Nanoemulsions as topical delivery for anti-psoriatic drugs (subject review)

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ABSTRACT

Psoriasis is an autoimmune disease in which hereditary and environmental factors play a key influence, with an estimated global prevalence of 2–5%. Furthermore, available treatment methods are linked to both an unflattering visual look and toxicities, resulting in poor patient compliance over time. The potential for nanotechnology-based drug delivery systems to improve the bioavailability and effectiveness of pharmaceuticals in their dose forms, particularly lipophilic medications, is enormous. The lipid imbalance and normal moisturizing factors can be overcome with a lipid-based carrier system. Nanoemulsions, as a novel carrier, appear to have the potential to solve a number of issues associated with topical anti-psoriatic therapy. This delivery technique could be a viable option for treating psoriasis on the skin.

Keywords: Psoriasis, Nanotechnology, Nanoemulsions

Introduction

Psoriasis is a type of autoimmune disease in which both genetic and environmental factors have a role. The disease's name comes from the Greek word "psora," which meaning "itch." Psoriasis is a non-contagious, dry, inflammatory, and unsightly skin illness that can affect a person's entire system [1]. It is characterized by sharply marginated scaly, erythematous plaques that grow in a somewhat symmetrical pattern and is mostly hereditary. The scalp, tips of fingers and toes, palms, soles, umbilicus, gluteus, under the breasts and genitals, elbows, knees, shins, and sacrum are the most usually afflicted areas [2].

Psoriasis affects both men and women equally and can strike at any age, though it most typically strikes between the ages of 15 and 25. In western populations, the prevalence of psoriasis is estimated to be around 2-3 percent [3].

Psoriasis does not spread from person to person by contact, however it can be passed down genetically (up to 25%) [4]. Psoriasis is more common among people in their forties and fifties. Females are more likely to develop it than males. Children are almost never impacted. White people suffer more than black people. Nearly a third of psoriasis patients suffer from arthritis. The condition usually begins when a person is around the age of 20.

Psoriatic arthritis affects 10 to 15% of the population. Psoriasis affects around 7 million people in the United States (2 percent to 3 percent of the population). Every year, between 150,000 and 260,000 new cases are diagnosed [5].

Nanotechnology is one of the most important topics in modern science because it allows scientists to develop astonishing nanoparticle (NP) size advances. NPs are defined as particles with a diameter of less than 100 nanometers. Metal NPs of the lowest feasible size are prepared using a variety of processes. Chemical, physical, photochemical, and organic procedures are the four broad categories of methodologies [6-7]. Existing antibiotics have new value thanks to nanotechnology, which reduces their size to nanoscale and increases cell permeability [8].

Psoriasis

Psoriasis is a skin and joint inflammatory disease that is autoimmune and noncommunicable. The word psoriasis is derived from the Greek words "Psora" (itchiness) and "iasis" (condition) [9]. The condition affects 2% of the global population, with a prevalence of roughly 4.6 percent in affluent countries [10]. Sharply delineated scaly, red, coin-sized skin lesions most commonly appear on the elbows, knees, scalp, hands, and feet. Itching, discomfort, stinging, and pain are some of the symptoms. Rarely, the entire body's skin surface can be affected [11].

The koebner phenomenon and Auspitz's sign are diagnostic signs for psoriasis [12]. The cause of this persistent illness is unknown. The most prevalent etiological factor is stress, and people with chronic illnesses such as Crohn's disease are more prone to get psoriasis. Beta-blockers, lithium, synthetic antimalarials, nonsteroidal anti-inflammatory medications (NSAIDs), and tetracyclines appear to have a substantial causal association with psoriasis. The risk of cardiac co-morbidities is higher in patients with a severe form of this condition [13].

Pathophysiology

The pathogenesis of this chronic inflammatory disease is mostly unknown, although it is known that when antigen comes into contact with keratinocytes, dendritic cells, also known as Antigen Presenting Cells (APC), detect stress signals. This activates naive T cells even more, resulting in the production of numerous cytokines that allow naive T cells to differentiate into effector cells such as Th1, Th2, and Th17. Interferon (IFN-a), tumor necrosis factor (TNF-a), and interleukin (IL2) are now secreted by each differentiated effector cell [14].

The presence of two distinct cytokines, IL-12 and IL23, is required for the development of naive T cells into Th1 and Th17 cells, respectively. TNF-a, IFN-a, and IL-2 release are aided by Th1 cells. As a result, APC secretes more signals, which activates more T cells. Th17 cells release IL-17, a key cytokine in psoriasis pathogenesis, and IL-23 enhances Th17 cell production of IL-17A, IL-17F, and IL-22 [15-16].

Diagnosis

The look of the skin is frequently used to diagnose psoriasis. Psoriasis does not require any particular blood tests or diagnostic procedures. To rule out other illnesses and confirm the diagnosis, a skin biopsy or scraping may be required. If you have psoriasis, a biopsy of your skin will reveal clubbed Rete pegs. When the plaques are scraped, there is pinpoint bleeding from the skin below, which is another symptom of psoriasis. Clinical examination is a simple way to diagnose psoriasis. Although no tests are usually necessary to diagnose psoriasis, blood tests, urine tests, and imaging examinations are frequently used to rule out additional problems. To distinguish it from a fungal infection, a biopsy may be required. Total count, ESSR, RA factor, ASO titre, serum uric acid level, T-cells, and other blood tests are performed. Increased T-cell lymphocytes and leucocytosis are frequently observed. Only lymphocytes can be seen infiltrating the discharges or blister fluid under a microscope. Imaging examinations such as an X-ray or a

bone scan can aid in the diagnosis of joint discomfort [17].

Treatment

Emollients, dithranol, tar, deltanoids, corticoids, tacrolimus) and systemic (methotrexate, cyclosporin, acitrecin, hydroxyurea, fumarates) treatments are available, as well as UV light therapy. When topical therapies are ineffective, phototherapy and systemic medicines should be employed. A growing number of biological therapies are being developed as new systemic treatments for psoriasis. These are proteins (typically antibodies) that have a very narrow range of functions. Symptoms of severe psoriasis, such as erythrodermic and widespread pustular psoriasis, can be life-threatening and necessitate hospitalization [18].

There can be substantial variation between individuals in the effectiveness of specific psoriasis treatments. Because of this, dermatologists often use a trial-anderror approach for finding the most appropriate treatment for their patient. The decision to employ a particular treatment is based on the type of psoriasis, its location, extent and severity. The patient‟s age, sex, quality of life, comorbidities, and attitude toward risks associated with the treatment are also taken into consideration [19].

Nanoemulsions

Nanospheres (drug nanoparticles in polymer matrix), nanotubes (sequence of nanoscale C60 atoms arranged in a long thin cylindrical structure), nanoshells (concentric sphere nanoparticles consisting of a dielectric core and a metal shell), nanocapsules (encapsulated drug nanoparticles), lipid nanoparticles (lipid monolayer enclosing a solid lipid core), and dendrimers are all examples of nano (nanoscale three-dimensional macromolecules of polymer). NEs are a type of dispersed particle utilized in pharmaceutical and biomedical aids and vehicles, and they have a bright future in cosmetics, diagnostics, medication therapies, and biotechnologies. Oil-in-water (o/w) emulsions with mean droplet diameters ranging from 50 to 1000 nm are known as NEs. The average droplet size is usually between 100 and 500 nanometers. The particles can exist in two forms: water-in-oil and oil-in-water, with the core of the particle being either water or oil. Surfactants allowed for human consumption and common food ingredients that have been deemed "Generally Recognized as Safe" (GRAS) by the FDA are used to make NEs. These emulsions may be easily made in large quantities by combining a water-immiscible oil phase with an aqueous phase using a high-stress, mechanical extrusion technique [20].

Characterization of nanoemulsion

Transmission electron microscopy, NE droplet size analysis, viscosity determination, refractive index, in vitro skin penetration studies, skin irritation test, in vivo efficacy study, thermodynamic stability investigations, and surface properties are some of the characterization criteria for NE. The surface charge of NE droplets has a significant impact on the emulsion system's stability as well as droplet in vivo disposition and clearance (Figure 1). The inset (fig. 1) displays a greater magnification microscopy image. NE droplets ranged in size from 25 to 40 nanometers, with some particle aggregates of 100 to 150 nanometers [21].

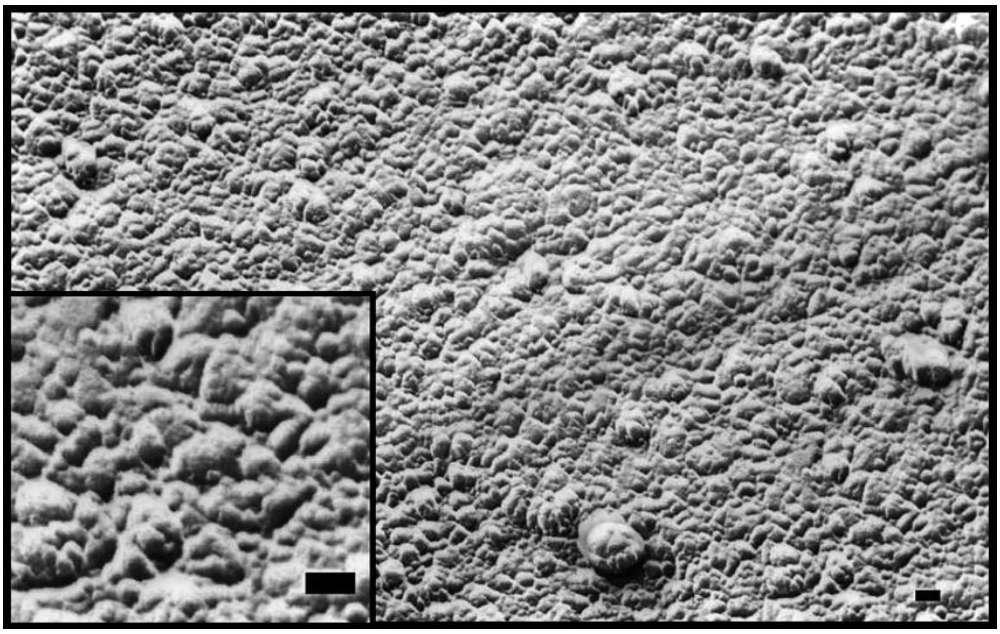

Figure (1): Freeze fracture electron microscopy image of paclitaxel nanoemulsions formulated using 20% oil phase (pine nut oil) and egg phosphatidylcholine as surfactant and deoxycholic acid as co-surfactant

Nanoemulsions as topical delivery for anti-psoriatic drugs

Nanoemulsions are emulsions with droplet sizes less than 100 nanometers. Oil, water, and an emulsifier make up a standard nanoemulsion. Nanoemulsions can be made into a variety of dosage forms, including liquids, creams, sprays, gels, aerosols, and foams, and they can be delivered by topical, oral, intravenous, intranasal, pulmonary, and ophthalmic routes. They have a better solubilization capacity than simple micellar dispersions, as well as a higher kinetic stability than coarse emulsions, and are used in the cosmetics sector [22].

Advantages of Nanoemulsion

The small droplet size, which prevents traditional destabilizing phenomena like creaming, sedimentation, and coalescence, is a direct result of their long-term physical stability. When applied topically, the nanoemulsion's miniscale size and capacity to solubilize extremely hydrophobic medicines provide a mechanism to dramatically boost drug dissolution and, as a result, predicted systemic bioavailability via the trancellular route, as shown in figure 2. The drug is released from a nanoemulsion by partitioning it from the oil into the surfactant layer, then into the aqueous phase, avoiding occlusive effects [23].

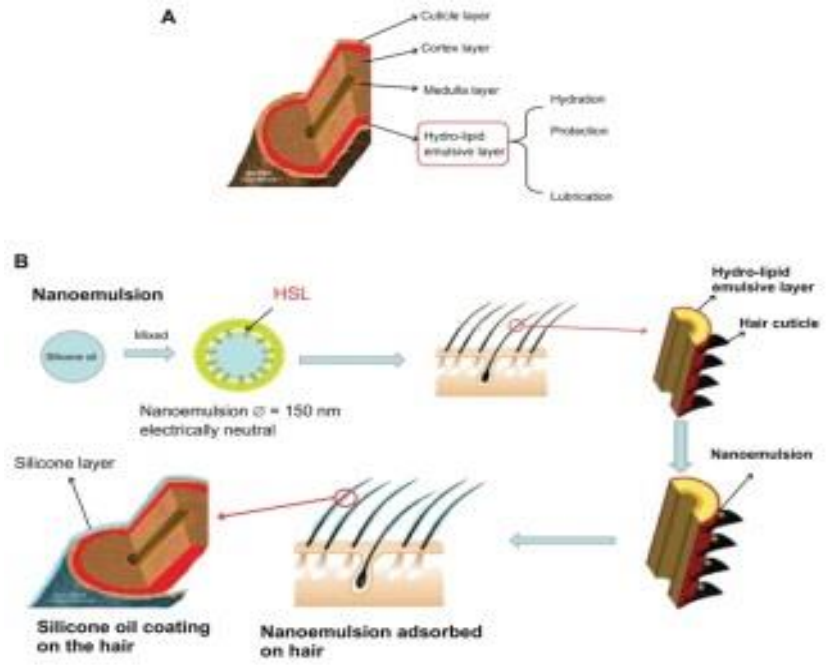

Figure (2): Mechanism of absorption of Nanoemulsion

Methods of preparation of nanoemulsion

As shown in Figure 3, there are two fundamental approaches for making nanoemulsion. High-energy emulsification technologies produce highly disruptive forces that cause the oil and water phases to intermix and form nanometer-sized droplets. Heat, stirring, and phase inversion are examples of low-energy emulsification processes [24].

1. High pressure homogenization

This is highly efficient method of preparation of nanoemulsion in which forcefully introduction of oil and water along with surfactants, cosurfactants are passed through a small orifice at high pressure. At first, emulsion is formed with large volume fraction of dispersed phase, which may be diluted later on. Excess amount of surfactants are added to avoid coalescence [25-26].

2. Microfluidisation

Water and oil are delivered from opposing directions into the mixing region through a small hole by a pressure pump, where they mix with other high shear and convert into small droplets, which are then used to make nanoemulsion [27].

3. Sonication

It is a frequently used approach in which a probe sonicator is inserted in a combination of oil and water with surfactants and cosurfactants to provide mechanical action, converting the dispersion into minute droplets [28].

4. Phase inversion temperature technique

In this technique at room temperature oil, water and surfactants are mixed and then temperature is increased, then surfactant mixed in the oily phase. Due to change in temperature phase inversion prevents coalescence and produce stable nanoemulsions [29].

5. Solvent displacement method

In this method nanoemulsions can be prepared by pouring the organic phase containing oil dissolved in a solvent into aqueous phase having surfactants at room temperature. The preparation of nanoemulsion occurs by diffusion of organic solvent, evaporated by vacuum. Small sized droplets of nanoemulsion can be prepared by taking appropriate ratio of solvent to oil [25].

6. Spontaneous emulsification

In the solution of oil and surfactant water is added at constant temperature and mixed lightly to produce o/w nanoemulsions. The

preparation of nanoemulsion depends on surfactant structure, its concentration, interfacial tension, interfacial and bulk viscosity, phase transition region [30-31].

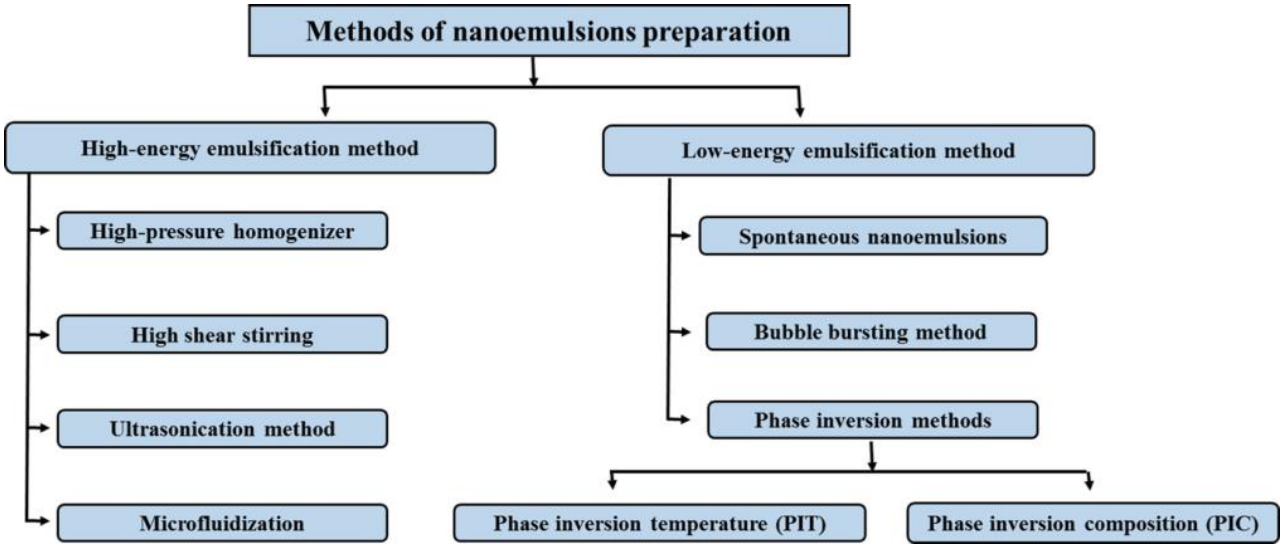

Figure (3): Methods of Preparation Nanoemulsion

Conclusion

Despite progress in understanding the mechanism of psoriasis and developing effective medications, the search for the appropriate therapeutic method for psoriasis remains a serious challenge. Psoriasis is a chronic condition that requires long-term treatment. Furthermore, there is still no safe, effective, patient-friendly, and cost-effective psoriasis delivery mechanism available. Nanoemulsions, as a novel carrier, appear to have the potential to overcome a variety of issues associated with topical antipsoriatic therapy. This delivery technique could be a viable option for treating psoriasis on the skin. The effectiveness of topical treatment for psoriasis depends not only on how nanoemulsions are made, but also on the active chemicals utilized and the oil chosen. A good combination of active and appropriate oils would result in a more effective treatment and effect.

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