International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 1057-1062 www.ijprajournal.com ISSN: 2456-4494

Nanocream: an advanced mode of cosmetic drug delivery system

Jacintha J Fernandes[1], Sumanji Bala[2]
Department of Pharmaceutics, Vivekananda College of Pharmacy Bengaluru-560055.

Date of Submission: 10-12-2024 Date of Acceptance: 20-12-2024

ABSTRACT
Nanoformulations play a crucial role in the delivery of active compounds to and through the skin for therapeutic purposes. They are elegant, simple, and inexpensive, offering significant delivery advantages over coarse emulsions. Nanotechnology is a significant technology that allows for innovative products, modifying various consumer products on a minute scale. One interesting field is nanocosmetics, where nanomaterials can be used to develop unique products. However, the production of UV filters in nano form may be more harmful due to their different behaviour. Extensive research has demonstrated the effectiveness of these delivery technologies, and the development of new excipients offers new opportunities for formulations with high delivery capacity and low irritancy and toxicity. Particle size measurement, pH, viscosity, spreadability and have been studied under different temperatures to evaluate the stability of nano-cream preparation. The industry and human life can be drastically modified with exceptional behaviour and properties of nanomaterials.

I. INTRODUCTION

In recent years, there has been a growing interest in topical vehicle systems for drug permeation through the skin. These systems are beneficial for problematic orally taken drugs like piroxicam, which is effective in anti-inflammatory, antipyretic, and analgesic applications.[1] Nano-cream/semi-solid emulsions are topical preparations applied to the outer surface, prepared using high-energy techniques like ultrasound generators, high-pressure homogenizers, or high shear stirring.[2] These droplets, with a particle size of 100-600 nm, allow uniform and smooth deposition of cream onto the skin surface, increasing the effective release of active drug ingredients for various diseases.[3]

Nanotechnology has significantly impacted the cosmetics and health products industry for nearly 40 years, with the increasing use of nanomaterials like liposome moisturizing creams. These materials include nanoemulsions and nanoparticles of natural minerals like copper, silver, titanium dioxide, silicon dioxide, alumina, zinc oxide, and calcium fluoride.[4] Drug molecules are transported through the skin through two processes: penetration through the stratum corneum and diffusion into deeper tissues. Size, log P, ionic strength, hydrogen bonding ability, and vehicle physicochemical characteristics influence the rate and degree of drug transport through the stratum corneum.[5]

1.1 The Penetration of Nanoparticles through the Skin:

The skin is composed of various layers, including the epidermis, dermis, hypodermis, and appendages. The epidermis is composed of keratinocytes, while the stratum corneum (SC) is a thin layer of about 10 µm. It consists of three main components: natural-moisturizing factor (NMF)-laden and lipid-bound corneocytes, corneodesmosomes, and lipids. The SC has a lamellar structure with well-structured lipid bilayers and performs barrier function due to its high content of proteins and lipids, including ceramides, fatty acids, and cholesterol.[6]Nanoparticles (NPs) that don't penetrate the skin can be used as photoprotective and antimicrobial agents, such as Ag-NPs, TiO2-NPs, ZnO-NPs, and calcium carbonate CaCO3-NPs. Recently, NPs have gained attention as carriers in transdermal drug delivery systems.[7]TDDS requires drug penetration through the skin barrier, bloodstream entry, and therapeutic concentration. Carriers with nanoparticles can enhance skin penetration, bioavailability, and immunogenicity, while also improving macromolecular compoundbioavailability.[8]

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 1057-1062 www.ijprajournal.com ISSN: 2456-4494

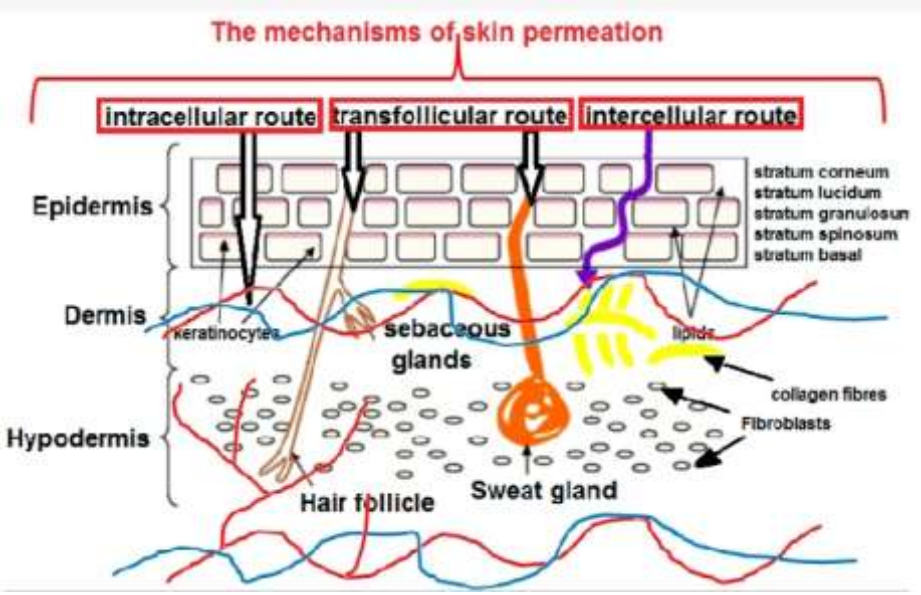

Figure 1. The schematic representation of the possible routes of the NP permeation through the multilayered structure of the skin together with its main components and blood vessels (artery-red, vein-blue).

1.2 Factors Affecting Skin Penetration

Skin penetration is influenced by factors similar to gastrointestinal absorption, with the rate of diffusion primarily influenced by the drug's physicochemical properties and secondarily by the vehicle, pH, and concentration. The hydration state of the stratum corneum is the primary physicochemical factor, which affects the rate of passage of substances that penetrate the skin. Hydration is crucial in occlusive plastic film in steroid therapy, as it prevents water loss and increases water concentration in the skin layer. The temperature of the skin and drug concentration are significant but secondary to hydration. The solubility of a drug determines the concentration presented to the absorption site, while the water or lipid partition coefficient influences the rate of transport. Small molecules penetrate more rapidly than large ones, but there is little correlation between size and penetration rate. Transdermal delivery depends on

- Release of the medication from the vehicle
- Penetration through the skin barrier
- Activation of the pharmacological response.[9]

1.3 Advantages of Nanocream

1. The use of nano cream is aimed to make fragrances last longer, sunscreens more effective, and anti-aging creams.
2. To optimize manufacturing conditions for skincare formulation, a multi-component system.
3. It keeps skin thriving with the help of different constituents that are rich in antioxidants.
4. The cream lightens the skin and helps get rid of marks that are a result of unequal arrangement and spread of melanin such as sunspots, age spots, and freckles.
5. It averts the occurrence of grey hair and also plays an important role in medical care given in the case of loss of hair. Additionally, it acts as a preservative to keep lightness and transparency of ingredients namely anti-oxidants as well as vitamins.
6. Another major advantage is that it protects from the harmful effects of UV radiation in conjunction with other substances called organic sunscreens such as 2- hydroxy-4- methoxy benzophenone. The purpose of organic sunscreens is to facilitate a decrease in the absorption of UV radiation.
7. most skin brighteners also have anti-aging effects. Such substances help to beautify the skin. This keeps the skin looking young and beautiful.
8. Nanomaterials used as UV filters in sunscreen products.[10]

1.4 Disadvantages of Nanocream

1. Smaller particles have a higher reactivity, are more chemically reactive, and produce more significant numbers of reactive oxygen species.
2. Nanoparticles of TiO2 that were photo-activated were found harmful to skin fibroblasts nucleic acids and human colon carcinoma cells.

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 1057-1062 www.ijprajournal.com ISSN: 2456-4494

3. It may cause oxidative stress, inflammation, and subsequent harm to proteins, membranes, and DNA.
4. However, certain ingredients such as hydroquinone, ammoniated mercury, and alcohol can be the cause of danger and result in severe and far-reaching health effects on the body.
5. Besides, ultrafine particles such as dust, coal, silicate, asbestos, etc. if inhaled cancause pulmonary inflammation. Such happenings can result in pulmonary fibrosis, cytotoxicity, and even malignancy.[11]

II. METHODS OF PREPARATION OF NANOCREAM

Nanocream/nanoemulsion can be prepared using high and low-energy methods. High-energy methods require mechanical devices to deliver disruptive forces, while low-energy methods don't require external power. Nano cream production uses the system's intrinsic physiological properties, utilizing stored energy through changes in parameters like temperature and composition.[12]At the initial studies of nano cream, the high energy methods were the only choice for research. Thus, high-energy stirring and ultrasonic emulsification were the most widely used methods for the preparation of nanocreams.[13]Low-energy methods are increasingly popular due to their softness, non-destructive nature, and lack of damage to encapsulated molecules.[14]

2.1 High–Energy Emulsification Method:

Nanocream, or nanoemulsions, are non-equilibrium systems that require mechanical or chemical energy input to be formed rapidly. They are typically prepared using high-energy methods like high-pressure homogenizers, high-shear stirring, and ultrasound generators.[15]Mechanical devices disrupt oil and water phases to form cream. High energy methods require a high input energy density of 108-1010 W kg^{-1} to obtain homogeneous small particles. High-pressure homogenizers are extensively used for nanocream preparation due to their potential to achieve this.[16]

2.2 High Pressure Homogenization:

Using a homogenizer, this method involves applying high pressure to a system with oil, aqueous, and surfactant phases. However, this method has problems like poor productivity, component deterioration, and heat generation. It can only prepare oil in water (o/w) liquid nanoemulsions with less than 20% oil phase, and nanocreams with high viscosity or hardness with a mean droplet diameter below 200 nm.[17]

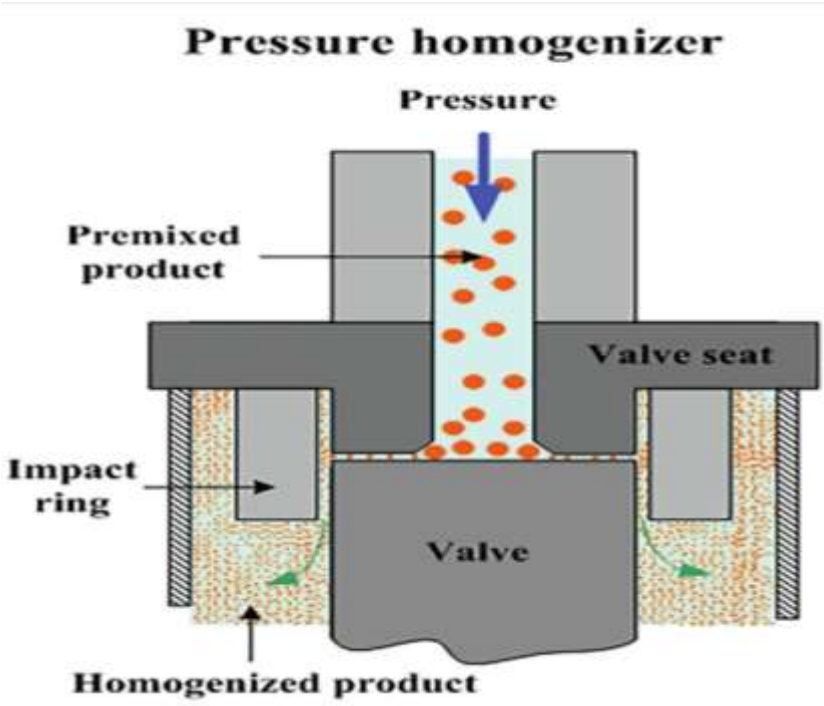

Figure 2: Schematic representation of high-pressure valve homogenizer.

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 1057-1062 www.ijprajournal.com ISSN: 2456-4494

2.3 High-Shear Stirring

Energy blenders and rotor-stator frameworks are currently used for nanocream production, which can reduce inward emulsion size by increasing their blending force, but obtaining emulsions with a typical bead size under 200-300 nm is challenging.[13]

2.4 Ultrasonication or Ultra emulsification

Ultrasonication or ultra emulsification is a method used to produce kinetically stable nanoemulsions. It involves a sonicator probe in contact with liquids containing surfactants and cosurfactants, generating mechanical vibration and cavitation to form small droplets. This process is commonly used for small-scale nanoemulsion production, but caution must be taken to prevent shear-induced coalescence. The particle size of the dispersed phase decreases with the duration of homogenization, power levels, and surfactant concentration. To achieve a 20 nm droplet size, optimization of ultrasonic reaction chamber design, operating conditions, and product formulation is necessary. However, sonication is not suitable for large-volume nanoemulsion preparation.[19]

2.5 Microfluidization

The pharmaceutical industry commonly uses a microfluidizer to produce nanocream or nanoemulsions, which are small, submicron-sized particles. This process involves applying high pressure to the particle interaction chamber, resulting in uniform nanocream or nanoemulsions. The microfluidizer's collaboration chamber impacts rough emulsion planes from two inverse diverts. The portability of unrefined emulsion is provided by a pneumatically fuelled siphon that can pack air up to 150-650 MPa. This high weight powers the unrefined emulsion stream to experience microchannels, resulting in a high degree of shearing power. Repeating this process multiple times and adjusting the operating pressure can achieve the desired particle size.[20]

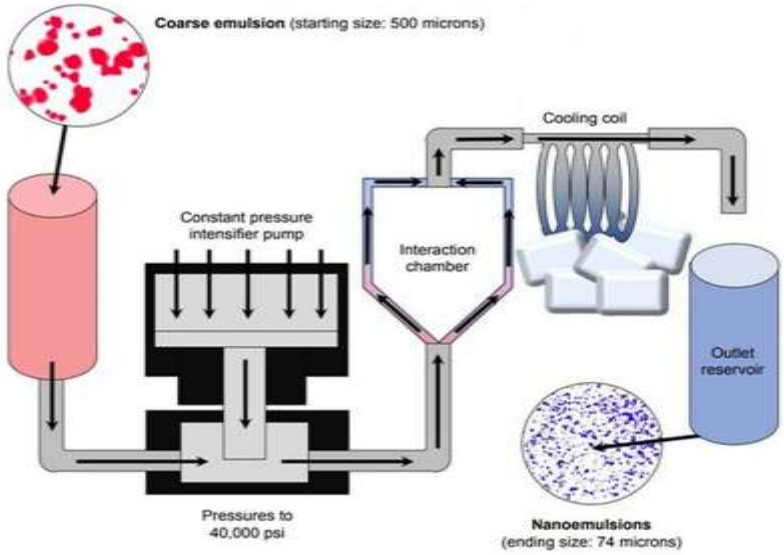

Figure 3. Microfuidization process for the preparation of nanodelivery system.

2.6 Phase Inversion Temperature

The phase inversion temperature (PIT) method, involves obtaining fine dispersion through chemical energy resulting from phase transitions in the emulsification path. This method is based on the changes in solubility of polyoxyethylene-type surfactants with temperature. As temperature increases, the surfactant becomes lipophilic due to polymer chain dehydration, while at low temperatures, it forms an oil-swollen micellar solution phase.[21]

III. GENERAL PARAMETERS FOR EVALUATION OF NANOCREAM

3.1 pH measurement

The pH of the preparations was measured using a pH meter after manufacturing for varying durations at room temperature.[22]

International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 6 Nov - Dec 2024, pp: 1057-1062 www.ijprajournal.com ISSN: 2456-4494

3.2 Viscosity Determination

The viscosity of the preparation was measured by using a Brookfield DV-E Viscometer selecting the appropriate spindle number.[23]

3.3 Particle size measurement

The particle size measurement was carried out by using the Particle Size Analyzer (PSA) with the Dynamic Light Scattering (DLS) method. The preparations were filled in a cuvette and entered into the Particle Size Analyzer to measure the droplet size.[24]

3.4 Spreadability

Two slides are taken and slipped off from the cream placed between the slides under a certain load. The time taken by the slide to slip off was noted. The spreadability was expressed in terms of time in seconds.[25]

3.5 Determination of Stability Study

Nanocream preparation was placed in a glass container and stored at two different temperatures. In the climatic chamber at a temperature of 40˚C±2˚C andRH 75%±5% for 4 weeks and at room temperature for 12 weeks.[26]

IV. PHARMACEUTICAL APPLICATIONS OF NANOCREAM

1. Topical drug applications target local tissues for dermatological effects.
2. Managing conditions like dermatitis, psoriasis, skin infections, and acne.
3. Nanocream is commonly used for sustained delivery, reducing drug administration frequency and providing a means to manage various conditions.[27]

V. CONCLUSION

Semisolid pharmaceutical dosages are commonly used in dermatology, including creams like moisturizing creams, sun lotions, baby lotions, and anti-aging creams. Nanotechnology has gained significant use in dermatology, cosmetics, and biomedical applications due to its perceived benefits. Recent inventions and novel delivery systems are being used to develop cosmeceutical products. Nanoproducts should be formulated to improve customer value and health, and nanotechnology has immense potential to transform the industry.

REFERENCES

[1]. Fakhry KR, Mohammed HK. Formulation and evaluation of diphenhydramine HCl release from different semi-solid bases (cream, gel and ointment). World J. Pharm. Res.2013;2(5):1-15.
[2]. Farahpour, MR., Habibi, M. Evaluation of the wound healing activity of an ethanolic extract of Ceylon cinnamon in mice. Vet. Med.2012; 1: 53–7.
[3]. Vishali K, Kapil KA.Comprehensive review on Nanocream. World J. Pharm. Res.2020; 9(4): 365-77.
[4]. Starzyk E, Frydrych A, Solyga A. Nanotechnology: does it have a future in cosmetics? SÖFW Journal. 2008; 134(6): 42– 52.
[5]. Roberts MS, Cross SE. Percutaneous absorption of topically applied NSAIDs and other compounds: Role of solute properties, skin physiology and delivery systems. Inflammopharmacology. 1999; 7: 339–50.
[6]. Mohd N, Ahmad UU, Salim N, Mohd Y. Lipid-based nanoparticles for psoriasis treatment: A review on conventional treatments, recent works, and future prospects. RSC Adv.2021;11: 29080–101.
[7]. Wang M, Marepally S.K, Vemula P.K, Xu C. Inorganic Nanoparticles for Transdermal Drug Delivery and Topical Application. Academia access. 2016;57-72.
[8]. Dianzani, C. Z, Maina G. P, Pettazzoni G. P. Pizzimenti S, Rossi F, Gigliotti C.L, Ciamporcero, E.S, Daga, M, Barrera, G. Drug delivery nanoparticles in skin cancers. Biomed. Res. Int. 2014;895-986.
[9]. Harsha V.S, Lalit G.P, Vikrant V. C, Chandrashekhar A. D. Nanocream: A Review Nanotechnological Aspect. Int. J. Recent Sci. Res. 2017;8(5):17105-107.
[10]. Singhal M, Khanna S, Nasa A. Cosmeceuticals for the Skin: An Overview. Asian J. Pharm. Clin. Res.2011; 4(2): 1-6.
[11]. Dureja H, Kaushik D, Gupta M, Kumar K, Lather V. Cosmeceuticals: An Emerging Concept. Indian J. Pharmacology. 2005; 37(3): 155-59.
[12]. Paliwal S, Kaur G, Arya KK Rajeshwar. Formulation and characterization of topical nanoemulgel of terbinafine.

Universal Journal of Pharmaceutical Research, 2018; 3(6): 28-37.

[13]. KorolevaMY,YurtovEV. Nanoemulsions: the properties, methods of preparation and promising applications, Russian Chemical Reviews, 2012; 81(1): 21-43.

[14]. Anton, N., Benoit, J.P., and Saulnier, P., Design and production of nanoparticles formulated from nano-emulsion templates-A review, Journal of Controlled Release, 2008; 128: 185-99.

[15]. Algin YE, Beskan U, Karavana SY. A recent overview of locally administered topical otic dosage forms. Universal Journal of Pharmaceutical Research, 2019; 4(4): 47-50.

[16]. Solans, C, Izquierdo P, Nolla J, Azemar N, Garcia-Celma M.J. Nano-emulsions, Current Opinion in Colloid & Interface Science. 2005; 10: 102-10.

[17]. Floury J, Desrumaux, Axelos MAV, Legrand J, Effect of high pressure homogenisation on methylcellulose as food emulsifier, J. Food. Engg, 2003; (58): 227-38.1

[18]. Hadziabdic J, Orman D, Elezovic A, Vranic E, Rahic O. Preparation of nanoemulsions by high energy and low energy emulsification methods. IFMBE Proceeding. 2017;62:317-22

[19]. Chime SA, Kenechukwu FC, Attama AA. Nanoemulsions-Advances in Formulation, Characterization and Applications in Drug Delivery, Ali DS, Application of Nanotechnology in Drug Delivery. Crotia: In Tech, 2014; 77-111.

[20]. Shinoda K, Saito H. The effect of temperature on the phase equilibria and the type of dispersion of the ternary system composed of water, Cyclohexane and nonionic surfactant, J. Colloid Interface Sci, 1968; (26): 70-4.

[21]. Nur AY, Roswanira AW, Nursyaafreens A, Mariani AH, Norhayati MN, Rovina K. Ananas cosmosus peels extract as a new natural cosmetic ingredient: oil-inwater(o/w) topical nanocream stability and safety evaluation. Evidence-Based Complementary and Alternative Medicine. 2022;2022: 1-9

[22]. Sinko PJ. Pharmaceutical Physics and Pharmaceutical Science. 2006; 647-48.

[23]. Juniatik M, Hidayati K, Wulandari FP, Pangestuti N, Munawaroh N, Martien R. Formulation of nanoemulsion mouthwash combination of lemongrass oil and kaffir lime oil for anticandidiasis against candida albicans. Tradit. Med. J. 2017;22(1):7-15.

[24]. Nikhil NN, Kamalapurkar KA, PrashantSC. Formulation and evaluation of multipurpose herbal cream. Int. J. Current Pharm. Res. 2020;12(3):25-30.

[25]. Sumaiyah, Sumaiyah*, Meyliana. Formulation and evaluation of skin anti-aging nanocream containing canola oil. Indonesian J. Pharm. Clin. Res. 2021;4(1):47-58.

[26]. Kumari, V. S. Novel nanosystems for herbal drug delivery. World J. Pharm.. Pharm. Sci. 2017; 6.(5): 1447-63.