H., & Maithil, A. (2012). Enhancement of bioavailability of aceclofenac by preparing microemulsion gel. *Asian Journal of Pharmacy and Life Science*, 2(2), 151–160.
19. Mortazavi, S. A., Moghimi, H. R., Khosravi, M., Aninaghi, A., & Farzaneh, A. (2014). Preparation and evaluation of an emulgel containing propranolol hydrochloride for skin administration. *Iranian Journal of Pharmaceutical Research*, 13, 21–27.
20. Milutinov, J., Krstonošić, V., Ćirin, D., & Pavlović, N. (2023). Emulgels: Promising carrier systems for food ingredients and drugs. *Polymers*, 15(10), 2302. <https://doi.org/10.3390/polym15102302>
21. Sastri, T. K., Gupta, V. N., Chakraborty, S., Madhusudhan, S., Kumar, H., Chand, P., Jain, V., Veeranna, B., & Gowda, D. V. (2022). Novel gels: An emerging approach for delivering of therapeutic molecules and recent trends. *Gels*, 8(5), 316. <https://doi.org/10.3390/gels8050316>
22. Choudhury, H., Gorain, B., Pandey, M., Chatterjee, B., Sengupta, P., & Kumar, R. (2017). Nanoemulgel: A novel nano carrier as a tool for topical drug delivery. *Journal of Pharmaceutical Sciences*, 106(7), 1736–1751.
23. Kulawik-Pióro, A., & Miastkowska, M. (2021). Polymeric gels and their application in the treatment of psoriasis vulgaris: A review. *International Journal of Molecular Sciences*, 22(10), 5124. <https://doi.org/10.3390/ijms22105124>
24. Varma, V. N. S. K., Maheshwari, P. V., Navya, M., Reddy, S. C., Shivakumar, H. G., & Gowda, D. V. (2014). Calcipotriol delivery into the skin as emulgel for effective permeation. *Saudi Pharmaceutical Journal*, 22(6), 591–599. <https://doi.org/10.1016/j.jsps.2014.02.007>
25. Pandey, P., Minocha, N., Vashist, N., Shah, R., Saini, S., Makhija, M., Purohit, D., & Kaushik, D. (2022). Emulgel: An emerging approach towards effective topical drug delivery. *Drug Delivery Letters*, 12(4). <https://doi.org/10.2174/2210303112666220818115231>
26. Panchal, J. H., Patel, P. B., Patel, R. B., & Bhimani, B. V. (2011). Formulation and evaluation of topical emulgel of mefenamic acid. *Journal of Pharmaceutical Sciences and Bioscientific Research*, 1(1), 1–9.
27. Sintov, A. C., & Botner, S. (2006). Transdermal drug delivery using microemulsion and aqueous systems: Influence of skin storage conditions on the *in vitro* permeability of diclofenac from aqueous vehicle systems. *International Journal of Pharmaceutics*, 311(1–2), 55–62. <https://doi.org/10.1016/j.jipharm.2005.12.019>
28. Abdel-Mottaleb, M. M., Mortada, N. D., El Shamy, A. A., & Awad, G. A. (2012). Preparation and evaluation of fluconazole topical gel. *International Journal of Pharmacy and Pharmaceutical Sciences*, 4(5), 176–183.
29. Vyas, A., Kumar Sonker, A., & Pahwa, R. (2013). Emulgel: A new approach to topical drug delivery. *International Journal of Pharmaceutical Erudition*, 3(1), 1–6.
30. Parmar, V. K., Patel, H. R., Bhimani, B. V., Bhatt, N. M., & Patel, C. N. (2013). Emulgel: A topical preparation for hydrophobic drugs. *The Pharma Innovation Journal*, 2(4), 50–63.
31. Burki, I. K., Khan, M. K., Khan, B. A., Uzair, B., Braga, V. A., & Jamil, Q. A. (2020). Formulation development, characterization, and evaluation of a novel dexibuprofen-capsaicin skin emulgel with improved *in vivo* anti-inflammatory and analgesic effects. *AAPS PharmSciTech*, 21, 211. <https://doi.org/10.1208/s12249-020-01760-7>
32. Kumbhar, P. R., Desai, H., Desai, V. M., Priya, S., Rana, V., & Singhvi, G. (2025). Versatility of emulgel in topical drug delivery transforming its expedition from bench to bedside. *Expert Opinion on Drug Delivery*, 22(1), 55–68. <https://doi.org/10.1080/17425247.2024.2439457>
33. Baibhav, J., Singh, G., Rana, A. C., Saini, S., & Singh, V. (2011). Emulgel: A comprehensive review

- on the recent advances in topical drug delivery. *International Research Journal of Pharmacy*, 2, 66–70.
34. Lee, C. H., Moturi, V., & Lee, Y. (2009). Thixotropic property in pharmaceutical formulations. *Journal of Controlled Release*, 136(2), 88–98. <https://doi.org/10.1016/j.jconrel.2009.02.013>
35. Talat, M., Zaman, M., Khan, R., Jamshaid, M., Akhtar, M., & Mirza, A. Z. (2021). Emulgel: An effective drug delivery system. *Drug Development and Industrial Pharmacy*, 47(8), 1193–1199. <https://doi.org/10.1080/03639045.2021.1993889>
36. Talat, M., Zaman, M., Khan, R., Jamshaid, M., Akhtar, M., & Mirza, A. Z. (2021). Emulgel: An effective drug delivery system. *Drug Development and Industrial Pharmacy*, 47(8), 1193–1199. <https://doi.org/10.1080/03639045.2021.1993889>
37. Nandgude, T. D. (2018). Emulgel: A comprehensive review for topical delivery of hydrophobic drugs. *Asian Journal of Pharmaceutics*, 12(2). <https://doi.org/10.22377/ajp.v12i02.2366>
38. Prajapati, M., Patel, M. R., Patel, K. R., & Patel, N. M. (2013). Emulgels: A novel approach to topical drug delivery. *International Journal of Universal Pharmacy and Bio Sciences*, 2, 134–148.
39. Zhang, J., Wang, C., Wang, J., Qu, Y., & Liu, G. (2012). *In vivo* drug release and antibacterial properties of vancomycin-loaded hydroxyapatite/chitosan composite. *Drug Delivery*, 19(5), 264–269. <https://doi.org/10.3109/10717544.2012.704093>
40. Singh, B., Khurana, L., Bandyopadhyay, S., Kapil, R., & Katore, O. O. (2011). Development of optimized self-nano-emulsifying drug delivery systems (SNEDDS) of carvedilol with enhanced bioavailability potential. *Drug Delivery*, 18(8), 599–612. <https://doi.org/10.3109/10717544.2011.604686>
41. Estabragh, M. A. R., Bami, M. S., Dehghannoudeh, G., Noudeh, Y. D., & Moghimipour, E. (2023). Cellulose derivatives and natural gums as gelling agents for preparation of emulgel-based dosage forms: A brief review. *International Journal of Biological Macromolecules*, 241, 124538. <https://doi.org/10.1016/j.ijbiomac.2023.124538>
43. Mohammad, T. K., Zakir, M. A., & Riyaz, A. M. (2013). Formulation and evaluation of novel topical emulgel of clotrimazole for antifungal activity. *International Journal of Pharmacy and Biological Sciences*, 4(1), 33–43.
44. Milutinov, J., Krstonošić, V., Ćirin, D., & Pavlović, N. (2023). Emulgels: Promising carrier systems for food ingredients and drugs. *Polymers*, 15(10), 2302. <https://doi.org/10.3390/polym15102302>
45. Choudhury, H., Gorain, B., Pandey, M., Chatterjee, L. A., Sengupta, P., Das, A., Molugulu, N., & Kesharwani, P. (2017). Recent update on nanoemulgel as topical drug delivery system. *Journal of Pharmaceutical Sciences*, 106(7), 1736–1751. <https://doi.org/10.1016/j.xphs.2017.03.042>
46. Solans, C., Izquierdo, P., Nolla, J., Azemar, N., & Garcia-Celma, M. J. (2005). Nano-emulsions. *Current Opinion in Colloid & Interface Science*, 10(3–4), 102–110. <https://doi.org/10.1016/j.cocis.2005.06.004>
47. Jaiswal, M., Dudhe, R., & Sharma, P. K. (2015). Nanoemulsion: An advanced mode of drug delivery system. *Biotech*, 5(2), 123–127. <https://doi.org/10.1007/s13205-014-0214-0>
48. Kotta, S., Khan, A. W., Ansari, S. H., Sharma, R. K., & Ali, J. (2015). Formulation of nanoemulsion: A comparison between phase inversion composition method and high-pressure homogenization method. *Drug Delivery*, 22(4), 455–466. <https://doi.org/10.3109/10717544.2013.866992>
49. McClements, D. J. (2012). Nanoemulsions versus microemulsions: Terminology, differences, and similarities. *Soft Matter*, 8(6), 1719–1729. <https://doi.org/10.1039/C2SM06903B>
50. Mohamed, M. I. (2004). Optimization of chlorphenesin emulgel formulation. *The AAPS Journal*, 6(3), e26. <https://doi.org/10.1208/aapsj060326>
51. Ajazuddin, Alexander, A., Khichariya, A., Gupta, S., Patel, R. J., Giri, T. K., & Tripathi, D. K. (2013). Recent expansions in an emergent novel drug delivery technology: Emulgel. *Journal of Controlled Release*, 171(2), 122–132. <https://doi.org/10.1016/j.jconrel.2013.06.030>
53. Vanpariya, F., Shiroya, M., & Malaviya, M. (2021). Emulgel: A review. *International Journal of Science and Research*, 10(3), 847–852. <https://doi.org/10.21275/SR21311095015>
54. Estabragh, M. A. R., Bami, M. S., Dehghannoudeh, G., Noudeh, Y. D., & Moghimipour, E. (2023). Cellulose derivatives and natural gums as gelling agents for preparation of emulgel-based dosage forms: A brief review. *International Journal of Biological Macromolecules*, 241, 124538. <https://doi.org/10.1016/j.ijbiomac.2023.124538>
55. Yadav, S. K., Mishra, M. K., Tiwari, A., & Shukla, A. (2017). Emulgel: A new approach for enhanced topical drug delivery. *International Journal of Current Pharmaceutical Research*, 9(1), 15–19. <https://doi.org/10.22159/ijcpr.2017v9i1.16628>
56. Haneefa, K. M., Easo, S., Hafsa, P. V., Mohanta, G. P., & Nayar, C. (2013). Emulgel: An advanced review. *Journal of Pharmaceutical Sciences and Research*, 5(12), 254.
57. Sharma, V., Nayak, S. K., Paul, S. R., Choudhary, B., Ray, S. S., & Pal, K. (2018). Emulgels. In *Polymeric gels: Characterization, properties and biomedical applications* (pp. 251–

- 264). Woodhead Publishing.
<https://doi.org/10.1016/B978-0-08-102179-8.00009-0>
- Light, K., & Karboune, S. (2022). Emulsion, hydrogel and emulgel systems and novel applications in cannabinoid delivery: A review. *Critical Reviews in Food Science and Nutrition*, 62, 8199–8229.
<https://doi.org/10.1080/10408398.2021.1926903>
59. Sabalingam, S., & Siriwardhene, M. A. (2022). A review on emerging applications of emulgel as topical drug delivery system. *World Journal of Advanced Research and Reviews*, 13(1), 452–463.
<https://doi.org/10.30574/wjarr.2022.13.1.0048>
60. Anand, K., Ray, S., Rahman, M., Shaharyar, A., Bhowmik, R., Bera, R., & Karmakar, S. (2019). Nano-emulgel: Emerging as a smarter topical lipidic emulsion-based nanocarrier for skin healthcare applications. *Recent Patents on Anti-Infective Drug Discovery*, 14(1), 16–35.
<https://doi.org/10.2174/1574891X14666190717111531>
61. Singh, M., Sharma, S., Khokra, S. L., & Saini, V. (2011). Formulation and evaluation of topical emulgel of rofecoxib. *International Journal of Pharmacy and Pharmaceutical Sciences*, 3(1), 210–213.
62. Sahu, G. K., Nayak, N., & Mishra, L. (2012). Formulation and in-vitro evaluation of Carbopol 934-based modified emulgel of ketoprofen. *International Journal of Pharmaceutical Research and Bio-Science*, 1(5), 65–76.
63. Osmani, R. A., Aloorkar, N. H., Kulkarni, A. S., Harkare, B. R., & Bhosale, R. R. (2013). A novel approach for topical delivery of hydrophobic drugs: Emulgel. *Journal of Advanced Pharmaceutical Sciences*, 3(3), 17–24.
64. Elmets, C. A., Korman, N. J., Prater, E. F., Wong, E. B., (2021). Joint AAD–NPF guidelines of care for the management and treatment of psoriasis with topical therapy and alternative medicine modalities for psoriasis severity measures. *Journal of the American Academy of Dermatology*, 84(2), 432–470.
<https://doi.org/10.1016/j.jaad.2020.07.087>
65. Rendon, A., & Schäkel, K. (2019). Psoriasis pathogenesis and treatment. *International Journal of Molecular Sciences*, 20(6), 1475.
<https://doi.org/10.3390/ijms20061475>
66. Zagórska-Dziok, M., & Sobczak, M. (2020). Hydrogel-based active substance release systems for cosmetology and dermatology application: A review. *Pharmaceutics*, 12(5), 396.
<https://doi.org/10.3390/pharmaceutics12050396>
67. Vijayalakshmi, A., Ravichandiran, V., Velraj, M., Nirmala, S., & Jayakumari, S. (2012). Screening of flavonoid “quercetin” from the rhizome of *Smilax china* Linn. for anti-psoriatic activity. *Asian Pacific Journal of Tropical Biomedicine*, 2(4), 269–275.
68. Kim, W. B., Jerome, D., & Yeung, J. (2017). Diagnosis and management of psoriasis. *Canadian Family Physician*, 63(4), 278–285.
69. Kaszuba, A., Uczniak, S., & Kaszuba, A. (2016). *Dermatologia geriatryczna* (Vol. 1). Wydawnictwo Czelej.
70. Jacobi, A., Mayer, A., & Augustin, M. (2015). Keratolytics and emollients and their role in the therapy of psoriasis: A systematic review. *Dermatology and Therapy*, 5(1), 1–18.
<https://doi.org/10.1007/s13555-015-0068-3>
71. Bos, J. D., & Spuls, P. I. (2008). Topical treatments in psoriasis: Today and tomorrow. *Clinics in Dermatology*, 26(5), 432–437.
<https://doi.org/10.1016/j.clindermatol.2007.10.025>
72. Dhanabal, S. P., Dwarampudi, L. P., Muruganantham, N., & Vadivelan, R. (2012). Evaluation of the antipsoriatic activity of *Aloe vera* leaf extract using a mouse tail model of psoriasis. *Phytotherapy Research*, 26(4), 617–619.
<https://doi.org/10.1002/ptr.3589>
73. Dwarampudi, L. P., Palaniswamy, D., Nithyanantham, M., & Raghu, P. S. (2012). Antipsoriatic activity and cytotoxicity of ethanolic extract of *Nigella sativa* seeds. *Pharmacognosy Magazine*, 8(32), 268–272.
<https://doi.org/10.4103/0973-1296.103650>
74. Lin, Z. X., Jiao, B. W., Che, C. T., Zuo, Z., Mok, C. F., Zhao, M., Ho, W. K. K., Tse, W. P., Lam, K. Y., Fan, R. Q., Yang, Z., & Cheng, C. H. K. (2010). Ethyl acetate fraction of the root of *Rubia cordifolia* L. inhibits keratinocyte proliferation in vitro and promotes keratinocyte differentiation in vivo: Potential application for psoriasis treatment. *Phytotherapy Research*, 24(7), 1056–1064.
<https://doi.org/10.1002/ptr.3079>
75. Charyulu, N. R., Joshi, P., Dubey, A., & Shetty, A. (2021). Emulgel: A boon for enhanced topical drug delivery. *Journal of Young Pharmacists*, 13(1), 76–79.
<https://doi.org/10.5530/jyp.2021.13.17>
76. Pandey, P., Minocha, N., Vashist, N., Shah, R., Saini, S., Makhija, M., Purohit, D., & Kaushik, D. (2022). Emulgel: An emerging approach towards effective topical drug delivery. *Current Pharmaceutical Design*, 28(4), 227–242.
<https://doi.org/10.2174/2210303112666220818115231>
77. Roy, S. B., Kothari, J. S., Sheikh, S., Patel, J. D., & Pancholi, J. S. (2012). *Topical pharmaceutical compositions containing nanodroplets for the treatment of psoriasis* (WO Patent No. WO2012053007A1). Cadila Healthcare Ltd.
78. Roy, S. B., Kothari, J. S., Sheikh, S., Patel, J. D., & Pancholi, J. S. (2016). *Topical pharmaceutical compositions containing nanodroplets for the treatment of psoriasis* (U.S. Patent Application No. US20160243133A1). Cadila Healthcare Ltd.
79. Foguet Roca, M. (2009). *Nanoemulsion compositions containing 5-aminolevulinic acid and uses thereof for treatment of skin disorders*

- including psoriasis (U.S. Patent Application No. US20090324727A1). Biofrontera Bioscience GmbH.
80. Dow, G. J., Pillai, R., & Bhatt, V. D. (2023). *Topical compositions and methods for treating psoriasis* (U.S. Patent No. US11679116B2). Bausch Health US LLC.
81. LEO Pharma A/S. (2024). *An anhydrous pharmaceutical composition for maintenance treatment of psoriasis* (European Patent No. EP4041186).
82. Kraus, J. E., & Lee, J. (2023). *Use of tapinarof for the treatment of chronic plaque psoriasis* (U.S. Patent No. US11590088B2). Dermavant Sciences GmbH.
83. Arkin, M., et al. (2022). *Treatment of skin disorders with topical tapinarof-EGFR inhibitor compositions* (U.S. Patent Application No. US20220142944A1). Sol-Gel Technologies Ltd.
84. Vaidya, V. R., & Bhise, K. S. (2023). *Microemulsion gel preparation for psoriasis therapy* (Indian Patent Application No. IN202121048108A).
85. Xiaoling, F., Xiao, W., & Xianyi, S. (2020). *Tripterygium glycoside-containing micro-emulsified gel transdermal preparation and preparation method thereof* (Chinese Patent No. CN107303263B).
86. Nastiti, C. M. R. R., Ponto, T., Abd, E., Grice, J. E., Benson, H. A. E., & Roberts, M. S. (2017). Topical nano and microemulsions for skin delivery. *Pharmaceutics*, 9(4), 37. <https://doi.org/10.3390/pharmaceutics9040037>
87. Raj, R., & Goyal, A. (2017). Potential and future scope of nanoemulgel formulation for topical delivery of lipophilic drugs. *International Journal of Pharmaceutics*, 526(1–2), 353–365. <https://doi.org/10.1016/j.ijpharm.2017.04.068>
88. Mishra, B., Patel, B. B., & Tiwari, S. (2016). Colloidal nanocarriers: A review on formulation technology, types and applications toward targeted drug delivery. *Nanomedicine: Nanotechnology, Biology and Medicine*, 12(5), 1377–1401. <https://doi.org/10.1016/j.nano.2015.11.004>
89. Jaiswal, M., Dudhe, R., & Sharma, P. K. (2015). Nanoemulsion: An advanced mode of drug delivery system. 3 *Biotech*, 5, 123–127. <https://doi.org/10.1007/s13225-014-0214-0>
90. Kaur, A., & Kaur, G. (2018). Topical nanoemulsions: An effective approach for dermal drug delivery. *Drug Development and Industrial Pharmacy*, 44(5), 725–734.
91. U.S. Food and Drug Administration. (2022). *Wynzora (calcipotriene and betamethasone dipropionate) cream: Prescribing information*. U.S. Department of Health and Human Services.
92. U.S. Food and Drug Administration. (2016). *Taclonex (calcipotriene and betamethasone dipropionate) topical suspension: Prescribing information*. U.S. Department of Health and Human Services.
93. LEO Pharma. (2024). *Xamiol 50 micrograms/g + 0.5 mg/g gel: Summary of product characteristics*. Electronic Medicines Compendium.
94. Menter, A., Stein Gold, L., Koo, J., et al. (2017). Fixed-dose combination calcipotriene 0.005% and betamethasone dipropionate 0.064% foam for the treatment of plaque psoriasis: A randomized, double-blind, vehicle-controlled study. *Journal of Drugs in Dermatology*, 16(12), 1227–1233.
95. Gooderham, M. J., Papp, K. A., & Lynde, C. W. (2018). A review of the efficacy and safety of calcipotriol/betamethasone dipropionate foam in the treatment of plaque psoriasis. *Journal of Cutaneous Medicine and Surgery*, 22(2), 139–147.
96. Glenmark Pharmaceuticals. (n.d.). *Tazret (tazarotene) topical gel: Product information*. Glenmark Pharmaceuticals.
97. Brodell, R. T., & O'Brien, M. (2010). Topical therapy for psoriasis. *Journal of the American Academy of Dermatology*, 63(5), 825–839. <https://doi.org/10.1016/j.jaad.2009.11.053>
98. Pinheiro, I. M., Carvalho, I. P., de Carvalho, C. E. S., Brito, L. M., da Silva, A. B. S., Conde Júnior, A. M., de Carvalho, F. A. A., & Carvalho, A. L. M. (2016). Evaluation of the in vivo leishmanicidal activity of amphotericin B emulgel: An alternative for the treatment of skin leishmaniasis. *Experimental Parasitology*, 164, 49–55. <https://doi.org/10.1016/j.exppara.2016.02.010>
99. Singh, V. K., Yadav, I., Kulanthaivel, S., Roy, B., Giri, S., Maiti, T. K., Banerjee, I., & Pal, K. (2016). Groundnut oil based emulsion gels for passive and iontophoretic delivery of therapeutics. *Designed Monomers and Polymers*, 19(4), 297–308. <https://doi.org/10.1080/15685551.2016.1152540>
100. Shahin, M., Abdel Hady, S., Hammad, M., & Mortada, N. (2011). Novel jojoba oil-based emulsion gel formulations for clotrimazole delivery. *AAPS PharmSciTech*, 12(1), 239–247. <https://doi.org/10.1208/s12249-011-9583-4>
101. Khullar, R., Kumar, D., Seth, N., & Saini, S. (2012). Formulation and evaluation of mefenamic acid emulgel for topical delivery. *Saudi Pharmaceutical Journal*, 20(1), 63–67. <https://doi.org/10.1016/j.jsps.2011.08.001>
102. Venkataharsha, P., Maheshwara, E., Prasanna Raju, Y., Ashok Reddy, V., Sanjeev Rayadu, B., & Karisetty, B. (2015). Liposomal Aloe vera trans-emulgel drug delivery of naproxen and nimesulide: A study. *International Journal of Pharmaceutical Investigation*, 5(1), 28–34. <https://doi.org/10.4103/2230-973X.147230>