Medical Sains : Jurnal Ilmiah Kefarmasian
Vol. 9 No. 2, April - June 2024
https:/ojs.stfmuhammadiyahcirebon.ac.id/index.php/iojs


# REVIEW: POTENTIAL OF NANOEMULGEL FORMULATIONS FOR TOPICAL DRUG DELIVERY

**Santi Hasanah[1*], Jessie Sofia Pamudji[1]**
[1]*Fakultas Farmasi, Universitas Jenderal Achmad Yani, Indonesia*
**Email Corresponding: santihasanah142@gmail.com*

***Submitted: February 7, 2024 Revised: May 15, 2024 Accepted: May 30, 2024***

## ABSTRACT

Nanoemulgel is a combination of two different formulation systems, known as nanoemulsion preparation with gel matrix. In recent years, there has been an increase in the use of topical nanoemulgel preparations because they are easy to apply and can avoid damage to various drugs in the body. Although topical nanoemulgel preparations have some limitations, they are capable of delivering lipophilic drugs topically. The purpose of this review is to summarize the potential of nanoemulgel formulations for topical drug delivery against various physiological challenges and limitations of the formula. Through the publication search, as many as 124 articles were obtained based on the screening results of 29 articles that met the inclusion criteria and were used as a review. The analysis of data for this article was conducted through a narrative review. This preparation may improve the permeability of the drug into the skin by penetrating the stratum corneum through intercellular and intracellular pathways, depending on the components used: oil phase, surfactants, co-surfactants, and gelling agents. Surfactants are responsible for damaging the structure of the skin layer by lowering the surface tension, and gelling agents are responsible for increasing the viscosity and adhesiveness of the skin. Nanoemulgel formulations for topical drug delivery can be used to treat several diseases, such as inflammation, arthritis, wounds, fungal infections, bacterial infections, *and psoriasis*. The nanoemulgel formulation may provide promising potential in delivering lipophilic drugs topically in the future

**Keywords**: Nanoemulgel, nanoemulsion, gel, topical drug delivery

## INTRODUCTION

A Localized drug delivery system in which drugs are incorporated into the skin to attain the local effects of a drug, known as a topical drug delivery system, can mitigate various risks such as gastric-induced drug degradation, first-pass metabolism in the liver, and varied absorption conditions due to changes in pH, the availability of enzymes, and gastric emptying time. However, topical drug delivery systems have major challenges related to the skin barrier properties of the stratum corneum, which require nano-based delivery systems to improve drug bioavailability and permeability (Gadkari Patil and Saudagar, 2019; Singh et al., 2013). Nanoemulsions are nanotechnology-based systems.

Nanoemulsions have been reported to work as novel carrier systems to resolve the problems related to topical delivery of lipophilic drug molecules. These systems can load drugs and enhance permeability by enveloping lipophilic molecules in an oil film and delivering them through the stratum corneum into the skin (Kumar Ali and Baboota, 2016). Despite their excellent properties, nanoemulsions have some disadvantages, such as low viscosity, poor retention and spreadability, and unfavorable product stability owing to the thermodynamically unstable nanoemulsion interface. Therefore, it is important to incorporate

nanoemulsions into gel dosage forms to enhance the pharmacological viscosity, adhesiveness, and exposure time of the drug to the skin surface (Sharma, et al., 2019).

Nanoemulgel is a combination of two different systems in which a nanoemulsion loaded with a drug is incorporated into a gel base to provide a dual controlled release system (Paliwal and Kaur, 2019). This type of gel base has the limitation of being unable to transport lipophilic drugs. For this reason, lipophilic drugs are dissolved in the nanoemulsion phase to increase drug permeability through the skin and incorporated into the gel base to solve the problem of low viscosity in nanoemulsion systems (Ghiasi, et al., 2019; Abdallah, et al., 2021). The objective of this review is to provide a summary of the potential of nanoemulgel formulations for topical drug delivery against various physiological challenges and limitations of its formulation, but still provides good efficacy.

## RESEARCH METHODE

### Tools and Materials

This review article used data collected by conducting online research from national and international publications in electronic databases, including Google Scholar and PubMed. The keywords "Nanoemulgel", "Nanoemulsion", Nanoemulsion Gel", "Hydrogel" and "Topical Drug Delivery System" were used during the search. Compilation of this review article was assisted by Mendeley® software.

### Article Selection Criteria

The inclusion criteria in this study were articles in accredited journals or those with ISSN and E-ISSN published between 2013 and 2023, with a complete article structure, suitable with predetermined themes, and research articles. The exclusion criteria in this study were articles in non-accredited journals published before 2013, incomplete article structure, not following the specified theme, and article reviews.

### Research Procedure

The literature search yielded 124 national or international publications. There were 29 articles that met the predetermined inclusion criteria, while the other 95 articles did not meet the set criteria because of the exclusion criteria, could not be found because of errors in the web journal, and could not be accessed in full text. This review article is presented using a descriptive analysis. The publication search process is illustrated in Figure.**Figure 1**.

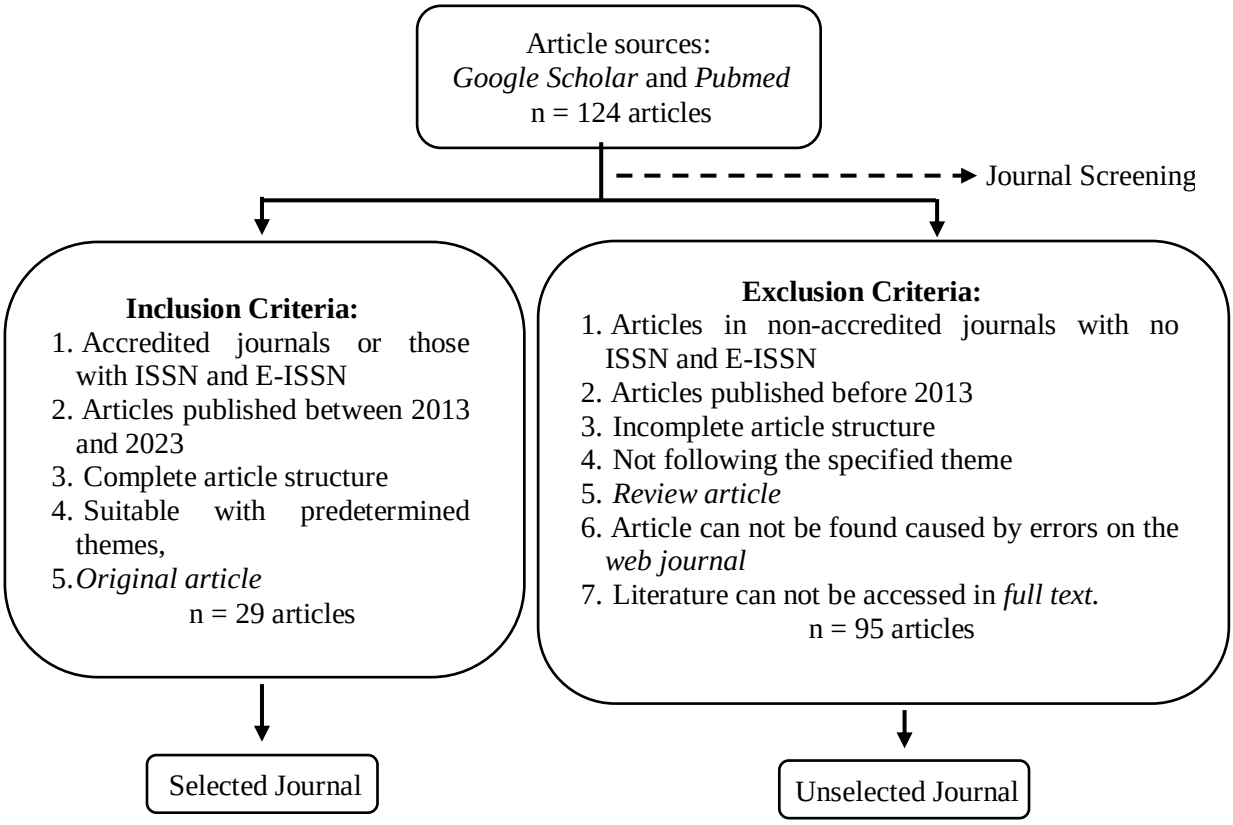


***Figure 1. Flow Chart Of The Publication Search Method***

## RESULTS AND DISCUSSION

Skin has permanent properties that act as a protective barrier against external agents. The outermost layer of the skin is the stratum corneum, which is a part of the skin epidermis. The stratum corneum consists of keratinized cells, lipids, fatty acids, and cholesterol, which help to retain moisture and provide a hydrophobic barrier to the skin. After successfully passing through the stratum corneum, the drug penetrates the dermal layer with abundant blood vessels. A part of the active substance of the drug enters the systemic circulation. Thus, skin penetration is a major challenge for topical drug delivery. The application of nanocarriers is an effective strategy to penetrate the stratum corneum barrier without disrupting the structure of the skin layer by utilizing intercellular and intracellular transport mechanisms (Hussain et al., 2016).

One of the new carriers for topical preparations is a nanoemulgel based on nanoemulsion preparations incorporated into a gel matrix (Tayah and Eid, 2023). Nanoemulsion is a heterogeneous colloidal mixture of oil and water, with one component as the dispersed phase and the other as the dispersion phase. Surfactants are emulsifying agents adsorbed at the interfaces of dispersed and dispersed phases by reducing surface tension. High solubilization capacity may improve the thermodynamic activity of the skin. However, the low viscosity of this system results in low retention time and spreadability. On the other hand, gel preparation cannot contain a large amount of drug, but this system can improve viscosity, spreadability, and adhesiveness (Ghiasi, et al., 2019).

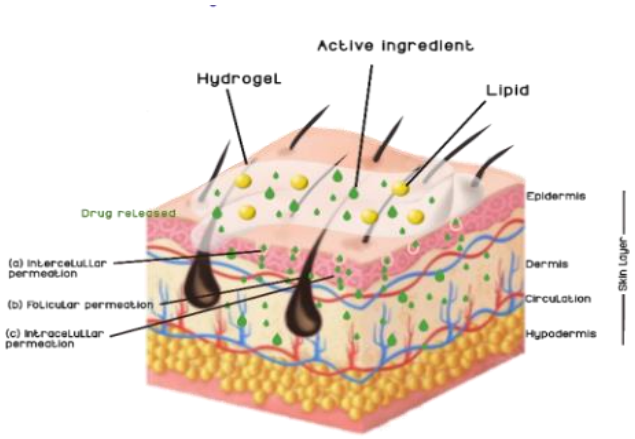


**Figure 2. Nanoemulgel Delivery System for Topical Preparations**

The distinctive drug release of nanoemulgel formulations includes drug release from the inner phase of the nanoemulsion into the gel base and then into the skin. When the nanoemulsion gel comes into contact with the skin, it releases nano-sized droplets owing to their small diameter, which traverses two different pathways, as shown in **Figure 2**. One is cell-to-cell transfer involving concentration gradient-based movement, called intercellular or intracellular transport, while the other is traversing through the intercellular space or paracellular transport. Although there is a third pathway called transappendageal transport, its influence on drug penetration is limited, as hair follicles and glandular ducts constitute a negligible portion of the total skin surface area (Raju et al., 2019).

Numerous advantages have been reported for the application of nanoemulgels for drug delivery, including nanoemulgels capable of delivering larger amounts of the drug due to their better solubilization capacity, good adhesion and cross-linking properties that affect drug penetration on the skin, providing better lipophilic drug delivery, increasing nanoemulsion stability, facilitating the movement of drugs to the stratum corneum due to the fine dispersion of drugs in nanoemulsion droplets (Ghiasi, et al., 2019), providing a pleasant appearance, ease of application, and ease of cleaning (Eid, et al., 2014). However, nanoemulgel also has several disadvantages, including the manufacturing of the nanoemulsion phase, which is quite expensive because it requires special tools and high maintenance costs, such as the fact that it is sometimes difficult to control the formation of bubbles, and is a new technology that has not been widely used. Therefore, there is still little interest from manufacturers to convert existing products on the market into nanoemulgel preparations (Raju, et al., 2019).

The main components of nanoemulgels (**Table I**) consist of an oil phase, surfactants, co-surfactants, and gelling agents that improve permeability and adhesiveness to the skin by increasing the partition coefficient and retention of the product on the skin (Ghiasi et al., 2019). Nanoemulgel characteristics have good thermodynamic stability with particle sizes less than 100 nm and excellent bioavailability and permeability (Abdallah et al., 2021; Tayah and Eid, 2023).

**Table I. Components Of Nanoemulgels**

| Formulation | Use | Example | Reference |
|---|---|---|---|
| Aqueous Phase | For aqueous phase emulsion | Water, alcohol | (Mittal, Ali and Baboota, 2021) |
| Oil Phase | For oil phase emulsion | Oleic acid, emu oil | (Mittal, Ali and Baboota, 2021) |
| Surfactant | Reducing surface tension | - Cationic: hexadecyl trimethyl ammonium bromide, quaternary ammonium compounds, and dodecyl dimethyl ammonium bromide | (Shakeel, et al., 2013) (Mittal, Ali and Baboota, 2021) |
| | | - Nonionic: Poloxamer 124 , Tween 20, Tween 80, Caproyl 90 | (Shakeel, et al., 2013) |
| | | - Anionic: sodium dodecyl sulfate and sodium bis-20 ethylhexylsulfosuccinate | (Usman, et al., 2013) |
| | | - Zwitterionic: carboxybetaine | (Kumar, Saw and Mandal, 2019) |
| Co-surfactant | Help improve surfactant performance | PEG-400, Transcutol HP, ethyl alcohol | (Kesan, et al., 2017) |
| Gelling Agent | Increasing viscosity | - Natural: pectin, carrageenan, alginate acid, *xanthan gum*, acacia gum | (Mittal, Ali and Baboota, 2021) |
| | | - Synthethic: carbomer | (Chen, et al., 2013) |
| | | - Semi synthethic: hydroxypropyl cellulose, ethyl cellulose | (Shende and Gupta, 2020) |
| Preservative | Protection from microorganism | Methylparaben, propylparaben, benzalkonium chloride, benzoic acid, sodium benzoate | (Raju, et al., 2019) |
| Antioxidant | Prevent degrading preparation by oxidation | Butyl hydroxy toluene (BHT), Butyl hydroxy anisole (BHA) | (Raju, et al., 2019) |
| Humectant | Maintain moisture | Glycerin, propyleneglycol | (Raju, et al., 2019) |
| Penetration Enhancer | Enhancing drug penetration into skin | Isopropyl myristate, urea, chenopodium oil, pyrrolidone, dimethyl sulfoxide, linoleic acid, menthol | (Raju, et al., 2019) |

Based on emulsification techniques, nanoemulgel preparations can be divided into 2 types.

1. High-energy method
   This method uses mechanical devices, such as *microfluidizers*, high-pressure *homogenizers*, and ultrasonication, to generate forces that can disrupt both phases. High-energy methods can generate heat in the components during preparation, resulting in thermodynamic instability. However, this method is not suitable for thermolabile drugs (Kotta et al., 2015).
2. Low energy method
   This method includes phase-inversion emulsification and self-emulsification. The phase inversion emulsification method results from the alteration of surface affinity due to changes in temperature and composition. The self-emulsification (spontaneous) method involves blending the oil phase, surfactant, and aqueous phase at an appropriate ratio. This method is suitable for thermolabile drugs (Kotta et al. 2015).

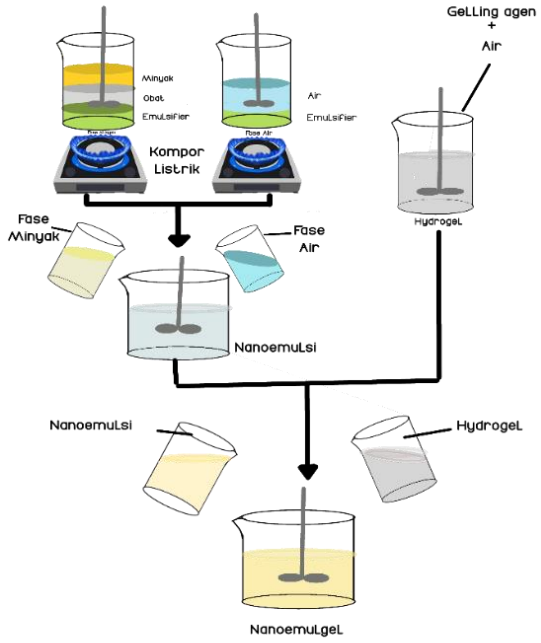


**Figure 3. Nanoemulgel Preparation Procedure**

Nanoemulgel preparation procedure consists of three main steps (Raju. et al., 2019)

1. Formulation of oil-in-water or water-in-oil nanoemulsion
   - Oil phase preparation occurs when the emulgator is dissolved under hot conditions. For example: Span 20 in liquid paraffin
   - Preparation of aqueous phase i.e. the aqueous phase is prepared by dissolving the emulgator under hot conditions. Example: Tween 20 in pure water
   - The drug is dissolved in the oil or water phase (according to its solubility).
   - The oil and aqueous phases were mixed gradually and then stirred at room temperature until they were homogeneous.
2. Formulation of gel base
   The gel base was prepared by dispersing the polymer in pure water at moderate and constant stirring speeds using a mechanical stirrer, and the pH was adjusted to 6-6.5 using neutralizing agents such as triethanolamine (TEA).
3. Incorporation of nanoemulsion into gel base
   The nanoemulsion was placed into the gel base, stirred gently until homogeneous, and then tested.

**Table II. Nanoemulgel Testing**

| Test | Objective | Tools | Reference |
|---|---|---|---|
| **Physical Test** | | | |
| Appearance | Observe color stability, homogeneity, and phase separation | Visual observation | (Print, et al., 2015) |
| pH | Measure suitability of product's pH to skin pH | pH meter | (Paliwal and Kaur, 2019b) |
| Viscosity | Measure viscosity of preparation | Viscometer | (Yeo, et al., 2021) |
| Spreadability | Measure spreadability of preparation | Vernier Caliper | (Das, M. Sharadha, et al., 2021) |
| Particle Size | Determine particle size | Zetasizer | (Print, et al., 2015) |
| Polidispersity Index | Determine droplet size distribution | Zetasizer | (Tayah and Eid, 2023) |
| Zeta Potensial | Measure electric charge on shear plane/shear field | Zetasizer | (Das, M. Sharadha, et al., 2021) |
| Rheology Characteristic | Evaluate and flow property of semisolid preparation | Viscometer rotation | (Eid. et al., 2014) |
| Bioadhesivity | Measure adhesiveness | Glass plate | (Raju, et al., 2019) |
| **Chemical Test** | | | |
| Assay | Determine drug content of preparation | Spectrophotometry | (Raju, et al., 2019) |
| *In vitro* Release Assay | Determine drug release of preparation | Spectrophotometry UV | (Hussain. et al., 2016) |
| **Microbiology Test** | | | |
| Microbiology | Ensure peraparations are free of bacteria and mold | Petri dish | (Raju, et al., 2019) |
| **Activity Test** | | | |
| Skin Irritation Test | Testing skin irritation | Visual observation | (S. Bhattacharya and Prajapati, 2017) |
| Skin Penetration (Cell Diffuse Test) | Testing drug penetration ability | Spectrophotometry UV | (S. Bhattacharya and Prajapati, 2017) |

To obtain a nanoemulgel formulation that is stable, microbe-free, and effective, it is necessary to conduct several tests, including physical, chemical, microbiological, and activity tests. Physical testing included physical examination/description, pH, viscosity, spreadability, particle size, polydispersity index, zeta potential, rheological characteristics, and bioadhesivity. Chemical testing includes assays and in vivo release tests, while activity testing includes skin irritation and penetration tests. The functions of each test and the tools used to conduct nanoemulgel testing can be seen in **Table II**.

**Table III. Applications of Nanoemulgel Formulation**

| Active substances | Formulation | | | | Therapeutic effects | References |
|---|---|---|---|---|---|---|
| | Oil phase | Surfactant | Co-surfactant | Gelling agent | | |
| **A. Synthetic drug** | | | | | | |
| Natrium diclofenac | - Clove oil<br>- Eucalyptus oil | Isopropyl myristate | Tween 20 | Carbopol 980 | Anti inflammatory | (Md, et al., 2020) |
| Miconazole | Almond oil | Span 80 | Tween 20 | Carbopol 940 | Antifungal | (Tayah and Eid, 2023) |
| Amphotericin B | Sefsol oil 218 | Tween 80 | Transcutol P | Carbopol | Antifungal | (Hussain, et al., 2016) |
| Methotrexate | Peanut oil | Tween 20 | PEG-400 | Xanthan gum | Joint inflammation | (Das, M Sharadha,et al., 2021) |
| Celecoxib | Combination of acetonitrile, triacetin, Campul 908 | Acconom MC8-2EP | Capmul MCM C10 | Carbopol 940 | Joint inflammation | (Bhattacharya and Prajapati, 2017) |
| Fusidic Acid Na. Fusidic | Pine oil | Tween 80 | Span 20 | Carbopol | Anti-bacterial | (Eid, et al., 2019) |
| Tacrolimus | Fish oil and flaxseed oil | Tween 80 | Transcutol P | Carbopol 934 | Anti-psoriasis | (Mittal, Ali and Baboota, 2021) |
| Adapalene | Soya bean oil | Tween 80 | Isopropyl myristate | Carbopol 934 | Anti-acne | (Print, et al., 2015) |
| **B. Natural drug** | | | | | | |
| Brucine | Nut oil | Tween 80 | PEG-400 | Na-CMC | Anti inflammatory and antiseptic | (Abdallah, et al., 2021) |
| Ginger extract | Isopropyl myristate | Tween 80 | Ethanol | Carbopol 934 | Joint inflammation | (Amit et al., 2019) |
| Naringen | Combination of Capryol 90 and tocotrienols | Solutol HS15 | Transcutol P | Carbopol | Wound healing | (Yeo, et al., 2021) |
| Ebselen | Captex | Koliphor® ELP | EBP-Soluplus | HPMC K4M | Antifungal | (Vartak, et al., 2020) |
| Terbinafine | Oleic acid | Span 20 | Propylene-glycol | Carbopol 934 | Antifungal | (Paliwal and Kaur, 2019) |
| Tolnaftate | Almond oil | Tween 80 | Propylene-glycol | Carbopol 934 | Antifungal | (Gadkari, Patil and Saudagar, 2019) |
| Thymoquinone | Chia seeds oil | Coliphor | Transcutol HP | Carbopol 940 | Wound healing | (Algahtani,et al., 2021) |
| Black cumin | Black cumin oil | Tween 80 | Propylene-glycol | Carbomer 940 | Anti-bacterial | (Jufri and Natalia, 2014) |
| Capsaicin | Olive oil | Tween 80 | Ethanol | Carbomer | Analgesic, anti inflammatory | (Ghias, et al., 2019) |

Lipophilic drugs of both synthetic and natural origin have been reported to be successfully prepared in topical nanoemulgel preparations used for several treatments, such as inflammation, wound healing, arthritis, bacterial infections, and fungal infections with formulations such as oil phase, surfactants, co-surfactants, and gelling agents, as shown in **Table III**.

## CONCLUSION

Topical nanoemulgel formulation is one of the effective strategies to penetrate the stratum corneum barrier as one of the major challenges of topical administration without disturbing the structure of the skin layer by utilizing intercellular and intracellular transport mechanisms and the role of nanoemulgel components in overcoming the limitations of the formulation consisting of oil phases, surfactants, co-surfactants, and gelling agents that can lower surface tension and improve drug adhesion. Topical nanoemulgel formulations can be used to treat several diseases, such as inflammation, arthritis, wounds, fungal infections, bacterial infections, *and psoriasis*. Therefore, this topical nanoemulgel formulation could provide promising potential for the topical delivery of lipophilic drugs in the future.

.

## REFERENCES

Abdallah, M.H. et al. (2021) 'Preparation, Characterization and Evaluation of Anti-Inflammatory and Anti-Nociceptive Effects of Brucine-Loaded Nanoemulgel', Colloids and Surfaces B: Biointerfaces, 205(May), P. 111868. Available at: Https://Doi.Org/10.1016/J.Colsurfb.2021.111868.

Algahtani, M.S. et al. (2021) 'Thymoquinone Loaded Topical Nanoemulgel for Wound Healing: Formulation Design and In-Vivo Evaluation', Molecules, 26(13), Pp. 1–16. Available at: Https://Doi.Org/10.3390/Molecules26133863.

Amit, C. et al. (2019) 'Formulation and Evaluation of Ginger Extract Loaded Nanoemulgel for The Treatment of Rheumatoid Arthritis', 9(4), Pp. 559–570.

Bhattacharya, S. and Prajapati, B.G. (2017) 'Formulation and Optimization of Celecoxib Nanoemulgel', Asian Journal ofPharmaceutical and Clinical Research, 10(8), Pp. 353–365. Available At: Https://Doi.Org/10.22159/Ajpcr.2017.V10i8.19510.

Chen, J. et al. (2013) 'Mechanical, Rheological and Release Behaviors of a Poloxamer 407/Poloxamer 188/Carbopol 940 Thermosensitive Composite Hydrogel', Molecules, 18(10), Pp. 12415–12425. Available at: Https://Doi.Org/10.3390/Molecules181012415.

Das, S., Sharadha, M., et al. (2021) 'Formulation and Evaluation of Topical Nanoemulgel of Methotrexate for Rheumatoid Arthritis', International Journal of Applied Pharmaceutics, 13(5), Pp. 351–357. Available at: Https://Doi.Org/10.22159/Ijap.2021v13i5.41026.

Eid, A.M. et al. (2014) 'Preparation, Characterization and Anti-Inflammatory Activity of Swietenia Macrophylla Nanoemulgel', Journal of Nanomedicine and Nanotechnology, 5(2). Available at: Https://Doi.Org/10.4172/2157-7439.1000190.

Eid, A.M. et al. (2019) 'Antibacterial Activity of Fusidic Acid and Sodium Fusidate Nanoparticles Incorporated In Pine Oil Nanoemulgel', International Journal of Nanomedicine, 14, Pp. 9411–9421. Available at: Https://Doi.Org/10.2147/IJN.S229557.

Gadkari, P.N., Patil, P.B. and Saudagar, R.B. (2019) 'Formulation, Development and Evaluation of Topical Nanoemulgel of Tolnaftate', Journal of Drug Delivery and Therapeutics, 9, Pp. 208–213. Available at: Http://Jddtonline.Info.

Ghiasi, Z. et al. (2019) 'Enhancing Analgesic and Anti-Inflammatory Effects of Capsaicin When Loaded Into Olive Oil Nanoemulsion: an In Vivo Study', International Journal of Pharmaceutics, 559(September 2018), Pp. 341–347. Available at: Https://Doi.Org/10.1016/J.Ijpharm.2019.01.043.

Hussain, A. et al. (2016) 'Nanoemulsion Gel-Based Topical Delivery of an Antifungal Drug: In Vitro Activity and In Vivo Evaluation', Drug Delivery, 23(2), Pp. 652–667. Available at: Https://Doi.Org/10.3109/10717544.2014.933284.

Jufri, M. and Natalia, M. (2014) 'Physical Stability and Antibacterial Activity of Black Cumin Oil (Nigella Sativa L.) Nanoemulsion Gel', International Journal of Pharmtech Research, 6(4), Pp. 1162–1169.

Kesan, K. et al. (2017) 'Study on The Effect Of Oil Phase and Co-Surfactant on

Microemulsion Systems', Malaysian Journal of Analytical Science, 21(6), Pp. 1409–1416. Available At: Https://Doi.Org/10.17576/Mjas-2017-2106-23.

Kotta, S. et al. (2015) 'Formulation of Nanoemulsion: A Comparison Between Phase Inversion Composition Method and High-Pressure Homogenization Method', Drug Delivery, 22(4), Pp. 455–466. Available At: Https://Doi.Org/10.3109/10717544.2013.866992.

Kumar, A., Saw, R.K. and Mandal, A. (2019) 'RSM Optimization of Oil-In-Water Microemulsion Stabilized by Synthesized Zwitterionic Surfactant and Its Properties Evaluation for Application In Enhanced Oil Recovery', Chemical Engineering Research and Design, 147, Pp. 399–411. Available at: Https://Doi.Org/10.1016/J.Cherd.2019.05.034.

Kumar, D., Ali, J. and Baboota, S. (2016) 'Omega 3 Fatty Acid-Enriched Nanoemulsion of Thiocolchicoside for Transdermal Delivery: Formulation, Characterization and Absorption Studies', Drug Delivery, 23(2), Pp. 591–600. Available at: Https://Doi.Org/10.3109/10717544.2014.916764.

Md, S. et al. (2020) 'Improved Analgesic and Anti-Inflammatory Effect of Diclofenac Sodium by Topical Nanoemulgel: Formulation DevelopmentIn Vitro and In Vivo Studies', Journal of Chemistry, 2020. Available At: Https://Doi.Org/10.1155/2020/4071818.

Mittal, S., Ali, J. and Baboota, S. (2021) 'Enhanced Anti-Psoriatic Activity of Tacrolimus Loaded Nanoemulsion Gel Via Omega 3 - Fatty Acid (EPA and DHA) Rich Oils-Fish Oil and Linseed Oil', Journal of Drug Delivery Science and Technology, 63(March), P. 102458. Available at: Https://Doi.Org/10.1016/J.Jddst.2021.102458.

Paliwal, S. and Kaur, G. (2019a) 'Formulation and Characterization of Topical Nano Emulgel of Terbinafine', Universal Journal of Pharmaceutical Research [Preprint], (March). Available at: Https://Doi.Org/10.22270/Ujpr.V3i6.223.

Print, I. et al. (2015) 'World Journal of Pharmaceutical Sciences Formulation and Evaluation of Topical Nano Emulgel of Adapalene', World Journal of Pharmaceutical Sciences, 3(93), Pp. 1013–1024. Available At: Http://Www.Wjpsonline.Org/.

Raju, K. et al. (2019) 'Formulation and Evaluation of Ornidazole Topical Emulgel', World Journal of Pharmacy and Pharmaceutical Sciences Sjif Impact Factor, 8(7), P. 1180. Available at: Https://Doi.Org/10.20959/Wjpps20197-14181.

Shakeel, F. et al. (2013) 'Impact of Various Nonionic Surfactants on Self-Nanoemulsification Efficiency of Two Grades of Capryol (Capryol-90 and Capryol-PGMC)', Journal of Molecular Liquids, 182, Pp. 57–63. Available at: Https://Doi.Org/10.1016/J.Molliq.2013.03.011.

Sharma, B. et al. (2019) 'Resveratrol-Loaded Nanoemulsion Gel System to Ameliorate UV-Induced Oxidative Skin Damage: From In Vitro to In Vivo Investigation Of Antioxidant Activity Enhancement', Archives Of Dermatological Research, 311(10), Pp. 773–793. Available at: Https://Doi.Org/10.1007/S00403-019-01964-3.

Shende, P. and Gupta, H. (2020) 'Formulation and Comparative Characterization of Nanoparticles of Curcumin Using Natural, Synthetic and Semi-Synthetic Polymers for Wound Healing', Life Sciences, 253(December 2019), P. 117588. Available at: Https://Doi.Org/10.1016/J.Lfs.2020.117588.

Singh, B. et al. (2013) 'Optimized Nanoemulsifying Systems with Enhanced Bioavailability of Carvedilol', Colloids And Surfaces B: Biointerfaces, 101, Pp. 465–474. Available At: Https://Doi.Org/10.1016/J.Colsurfb.2012.07.017.

Tayah, D.Y. and Eid, A.M. (2023) 'Development of Miconazole Nitrate Nanoparticles Loaded In Nanoemulgel to Improve Its Antifungal Activity', Saudi Pharmaceutical Journal, 31(4), Pp. 526–534. Available at: Https://Doi.Org/10.1016/J.Jsps.2023.02.005.

Usman, M. et al. (2013) 'Thermodynamic Solution Properties of Pefloxacin Mesylate and Its Interactions with Organized Assemblies of Anionic Surfactant, Sodium Dodecyl Sulphate', Thermochimica Acta, 573, Pp. 18–24. Available at:

Https://Doi.Org/10.1016/J.Tca.2013.08.014.

Vartak, R. et al. (2020) 'Ebselen Nanoemulgel for The Treatment of Topical Fungal Infection', European Journal of Pharmaceutical Sciences, 148(April), P. 105323. Available at: Https://Doi.Org/10.1016/J.Ejps.2020.105323.

Yeo, E. et al. (2021) 'Tocotrienols-Rich Naringenin Nanoemulgel for The Management of Diabetic Wound: Fabrication, Characterization and Comparative In Vitro Evaluations', Current Research In Pharmacology and Drug Discovery, 2(December 2020), P. 100019. Available at: Https://Doi.Org/10.1016/J.Crphar.2021.100019.

.