NANOEMULSION: An Effective Therapy for Transdermal Drug Delivery

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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, ointments 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 in increasing 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 nanoemulsion includes [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>
<thead>
<tr>
<th>S.NO.</th>
<th>Formulation</th>
<th>Active Ingredient</th>
<th>References</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Nanoemulsion</td>
<td>Ibuprofen</td>
<td>22, 28</td>
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<td>Nanoemulsion Gel</td>
<td>Carvedilol</td>
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<td>Nanoemulsion Gel</td>
<td>Etoricoxib</td>
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<td>Nanoemulsion Gel</td>
<td>Betamethasone Valerate</td>
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<td>Nanoemulsion</td>
<td>Lecithin</td>
<td>32</td>
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<td>Nanoemulsion</td>
<td>Glibenclamide</td>
<td>33</td>
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<td>7</td>
<td>Nanoemulsion</td>
<td>Turmeric oil</td>
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<td>8</td>
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<td>Dithranol</td>
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<td>Nanoemulsion gel</td>
<td>Beclomethasone dipropionate</td>
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<td>Nanoemulsion gel</td>
<td>Aceclofenac gel</td>
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<td>11</td>
<td>Microemulsion</td>
<td>Methoxalen</td>
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<td>Indomethacin</td>
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<td>17</td>
<td>Nanoemulsions</td>
<td>Rice Bran oil</td>
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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


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