ISSN: 2322-0066

Research and Reviews: Research Journal of Biology

NANOEMULSION: An Effective Therapy for Transdermal Drug Delivery

Rimmi Singh[1]*, Abhishek Chakravorty[1], Priya Kumar[2] and Ankita Chaturvedi[3]

[1]Lovely Faculty of Applied Medical Sciences, Lovely Professional University, Jalandhar, Punjab, India
[2]Department of Pharmaceutical Technology, Meerut institute of Engineering and Technology, Meerut, UP, India
[3]Department of Biotech, Utkal University, Bhubaneswar, Orissa, India

Mini Review

Received: 21st March, 2015
Revised: 25th March, 2015
Accepted: 30th March, 2015

***For Correspondence:**
Rimmi Singh
[1]Lovely Faculty of Applied Medical Sciences, Lovely Professional University, Jalandhar, Punjab, India, Tel: 7207148076; Email: rimmi.rajput70@gmail.com

Keywords: Transdermal drug delivery; Bioavailability; Gastrointestinal.

INTRODUCTION

Transdermal drug delivery is a well-known route of administration, in which active ingredients is delivered via skin for systemic distribution [1]. It is known to increase the bioavailability of drugs and to reduce the adverse effects [2]. Drug delivery via skin to the systemic circulation is suitable for a number of clinical conditions, because of those reason it has been a significant interest in this area [3]. Advantages of TDDS are as following [4-8]:

- TDDS bypasses the first pass metabolism effect due to which it is suitable for low bioavailability drugs [9]
- Controlled drug delivery over extended period of time [8]
- Self administration
- The drug can be eliminated at any time by removing the transdermal patch [9-11]
- Their transparent nature and fluidity, confers on nanoemulsion a pleasant skin feel
- Total absence of gastrointestinal side effects like irritation and bowel ulcers which are invariably associated with oral delivery.

The three routes by which drugs can primarily penetrate the skin are

1. Hair follicles,
2. Sweat ducts,

3. Directly across stratum corneum, which reduces the bioavailability by restricting their absorption to a large extent, whereas in case of dermatological disorder topical application of active ingredient enhances therapeutic efficacy [12,13].

For targeting the drug and to improve pharmacokinetics of drug, the primary skin barriers should be overcome [14]. The major disadvantages of transdermal application are possibility of local skin irritation due to an active substance or excipient [12]. Other disadvantages include vast absorption diversity due to differences in skin structure and thickness on different body parts. Long-term application transdermal drug on the same place can damage the skin by affecting its microflora and enzymes [12].

To overcome this issue and skin barrier effect, different modern techniques were developed. These techniques are classified as

1. Chemical (modification of drugs, using transdermal chemical penetration enhancers)
2. Physical (modification of drug particles size to nano size, physical enhancement techniques) [12]

Nano Drug Delivery System (NDDS) can enhance the bioavailability and solubility of marker compound by penetrating to cellular viral reservoirs [15-17]. Nowadays to promote the drug transport across the skin barrier, penetration enhancers are used. Nanoemulsions are composed of oil, surfactant, cosurfactant and aqueous phase. Nanoemulsions are considered as to improve transdermal permeation of many drugs (lipophilic drugs) over the conventional topical formulations such as emulsions, gels, ointements creams etc. Surfactants have the potential for the solubilization of the stratum corneum lipids and thus act as penetration enhancers [13]. The interaction between the enhancers and polar head groups of the lipids is the possible way to increase the penetration of poorly soluble drugs [13]. To explain the advantages of nanoemulsion as TDDS, 2 mechanisms have been proposed.

1. The high solubility potential for drugs of nanoemulsion system might increase thermodynamic activity towards the skin [18]
2. Ingredients of nanoemulsion, acting as penetration enhancers, might increase the flux of drug via skin [18]

Nanoemulsions contain surfactant compounds as its composition, and it helps inincreasing the membrane permeability and enhances transdermal transport [18]. According to literatures, NE can control drug release and bioavailability of many drug compounds [18]. Nanoemulsions are defined as isotropic, thermodynamically stable, transparent or translucent dispersions of oil and water which is stabilized by an interfacial film of surfactant molecules with droplet size of 20-500nm [19]. Ease of preparation and scale-up, stability and increased bioavailability are main features of

nanoemulsion, which have attracted the attention of researchers [19-23]. The various advantages of nanoemulsionincludes [24-27]:

- Increase in the rate of absorption
- Helps in solubilizing lipophilic drug
- Various route of administration like topical, oral and intravenous can be used to deliver the product
- Rapid and efficient penetration of the drug moiety
- Increases patient compliance
- Thermodynamically stable system and the stability allows self-emulsification of the system

Nano sized emulsions have following advantages over skin barrier that are given below:

- Easily penetrate the pores of the skin
- Reach the systemic circulation thus getting channelized for effective delivery
- Enhances the therapeutic efficacy

Table 1: Active compound encapsulated in Nanoemulsion for TDDS

S.NO.	Formulation	Active Ingredient	References
1	Nanoemulsion	Ibuprofen	22,28
2	Nanoemulsion Gel	Carvedilol	29
3	Nanoemulsion Gel	Etoricoxib	30
4	Nanoemulsion Gel	Betamethasone Valerate	31
5	Nanoemulsion	Lecithin	32
6	Nanoemulsion	Glibenclamide	33
7	Nanoemulsion	Turmeric oil	34
8	Nanoemulsion	Dithranol	35
9	Nanoemulsion gel	Beclomethasonedipropionate	36
10	Nanoemulsion gel	Aceclofenac gel	37, 24
11	Microemulsion	Methoxalen	38
13	Nanoemulsion	Indomethacin	18
14	Nanoemulsion	Clarithromycin	39
15	Nanoemulsion	Pterostilbene	40
16	Nanoemulsion	Felodipine	41
17	Nanoemulsions	Rice Bran oil	42

CONCLUSION

Application of nanoemulsions in transdermal drug delivery signifies an important area of research in drug delivery. It is also considered as a promising technique with many advantages including, high storage stability, low preparation cost, thermodynamic stability, absence of organic solvents, and good production feasibility [27]. These systems are being used currently to provide dermal and surface effects, and for deeper skin penetration. Many studies have shown that nanoemulsion formulations possess improved transdermal and dermal delivery properties in vitro, as well as in vivo. Nanoemulsions have improved transdermal permeation of many drugs over the conventional topical formulations such as emulsions and gels [9-11].

REFERENCES

1. Krishnaiah YSR. Pharmaceutical Technologies for Enhancing Oral Bioavailability of Poorly Soluble Drugs. J BioequivAvailab. 2010; 2: 28-36.
2. Ahmed T, et al. Bioavailability and Interaction Potential of Atorvastatin and Losartan on Co-administration in Healthy Human Subjects. J BioequivAvailab. 2009; 1: 18-27.
3. Parthasarathi D, et al. Analysis of Pharmacokinetic &Pharmacodynamic Models in Oral and Transdermal Dosage Forms. J BioequivAvailab. 2011; 3: 268-276.
4. Branvold A, Carvalho M. Pain Management Therapy: The Benefits of Compounded Transdermal Pain Medication. J Gen Practice. 2014; 2: 1-8.
5. Lin SL, et al. Enhancement of Transdermal Delivery of Indomethacin and Tamoxifen by Far-Infrared Ray-Emitting Ceramic Material (BIOCERAMIC): A Pilot Study. Transl Med. 2013; 3:1-5.
6. Meier-Davis SR, et al. Comparison of Metabolism of Donepezil in Rat, Mini-Pig and Human, Following Oral and Transdermal Administration, and in an in vitro Model of Human Epidermis. J Drug MetabToxicol. 2012; 3.
7. Meier-Davis SR, et al. Absorption, Distribution and Excretion Pattern of Oral and Transdermal Donepezil Hydrochloride after Single and Repeated Administration to the Rat. J Drug MetabToxicol. 2012; 3.
8. Malika V, et al. Nano-Carrier for Accentuated Transdermal Drug Delivery. J Develop Drugs. 2014; 3: 1-9.
9. Porras M, et al. Studies of formation of w/o nanoemulsions. Col Surf. 2004; 249: 115-118.
10. Haritha, et al. A brief introduction to methods of preparation, applications and characterization of nanoemulsion drug delivery systems. IJRPB. 2013; 1: 25-28.
11. Thakur Ajay, et al.Nanoemulsion in enhancement of bioavailability of poorly soluble drugs: A review, Pharmacophore. 2013; 4: 15-25.
12. Jampilek J. Transdermal Application of Drugs and Techniques Affecting Skin Barrier. J BioequivAvailab. 2013; 5:233-235.
13. Pandey A, et al. Role of Surfactants as Penetration Enhancer in Transdermal Drug Delivery System. J Mol Pharm Org Process Res. 2014; 2:1-10.
14. Lakshmi PK, et al. Transdermal Permeation Enhancement of Lamotrigine Using Terpenes. J Pharma Care Health Sys. 2014; 1: 1-6.
15. Shegokar R, Singh KK. Preparation, Characterization and Cell Based Delivery of Stavudine Surface Modified Lipid Nanoparticles. J NanomedBiotherapeutDiscov. 2012; 2: 2-9.
16. Liu R. Nanostructured Lipid Carriers as the Most Promising Approach in Ocular Drug Delivery System. J NanomedBiotherapeutDiscov. 2012; 2: 1.
17. Aliosmanoglu A, Basaran I. Nanotechnology in Cancer Treatment. J NanomedBiotherapeutDiscov. 2012; 2:1-3.

18. Barakat N, et al. Formulation Design of Indomethacin-Loaded NanoemulsionFor Transdermal Delivery. Pharm Anal Acta. 2011; S2: 1-8.
19. Caraglia M, et al. Nanotechnologies: New Opportunities for Old Drugs. The Case of Aminobisphosphonates. J NanomedicBiotherapeu Discover. 2011; 1: 1-2.
20. Vaghasia N, Federman N. Liposomes for Targeting Cancer: One Step Closer to the Holy Grail of Cancer Therapeutics? J NanomedicBiotherapeu Discover. 2011; 1:1-3.
21. Said N El, et al. Nanoemulsion for Nanotechnology Size-Controlled Synthesis of Pd (II) Nanoparticles via Nanoemulsion Liquid Membrane. J MembraSci Technol. 2013; 3: 2-6.
22. Salim N, et al. Phase Behaviour, Formation and Characterization of Palm-Based Esters Nanoemulsion Formulation containing Ibuprofen. J NanomedicNanotechnol. 2011; 2: 2-5.
23. Rocha- Filho PA, et al. Influence of Lavander Essential Oil Addition on Passion Fruit Oil Nanoemulsions: Stability and In vivo Study. J NanomedNanotechnol. 2014; 5: 2-11.
24. FaiyazShakeel, et al. Comparative Pharmacokinetic Profile of Aceclofenac from Oral and Transdermal Application Journal of Bioequivalence & Bioavailability. 2009;1: 13-17.
25. Kakumanu S, et al. A Self Assembling Nanoemulsion of Lovastatin (SANEL) Decreases Cholesterol Accumulation and Apob-100 Secretion Greater than Lovastatin alone a Hepg2 Cell Line. J NanomedNanotechol. 2012; 3: 1-4.
26. Rachmawati H, Haryadi BM. The Influence of Polymer Structure on the Physical Characteristic of Intraoral Film Containing BSA loaded Nanoemulsion. J NanomedNanotechnol. 2014; 5: 2-6.
27. Silva HR, et al. Surfactant-based Transdermal System for Fluconazole Skin Delivery. J NanomedNanotechnol. 2014; 5: 1-10.
28. Behzad Sharif Makhmalzadeh, et al.Optimization of Ibuprofen Delivery through Rat Skin from Traditional and Novel NanoemulsionFormulationsIran J Pharm Res. 2012; 11: 47–58.
29. Singh BhuwaneshPratap, et al. “Development and Characterization of ANanoemulsion Gel formulation for Transdermal delivery of Carvedilol”.Int J Drug Dev& Res. 2012; 4: 151-161.
30. R RLala N, GAwari.Nanoemulsion-based gel formulations of COX-2 inhibitors for enhanced efficacy in inflammatory conditions, ApplNanosci. 2014; 4:143–151.
31. Ali MdSajid, et al. Formulation,Characterization and In-vivo assessment of Topical Nanoemulsion of Betamethasone Valerate for psoriasis and dermatose.Int J Pharm. 2013;3: 186-199.
32. Huafeng Zhou, et al. Preparation and Characterization of a Lecithin Nanoemulsion as a Topical Delivery System.Nanoscale Res Lett. 2010;5: 224–230.
33. Abdul Bari Mohd, et al. Development and Validation of Glibenclamide in Nanoemulsion Formulation by using RP-HPLC.JPBMS. 2011; 8: 1-5.
34. Ali MdSajid, et al. Topical nanoemulsion of turmeric oil for psoriasis: characterization, ex vivo and in vivo assessment., International Journal of Drug Delivery. 2012;4: 184-197.
35. http://www.allindianpatents.com/patents/208817.
36. Ali MdSajid, et al. Formulation, Characterization and In-vivo study of nanoemulsion topical gel of beclomethasonedipropionate for psoriasis, World journal of pharmacy and pharmaceutical sciences. 2012;1: 839-857.
37. Jignesh D Modi, JayvadaN K Patel.Nanoemulsion-Based Gel Formulation of Aceclofenac for Topical Delivery, International Journal of Pharmacy and Pharmaceutical Science Research. 2011; 1: 6-12.

38. Shah Nirmal, et al. Formulation, design and characterization of microemulsion based system for topical delivery of antipsoriatic drug.World journal of pharmacy and pharmaceutical sciences. 2013; 3: 1464-1480.
39. StutiVatsraj, et al.Formulation of a Novel Nanoemulsion System for Enhanced Solubility of a Sparingly Water Soluble Antibiotic, Clarithromycin, Journal of Nanoscience.2014.
40. Yue Zhang, et al. Nanoemulsion for Solubilization, Stabilization, and In Vitro Release of Pterostilbene for Oral Delivery, AAPS PharmSciTech. 2014; 15: 1000-1008.
41. PoluriKoteswari, et al. Formulation and preparation of felodipinenanoemulsions. Asian Journal of Pharmaceutical and Clinical Research. 2011; 4: 116-117.
42. Daniela S Bernardi, et al. Formation and stability of oil-in-water nanoemulsions containing rice bran oil: in vitro and in vivo assessments. Journal of Nanobiotechnology. 2011;9.