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Nanoemulsion as a Vehicle in Transdermal Drug Delivery

Ali A and Ahmad U*

Faculty of Pharmacy, Integral University, Lucknow, India

*Corresponding author:
Dr. Usama Ahmad

usamaahmad.10@outlook.com

Assistant Professor, Faculty of Pharmacy, Integral University, Lucknow.

Tel: 0522 289 0730

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Abstract

With the progress in time and advances in science and technology, dosage forms have evolved from traditional systems of simple mixtures, syrups and tablets, to highly sophisticated techniques, which are referred to as novel drug delivery systems. An ideal drug delivery system fulfils the objective of maximizing therapeutic effect while minimizing toxicity. Nanoemulsions are proposed for numerous applications in pharmaceutical sciences as drug delivery systems because of their capacity to solubilize non-polar active compounds. Nanoemulsions have been widely used in development of cosmetic products. One of the versatile applications of nanoemulsions is in the transdermal drug delivery where they act as efficient carriers for bioactives, facilitating ease of administration.

Keywords: Nanoemulsion; Transdermal; Bioavailability

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Introduction

The term Nanoemulsion is derived from two words i.e. Nano and Emulsion, meaning emulsion whose particle size is in nanometer range i.e. 10^{-9} m. The term mini emulsion was also used for nanoemulsion [1-3]. Basic component which are required for the formulation of nanoemulsion are surfactant, co-surfactant, co-solvent, oil and water which forms an isotropic, thermodynamically stable, transparent or translucent system with mean droplet size of 100 nm [4-8]. Due to its small size, it has the potential to cross the biological membrane and thereby increasing the therapeutic efficacy of a drug molecule. Furthermore, the advantage associated with nanoemulsion is that is has minimum adverse effect and toxic reactions.

Transdermal drug delivery system

Transdermal drug delivery systems (TDDS) are designed by incorporating several technologies to deliver therapeutic amount of drug to patient's body through skin. Last 25 years have revolutionized the Transdermal system and has become one of the most promising drug delivery system offering variety of clinical benefits over other dosage forms. In TDDS skin is used as a medium through which the drug loaded nano particles are dispensed [9,10].

Nausea, vomiting, motion sickness were the conditions for which the first Transdermal patch was approved in 1981 for the relief of symptoms. Since then there are approx. 35 transdermal products which contains at least 13 approved molecules [11]. According to a report by Jain Pharma Biotech, the value of the global market for transdermal delivery was $12.7 billion in the year 2005 and was expected to increase to $21.5 billion in the year 2010 and $31.5 billion in the year 2015. Creams, ointments, and lotions are the conventional transdermal drug delivery vehicles which treats mostly local skin diseases is now changing at a rapid rate towards more advanced level. Solvay Pharmaceuticals' Androgel testosterone gel delivers male sex hormone systemically through topical application.

Preferences of patient as well as physician is changing from creams to patches which has led to the exponential growth of transdermal drug delivery system in therapeutic class including hormone replacement, analgesia, relief of chest pain brought on by heart disease, smoking cessation, and neurological disorders.

Passive patches where used until recent, that were based on simple diffusion across the skin. The technology of passive patches is still developing and fabricating smaller patches with better adhesion. In active patches compounds having size range over 500 Dalton and those with challenging physical properties can be driven through the skin barrier. This property has led to the development of active patches to deliver pain management drugs, proteins, and vaccines. These patches continue to control the hormone market and CNS segments with CNS providing the most growth due to entry into new disease indications.

Nanoemulsion in transdermal drug delivery system

Researchers have shown a considerable interest in field of Transdermal drug delivery system because the drug delivery through skin to the blood is convenient for number of clinical conditions [12,13].

The advantages of this system are as follows:

1. Self-administration is possible.
2. Steady state-controlled drug delivery over extended period of time.
3. The patient can remove the patch and the input of drug can be eliminated.
4. One of the disadvantages associated with oral drug delivery is gastro intestinal side effects like irritation and bowel ulcers which can be totally eliminated in this system.

Parkinson's and Alzheimer diseases, anxiety, depression etc. are the conditions for which transdermal patches have been developed.

Disadvantages associated with this system are:

1. Skin poses a major barrier for the effective penetration of drug molecules.

2. Hair follicles, sweat ducts, stratum corneum are the 3 routes through which the drug penetrates the skin and these routes restrict the absorption of drug to a large extend and limit their bioavailability.

If primary skin barriers can be overcome, then improved drug pharmacokinetic and targeting can be achieved. Also, the locally applied drug redistribution through cutaneous blood and lymph vessel system needs to be controlled.

Nanotechnology has greatly succeeded in overcoming this hurdle by using nano sized particles [14,15]. Due to their decreased sized nanoemulsion can easily penetrate through the skin pores and reach the blood and can show effective drug delivery with increased therapeutic effect. Drug penetration through skin can be increased by number of ways like if the drug and vehicle properties are optimized for e.g. when the drug is at its maximum thermodynamic activity like in case of supersaturated solution maximum penetration of drug can be observed [16-18].

Discussion

For the treatment of different type of cancer caffeine has been used by oral routes. Water in oil nanoemulsion formulations of caffeine has been developed for transdermal drug delivery. On comparison between water in oil nanoemulsion and aqueous solution of caffeine for *in vitro* skin permeation profile the water in oil nanoemulsion of caffeine showed significant increase in permeability parameter [19].

Magnetic nanoemulsion is a new approach for cancer therapy. These can deliver photosensitizers like Foscan to deep tissue layers across the skin thereby inducing hyperthermia for subsequent free radical generation. This methodology can be used for the treatment of cancer in the form of photodynamic therapy [20]. Researcher have reported the comparative pharmacokinetic profile of aceclofenac obtained from oral delivery and transdermal application inferring that the absorption of this drug in the latter case resulted in 2.95-fold increase in bioavailability [21].

Conclusion

Use of nanoemulsions in transdermal drug delivery represents an important area of research in drug delivery, which enhances the therapeutic efficacy and also the bioavailability of the drugs without any adverse effects. It is also regarded as a promising technique with many advantages including high storage stability, low preparation cost, thermodynamic stability, absence of organic solvents, and good production feasibility. They have also made the plasma concentration profiles and bioavailability of drugs reproducible. These systems are being used currently to provide dermal and surface effects and deeper skin penetration.

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