WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 11, Issue 12, 561-577. Review Article ISSN 2277– 7105

FORMULATION AND DEVELOPMENT OF TRANSDERMAL PATCHES OF IBUPROFEN WITH NOVEL PENETRATION ENHANCERS

Priti Prabhakar Deshmukh[1]*, Vaibhav Changediya[2] and Vikas Rajurkar[2]

[1]M. Pharm, Department of Pharmaceutics, Shri. Dhaneshwari Manav Vikas Mandal, Dr. Vedprakash Patil Pharmacy College, Georai Tanda, Paithan Road, Aurangabad, Maharashtra, 431002.

[2]Assistant Professor Department of Pharmaceutics, Shri. Dhaneshwari Manav Vikas Mandal, Dr. Vedprakash Patil Pharmacy College, Georai Tanda, Paithan Road, Aurangabad, Maharashtra, 431002.

Article Received on
01 July 2022,

Revised on 21 July 2022,
Accepted on 11 August 2022

DOI: 10.20959/wjpr202212-25317

***Corresponding Author**
Priti Prabhakar Deshmukh
M. Pharm, Department of Pharmaceutics, Shri. Dhaneshwari Manav Vikas Mandal, Dr. Vedprakash Patil Pharmacy College, Georai Tanda, Paithan Road, Aurangabad, Maharashtra, 431002.

ABSTRACT

When used orally, the non-steroidal anti-inflammatory medication ibuprofen causes stomach discomfort. To avoid this adverse effect, ibuprofen transdermal patches have been developed and evaluated. In this study, polyvinyl pyrrolidone (PVP) polymer basis was used to create Ibuprofen transdermal patches. As a penetration enhancer, four formulations with varying menthol concentrations were created. Menthol weight ratios to PVP ranged from 0% (F0), 5% (F1), 10% (F2), to 15%. (F3). Ibuprofen transdermal patches are assessed for their organoleptic properties as well as their weight homogeneity, thickness, drug content, and in vitro drug diffusion. These assessments revealed that every recipe had positive outcomes. After 180 minutes of in vitro diffusion, 1.7083 mg/cm2 of ibuprofen had diffused using Franz diffusion cells in phosphate buffer pH 7.4 medium. Due to substantial study into transdermal drug delivery, topical formulation has gained popularity during the past ten years. The range of therapeutic substances that can be administered to systemic circulation through the skin is therefore being expanded to include an increasing number of medications. Creams, ointments, gels, patches, and other commonly accessible dose forms for topical treatment are available. Due to the stratum corneum's barrier characteristic, the therapeutic advantages of the aforementioned topical formulations

are quite modest (SC). Chemical penetration enhancers (CPEs) are a tried-and-true method for overcoming SC's barrier feature. Many classes of new compounds have been tested for their ability to increase penetration, including SEPA (soft enhancement for percutaneous absorption), for instance.

INTRODUCTION

Non-steroidal anti-inflammatory drugs (NSAIDs) like ibuprofen are used to treat pain, reduce inflammation, and lower fever. Orally ingesting it causes gastrointestinal discomfort as a negative effect. As you take drugs more frequently, these adverse effects could get worse. Due to the drugs' high first-pass metabolism and brief elimination half-life, conventional forms of these products call for dosing at least three times per day, while sustained-release forms call for dosing twice daily. Due to the medication's prolonged use in the treatment of rheumatoid arthritis conditions, adverse side-effects such headaches, nausea, and vomiting as well as gastrointestinal discomfort may occur. The medicine has a modest daily dose, making it a candidate for design into a successful transdermal system that would obviate first pass metabolism, ensure more consistent plasma levels, and lessen side effects including gastrointestinal irritation. When compared to traditional delivery techniques like injectable and oral medications, transdermal drug delivery systems (TDDs) have a number of potential benefits. The skin's permeability, which makes it highly resistant to macromolecules and hydrophilic medicines and permeable to tiny molecules and lipophilic ones, is the main drawback of TDDs. The stratum corneum (SC), the top layer of skin, serves as the primary barrier and rate-limiting step for drug diffusion over the skin. In order to overcome the skin's resistance, a number of techniques have been devised, including the use of prodrugs, ion pairs, liposomes, microneedles, ultrasound, and iontophoresis. Liposomes (LPs) come in a variety of forms, including regular liposomes, niosomes, ethosomes, and transfersomes. Numerous LPs have been thoroughly researched for enhancing skin permeability.

Ibuprofen (IBU) is a highly effective nonsteroidal anti-inflammatory medication (NSAID) used to treat osteoarthritis and rheumatoid arthritis.[16–18] It has a low solubility in water. IBU is as effective at reducing inflammatory and pain symptoms, although it is less hazardous than other NSAIDs. Although IBU is generally safe and powerful, its imitators have poor solubility, poor integration, and poor skin penetration. Vesicles were employed in this work as a cutting-edge IBU transdermal medication delivery device. The system's physicochemical properties, such as particle size, surface charge, entrapment efficiency, loading efficiency,

stability, and in vitro skin permeation, were produced and assessed. The vesicle type (liposomes and transfersomes), the lipid makeup (cholesterol) of the liposomes, and the transfersomes (cholesterol and surfactants). A pharmaceutical product is applied to the skin as part of transdermal drug administration; the drug then permeates the epidermis and dermis and, in many instances, results in a dermal microcirculation. Contrary to parenteral administration, transdermal administration offers a non-invasive option, reduces the possibility of hazardous side effects, and avoids pre-systemic metabolism (oral route), enhancing bioavailability. Dendritic cells, which are found in the epidermis and dermis and play a critical role in immune responses, are encountered when pharmaceutical compounds are supplied to the skin and come into contact with them after penetrating through its layers.[3] The use of penetration enhancers as well as laser and light devices are some methods to facilitate and improve transdermal medication permeation. when in fractional mode.

The skin makes up 16% of the entire body. A dosage form called a transdermal drug delivery system (TDDS), commonly referred to as "patches" (non-invasive delivery), is made to spread medication across a patient's skin. With the aid of skin layers, the skin is the largest and most visible organ of the human body. Medication is administered as a sustained release, controlled release, or extendedrelease formulation and enters the bloodstream. Systems for transdermal delivery are intended to gain Since the 1950s, systemic blood levels have been used in the US. The FDA authorised transdermal SCOP, the first transdermal system, in for the purpose of preventing travel-related nausea and vomiting in 1979. The majority of transdermal patches are made to release the active component. The skin from a few hours to days after treatment. Here is especially helpful for preventative. Scopolamine was the first transdermal patch that the FDA approved in 1979 for motion sickness treatment. Nitroglycerine was the second patch that was authorised in 1981. Now a Currently, the market offers a number of patches for use on the skin. Several of these include clonidine, hormones, nicotine, fentanyl, testosterone, and more typically applied patches between 1 and 7 days under numerous circumstances. Most often, oral routes employed for drug delivery, but a number of significant flaws like a bad B.A., the first pass impact, and the capacity to cause medication levels to fluctuate in blood. Anti-analgesic medication administration via topical or transdermal means has grown in popularity in recent years due to its capacity to to deliver targeted, intensely localised pain alleviation unlike oral, direct delivery to a specific location of the body delivery of drugs.

Advantages of transdermal drug delivery system

1) First-pass metabolism is avoided.
2) Avoiding compatibility with the digestive system.
3) Reducing harmful side effects to a minimum.
4) Preventing changes in medication levels.
5) Keep powerful medicines' plasma concentrations stable
6) A delivery system known as a transdermal drug delivery system (TDDS) is a device that, when applied to a suitable skin surface, can to introduce the medication into the bloodstream at a concentration high enough to assure therapeutic effectiveness, a further oral medication restriction Transdermal delivery can be avoided administration.
7) Consistent drug penetration over the skin, enabling a constant blood drug level, frequently a The aim of therapy It accomplishes similar results to intravenous infusion. constant plasma levels, yet without intrusive procedures in nature.
8) If a medicine becomes poisonous, in addition. if transdermally applied, the results could be simply uninstalling the patch, moderated.
9) One option for drug administration is transdermal alternate method of patient delivery cannot take oral medication.

Disadvantages of transdermal drug delivery system

1) Some medications have a slow absorption rate into the skin, which may reduce the effectiveness of the treatment. Example: hydrophilic medications.
2) The elements that make up the TDDS formulation may cause localised edoema and skin irritation erythema.
3) A transdermal patch that has been damaged could inadequate release rate control.
4) The skin's barrier function shifts from on the same person, from one website to another depending on the individual and their age.
5) It is exceedingly difficult for patches to adhere to the skin.
6) It is inappropriate for medications with larger doses.
7) It is not appropriate for substances with greater molecular mass.
8) The skin and liver both process drugs, skin processes protein binding include.

MATERIAL AND METHODS

Material

Ibuprofen was provided by Micro Lab Baddi India as a gift sample. From SD Fine Chemical in Mumbai, India, and CDH Laboratory Pvt. Ltd. in Mumbai, respectively, Span 80 and Tween 80 were bought. We received soya phosphatidylcholine as a gift sample from Mumbai's HiMedia Laboratory pvt. Ltd. Analytical reagent grade chemicals and reagents made up the rest. Wuhan Senwayer Century Chemical provided APR (purity: 99.6 percent; MW: 460.5 g/mol), which was purchased (Wuhan, China). The manufacturer of Transcutol® P [Diethyleneglycol Monoethyl Ether] is Gattefossé in Barcelona, Spain. Durham Pharmaceuticals provided the permeation promoters Azone® [1-dodecylazacycloheptan-2-one] (Durham, UK). Sigma Aldrich was used to acquire the following chemicals: Carene [3-Carene], Decanol [1-Decanol], Limonene [(S)-4-Isopropenyl-1-methyl cyclohexene], Menthone [(2S,5R)-2-Isopropyl-5-methyl cyclohexanone], Nonane [n-Nonane], Pinene [(+)—P (Madrid, Spain). From Sigma and Thermo Fisher, reagents for histology processes were purchased.

Methods

Ibuprofen Maximum Wavelength Determination Ibuprofen solution 10 g/mL in pH 7.4 phosphate absorbance was measured to determine the maximum wavelength of the drug. buffering approach. As determined by the measurement findings, ibuprofen maximum 222.6 nm is the wavelength. Maximum Wavelength Metil Paraben Determination It was determined what methyl paraben's maximum wavelength was. by calculating the absorbance of a 4 mg/mL methyl paraben solution at pH 7.4 solution with phosphate buffers. Ibuprofen calibration curve determination The Ibuprofen standard solution was then diluted with pH 7.2. Placite buffer to create a series of dilutions with 4, 6, 8, 10, 12, and 14 mg of ibuprofen in each millilitre. Of solution. The aforementioned dilutions' absorbance was measured in UV visible at 221 nm and 255,8 nm in a spectrophotometer.

Anatomy of skin

An average person's skin makes up about 10% of their body weight and covers an area of 1.7 m2, making it the biggest organ in the human body. Human skin is a very effective self-repairing barrier meant to keep the insides in and the outsides out, therefore it appears to offer optimal and varied sites to inject therapeutic agents for both local and systemic action. Protection from physical, chemical, microbiological, UV radiation, and free radicals is the

main purpose of skin. Figure illustrates the three primary layers of human skin, which are also involved in thermoregulation and vitamin D production.

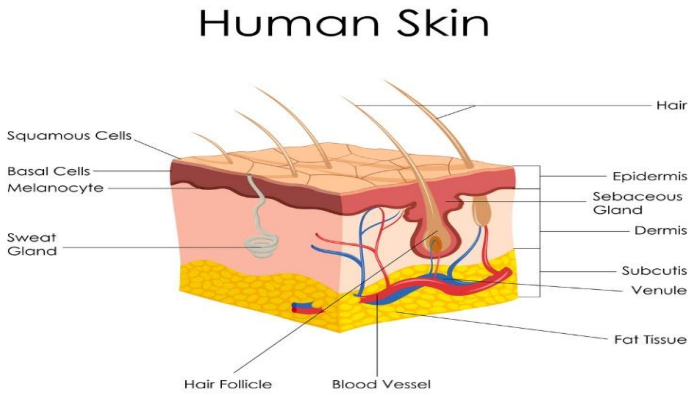

Figure 1: Anatomy of skin.

Route of penetration

The diffusion has two possible entry points into the living tissues: either through the epidermis itself, or by shunt channels that include masculine hair follicles and the sebaceous glands and sweat ducts that are connected to them.

There are the following two principal entry points

Penetration through the cornea

- Penetration inside cells
- Penetration of Intercellular

Mechanism of penetration enhancers

According to the Lipid Protein Partitioning (LPP) theory, there are three basic methods through which penetration enhancers work.

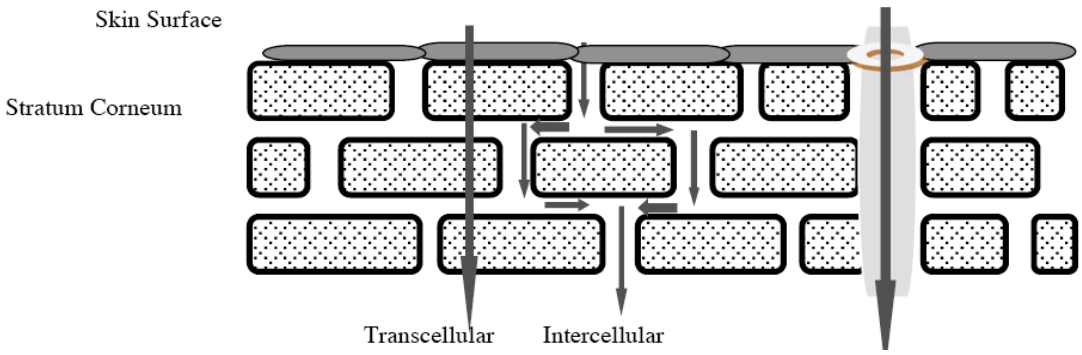

Fig. 2: Drug penetration enhancer.

1) The highly organised SC lipid structure is disturbed, and intercellular diffusivity rises. Terpenes and azones demonstrate this method.
2) Amplification of penetration via corneocytes through interaction withintracellular protein. Examples include pyrrolidones, dimethylformamide, and dimethyl lsulfoxide. The use of co-enhancers or cosolvents such propylene glycol and ethanol improves the partitioning of a medication into SC.
3) Corneocyte envelope disruption.
4) Impacts on squamae cohesion-related protein junctions, such as desmosomes.
5) The diffusion route alternates between dividing SC components and the lipid.

Complexity characterises PEs' general modes of operation. The majority of promoters interact with the intercellular lipid domain of SC at therapeutically appropriate doses. The fluidity of the intercellular lipids will thus be increased as the solute and/or solvent diffuse across the lipid area through interactions with the lipid tails (lipophilic enhancer and/or, with the disrupted polar head groups) (polar enhancers).

Lipids are extracted as a result, and the intercellular lipid's polarity may also shift. As a result of these processes, polar solvent interactions or the more lipophilic solvents in the lipid tail area may form pools or vesicles. Desmosomes and protein-like bridges may be destroyed by various enhancers, particularly hygroscopic chemicals, which will cause SC squames to split and intercellular lipid to fissure. Particularly when adverse situations exist.

The penetration boosters function in one of three ways

Lipid action: The enhancers cause the stratum corneum's lipid organisation to disorganize, increasing the stratum corneum's permeability and penetrat's diffusion coefficient. Numerous enhancers primarily function in this way (e.g., azone, fatty acids & DMSO). They could blend uniformly with the endogenous lipids or they might not.

Protein alteration: Substances like ionic surfactants, decylmethylsulfoxide, and DMSO can loosen the tight packing of keratin in corneocytes, improving their permeability by once more enhancing the proper diffusion coefficient. Additionally, these chemicals alter the peptide or protein composition of the bilayer domain and may potentially divide the stratum corneum, a procedure that is clinically inappropriate.

Partitioning promotion: The introduction of solvent changes the chemical environment and may lead to an increase in. Thus DMSO (above 60%) disturbs intercellular organization, extracts lipids, interacts with keratin and promotes partitioning of lipid drug.

Novel penetration enhancer

Numerous classes of novel compounds have been tested for their ability to increase penetration, such as soft enhancement for percutaneous absorption (SEPA), which includes substances like 2 Nnonyl- 1,3- dioxolanes, N-acetyle prolinate esters, pentyland octyl-N-acetyle prolinate, alkyldiloxanes, transcarbam, and iminosulfur ane (li)

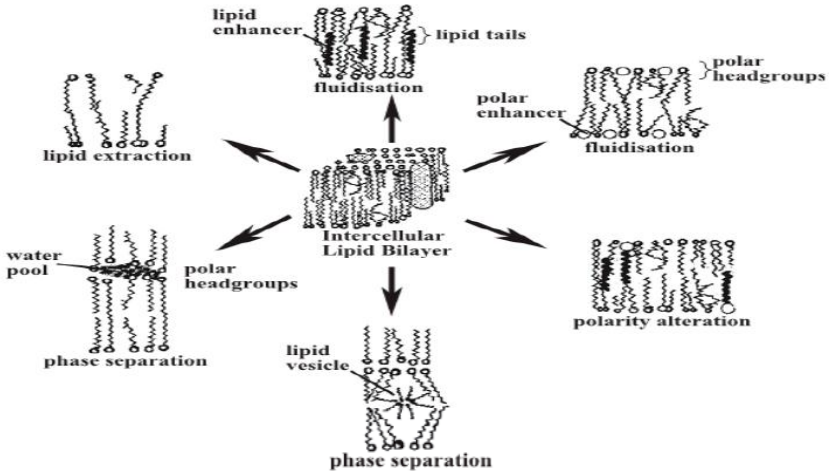

Fig. 3: Disruption of the highly ordered structure of SC lipid with an increase in intercellular diffusivity.

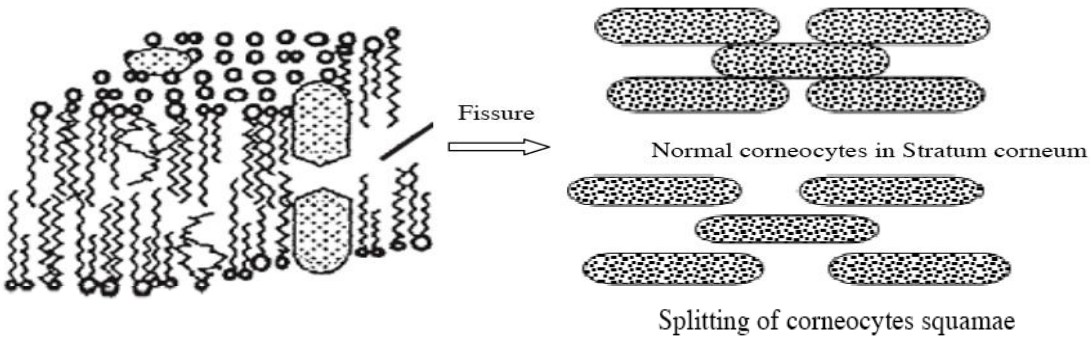

Fig. 4: Action at Desmosomes and Protein structures.

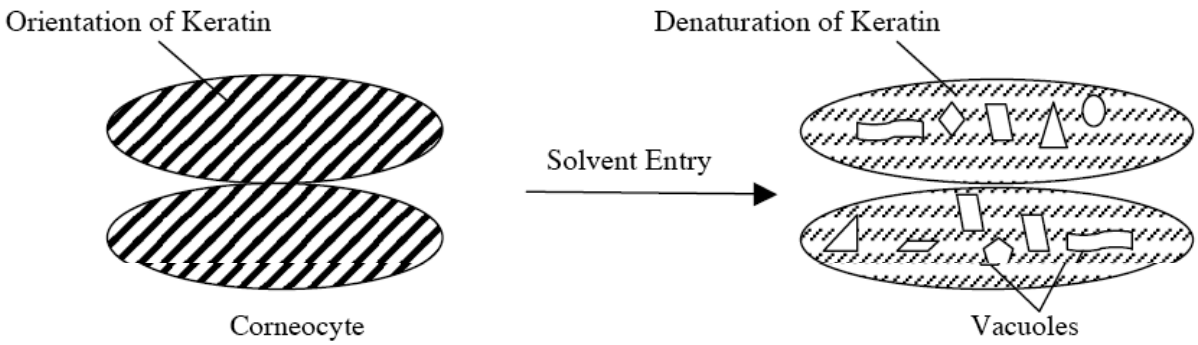

Fig. 5: Action on the corneocytes.

Soft enhancement for percutaneous absorption (sepa)

The term "SEPA" stands for "Soft Improvement of Percutaneous Absorption," where "soft" indicates that the enhancement of absorption is just momentary and reversible due to the enhancer's quick breakdown. To reduce the chance of being converted into a potentially hazardous substance, all SEPA family members are composed of carbon, hydrogen, and oxygen molecules without nitrogen molecules. The SEPA molecule 2-n-nonyl-1,3-dioxolanes (ND) is one example of a SEPA molecule. It is an amphiphilic chemical that has the ability to change the SC's lipid composition in a reversible manner. Drugs with smaller molecular weight can pass through the skin without creating a pathway for bacteria and viruses because SEPA alters the SC lipids to improve fluidity. Additionally, greater disorderiness alters the hydrophobic properties of the protein. reported that ND stimulates scalp hair growth in the balding stumptail macaque, which in turn affects the topical administration of minoxidil. In their study, minoxidil-SEPA (2.5 percent minoxidil, weight/volume in 10 percent SEPA, 25 percent propylene glycol, and 65 percent isopropyl alcohol) and Rogaine® topical solution (2 percent minoxidil, weight/volume in 20 percent propylene glycol, 60 percent ethanol, and 20 percent water) were topically applied to an inch2 area of balding scalp on a female monkey for five days per week for 16 weeks. Shaving was used to harvest scalp hair at intervals of four weeks. The removed hair was weighed, filtered, and recorded as the deviation from the norm. At the time specified, the minoxidil-SEPA groups showed a considerable rise in hair weight compared to their respective vehicles. For the aforementioned fact.

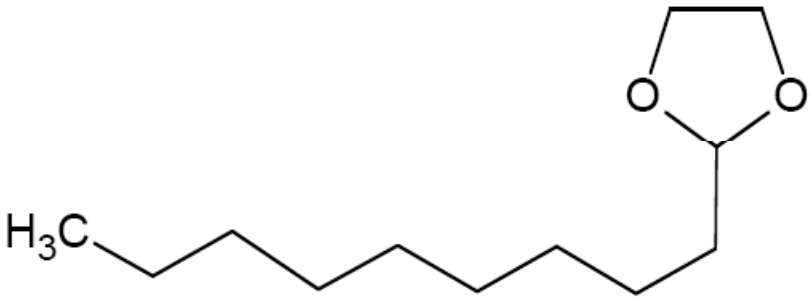

Fig. 6: 2-(1 nonyl)-1,3-dioxolane.

Scanner electron microscopy, differential scanning calorimetry, and Fourier transform infrared (FT-IR) techniques were used to examine the impact of SEPA on SC. (SEM). a material shift in location and intensity of SC lipids' thermal transition in the DSC and IR absorption band. were noticed. Additionally, SC was becoming looser. SEM analysis revealed cell packing.[42] These alterations were undone once SEPA had left the location. is

applicable. These outcomes unequivocally show that SEPA is able to alter the lipid matrix's structure in SC. In In a different study, ND made dapiprazole more permeable. When used in conjunction with propylene glycol, hairless mouse The model membrane chosen was skin. This discovery was due to the various mechanisms of action demonstrated by ND.

Examples of novel natural penetration enhancers

1. **Basil oil:** It naturally improves penetration. It is utilised to increase the drug's skin-crossing permeability. It serves as an antioxidant, diuretic, and antibacterial. The mechanism works by removing lipids from the stratum corneum and weakening the H-bonds between ceramide, which causes the lipid layer to fluidize.
2. **Clove oil:** It naturally improves penetration. It is utilised to increase the drug's skin-crossing permeability. It can be used without risk in toothpaste, drinks, and food. It also functions as an analgesic and an antiseptic.
3. **Capsaicin:** It is utilised as a penetration enhancer to make drugs more permeable to skin. For the treatment of pain, topical capsaicin formulations are employed. Mechanisms: There are numerous involved. One of these is receptor.

In vitro drug release studies

You can evaluate the drug release from the prepared patches using the paddles over disc method (USP apparatus V). A glass plate must be covered with dry films of defined thickness that have been cut into a specific form, weighed, and fastened with an adhesive. The device was then brought to an equilibrium temperature of 32 0.5 °C before the glass plate was submerged in 500 mL of the dissolving liquid or phosphate buffer (pH 7.4] The paddle was then turned on at a speed of 50 rpm while being placed 2.5 cm away from the glass plate. At suitable intervals up to 24 hours, samples (5-mL aliquots) can be taken out and examined using a UV spectrophotometer or HPLC.

In vivo study

The In vivo study involves:

a. Animal model
b. Human model

Animal model: The time and resources needed to conduct human studies can be a major factor in favouring animal studies. The most typical animal utilised to evaluate the transdermal patches on mice. Numerous studies carried out on these animals—hairless rat,

hairless dog, hairless rhesus monkey, rabbit, guinea pig, etc.—lead us to the conclusion. The rhesus monkey is the most trustworthy model for carrying out this experiment.

Human model: The application of the patch to human volunteers in order to acquire pharmacokinetic and pharmacodynamic data is the last step in the development of the transdermal device. Clinical trials were done using a variety of criteria, including patient compliance, risk involved, efficacy, and side effects. Phase 1 clinical trials are undertaken to assess the safety of volunteers, while Phase 2 clinical trials were mostly conducted to assess the patient's short-term safety and efficacy. Phase 3 trials show that the treatment is both safe and effective in a substantial number of individuals. For the commercialised patches, phase 4 studies are conducted during post-marketing surveillance to identify any negative medication reactions. Best case scenario Animal models are more readily available, easier to do experiments on, and have different toxicity and safety requirements than human models, which makes them a better choice for in vivo research. For animal studies, several species of mice, rats, dogs, monkeys, pigs, cats, rabbits, and squirrels are employed. For the evaluation of transdermal formulations, hairless animals are typically favoured over hairy animals. Human volunteers are studied during the formulation development process' final stages to ascertain the drug's pharmacokinetic and pharmacodynamic profile, as well as the formulation's safety and efficacy. IV stages are used in clinical experiments. A small group of volunteers participate in phase I trials to ascertain the safety and toxicity profile. Phase II trials are carried out on a small number of patients.

Transdermal drug delivery system

Effective drug distribution is necessary for optimal therapeutic results, in addition to adequate drug selection. The surface of the human skin is easily accessible for medication administration. The pharmaceutical industry has placed a growing emphasis on creating regulated drug delivery over the past three decades. Scopolamine (hyoscine) for motion sickness, clonidine and nitroglycerin for cardiovascular disease, fentanyl for chronic pain, and nicotine to help people quit smoking are all currently available in transdermal administration systems. Drugs having short biological half-lives can be continuously injected into the body through transdermal delivery, eliminating the need for pulsed systemic circulation.

Types of transdermal patches

a) **Single layer drug in adhesive:** In this case, the drug is contained in the adhesive layer. The adhesive layer is in charge of delivering the medicine onto the skin in addition to holding the other layers together. There is a backer and a temporary liner around the adhesive layer.

b) **Multi-layer drug in adhesive:** This kind is comparable to single-layer but includes a layer for quick drug release and another layer for controlled release in addition to the adhesive layer. The release of the medication is caused by the sticky layer. This patch also features a long-lasting backing and a short-term liner layer.

c) **Vapour patch:** This kind of patch uses an adhesive layer to hold the multiple layers together as well as to release essential oils, which is typically done to relieve congestion. There are many other kinds of vapour patches on the market that are designed to enhance sleep quality and lessen the effects of smoking.

d) **Reservoir system:** In this system, a membrane that controls flow rate is sandwiched between an impermeable backing layer and a drug reservoir. Only through the rate-controlling membrane, which may or may not be microporous, does the drug release. The drug may be present in the drug reservoir compartment as a solution, suspension, gel, or dispersed in a solid polymer matrix. A polymeric membrane with an outside surface that is hypoallergenic and medication compatible can be used.

e) **Matrix system**

i. **Drug-in-adhesive system:** In this kind of system, the drug reservoir is created by dispersing the medication in an adhesive polymer, which is subsequently dispersed by solvent casting or melting (in the case of hot-melt adhesives) on an impermeable backing layer. Unmediated sticky polymer layers are put on top of the reservoir for protection.

ii. **Matrix-dispersion system:** In this kind, a hydrophilic or lipophilic polymer matrix is used to disseminate the drug uniformly. This drug-containing polymer disc is housed in a compartment made from a drug-impermeable backing layer and bonded to an occlusive base plate. Instead of spreading the adhesive on the drug reservoir's face, it is spread around the perimeter to create a rim of adhesive.

f) **Microreservoir system:** This form of drug delivery system combines a matrix-dispersion mechanism and a reservoir. The drug reservoir is created by first suspending the drug in an aqueous solution of a water soluble polymer and then uniformly distributing the solution in a lipophilic polymer to create thousands of tiny, inaccessible drug reservoir

spheres. Using cross linking agents, the polymer is promptly cross-linked in situ, stabilising this thermodynamically unstable dispersion.

Evaluation parameters

1) Studies of interactions
2) Patch thickness
3) Weight homogeneity
4) folding toughness
5) Moisture content as a percentage
6) Moisture uptake as a percentage
7) Evaluation of water vapour permeability (WVP)
8) Drug usage
9) The dosage unit test's uniformity
10) Polariscope analysis
11) Shear Adhesion Test
12) Peel Adhesion Test
13) The thumb-tack test
14) Test for flatness.
15) Test for Percentage Elongation Break
16) Rolling ball tack test
17) Test using Quick Stick (peel-tack)
18) Test of Probe Tack
19) Research on in vitro drug release.
20) Studies on in vitro skin permeability
21) Study on Skin Irritation

Studies on stability permeation pathways through skin

Passive skin-to-skin diffusion of the compounds occurs during percutaneous absorption. The appendageal route and the epidermal route are two diffusional pathways that molecules can use to pass through normally undamaged skin.

a) Appendageal route: Transport via sweat glands and hair follicles with related sebaceous glands makes up the appendageal route. These paths are referred to as "shunt" routes because they avoid penetrating the stratum corneum. Due to its tiny size—roughly 0.1

percent of the overall skin area—this pathway is regarded as being of secondary relevance.

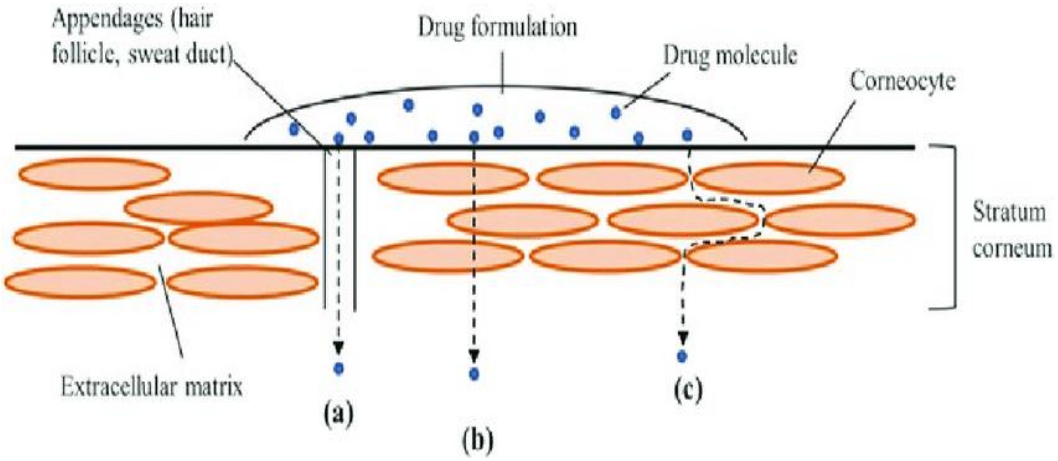

Fig. 7: Routes for drug permeation.

b) Epidermal route: The transcellular (intracellular) and intercellular pathways are two possible microroutes of entry for medications that mostly traverse the Horney layer.

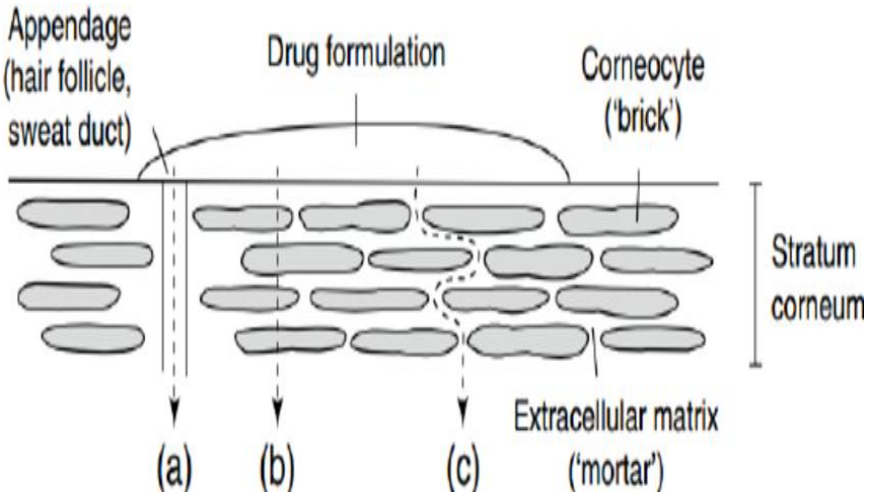

Fig. 8: Epidermal routes for drug permeation.

- **Transcellular:** This pathway refers to the movement of chemicals across the membrane of an epithelial cell. Small molecule passive transport, ion and polar compound active transport, and macromolecule endocytosis and transcytosis are a few of them.
- **Paracellular:** The term "paracellular route" refers to the movement of chemicals within or between cells. There are tight connections or other similar conditions between the cells. The partition coefficient primarily determines a permeant's primary path of travel (log k). While lipophilic permeants go through the stratum corneum via the intercellular pathway, hydrophilic medicines preferentially partition into the intracellular domains.

The majority of permeants penetrate the stratum corneum through both channels. However, the convoluted intercellular pathway is regarded as the main conduit and a significant obstacle to the penetration of most medicines.

Application of transdermal drug delivery system

1) Nicodermis, a nicotine transdermal patch sold to aid in quitting smoking. In the US, it is the most popular patch.
2) Two opioid drugs, fentanyl (marketed as Duragesic) and buprenorphine (marketed as BuTrans), are accessible as patches and are used to treat severe pain around-the-clock.
3) Estradiol patches, sold under the brand name Estraderm, are used to treat postmenopausal osteoporosis as well as menopausal symptoms. For menopausal symptoms, it is also offered in Climara Pro together with levonorgestrel.
4) Nitroglycerin transdermal patches are sometimes administered as an alternative to sublingual pills for the treatment of angina pectoris.
5) Clonidine is available as a transdermal patch to treat hypertension.
6) The first transdermal delivery system for major depressive illness was a transdermal patch containing the MAO inhibitor selegiline.
7) The transdermal methylphenidate for attention deficit disorder.

CONCLUSION

In order to create ibuprofen transdermal patches, polyvinylpyrrolidone (PVP) polymer basis was used. As a penetration enhancer, four formulations with varying menthol concentrations were created. Menthol weight ratios to PVP ranged from 0% (F0), 5% (F1), 10% (F2), to 15%. (F3). Ibuprofen transdermal patches are tested for their in vitro drug diffusion, weight homogeneity, thickness, and organoleptic properties. These assessments revealed that every recipe had positive outcomes. After 180 minutes of in vitro diffusion, 1.7083 mg/cm2 of ibuprofen had diffused using Franz diffusion cells in phosphate buffer pH 7.4 medium.

REFERENCE

1. Hestiary Ratih1, Fikri Alatas2 , Sinta Randini3, 123Department of Pharmacy, University of Jenderal Achmad Yani, Cimahi, formulation and evaluation of transdermal patch of ibuprofen, The 3rd International Conference on Pharmacy And Advanced Pharmaceutical Sciences, 1st Edition, 2013; ISBN: 978-602-1594-01-8, https://www.researchgate.net/publication/282136226.

2. Himanshi Tanwar * and Ruchika Sachdeva, TRANSDERMAL DRUG DELIVERY SYSTEM: A REVIEW, INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES AND RESEARCH, 2022; 13, 8: 01. DOI: 10.13040/IJPSR.0975-8232.7(6).2274-90, Page No: 2274-90, https://ijpsr.com/articles/.
3. Bhavana D.Tambe* Nikita kolpe, Recent Techniques for Transdermal Penetration Enhancement, International Journal of Pharmaceutical Research and Applications, 2021; 6, 2: 207-215. ISSN: 2249-7781, www.ijprajournal.com.
4. Rajeswari s1*, prasanthi t2, srilaxmi n2, gayathri t2, a review on transdermal drug delivery system: a novel tool for improving bioavailability, Innovare Journal of Science, 2021; 9, 4: 1-7. ISSN - 2321-5496, https://innovareacademics.in/journals/index.php/ijs.
5. Mohammed Irfan1, Sushma Verma2, Alpana Ram, Preparation And Characterization Of Ibuprofen Loaded Transferosome As A Novel Carrier For Transdermal Drug Delivery System, Asian Journal Of Pharmaceutical And Clinical Research, 2012; 5, 3. 0974-2441, 162-165.
6. Bhavana D.Tambe* Nikita kolpe, Recent Techniques for Transdermal Penetration Enhancement, International Journal of Pharmaceutical Research and Applications, 2021; 6, 2: 207-215, ISSN: 2249-7781, www.ijprajournal.com.
7. Rabinarayan Parhi*, Sumanta Mondal and Posa Mahesh Kumar, Novel Penetration Enhancers for Skin Applications: A Review, Current Drug Delivery, 2012, 9, 000-000, 2012; 9, 2. DOI: 10.2174/156720112800234585, https://www.researchgate.net/publication/51738503.
8. Dr. Dev Prakash1, Amrit Pal Singh1,*, Nishant Singh Katiyar1, Dr. Kamla Pathak2, Dr. Devender Pathak2 and Arti3, PENETRATION ENHANCERS: ADJUVANTS IN TRANSDERMAL DRUG DELIVERY SYSTEM, WORLD JOURNAL OF PHARMACY AND PHARMACEUTICAL SCIENCES, 2016; 5, 5: 353-376. ISSN 2278 – 4357, www.wjpps.com.
9. Bhavana D.Tambe* Nikita kolpe, Recent Techniques for Transdermal Penetration Enhancement, International Journal of Pharmaceutical Research and Applications, 2021; 6, 2: 207-215. ISSN: 2249-7781, www.ijprajournal.com.
10. Gore S. A., 1Satpute V. V., 1Gholve S. B.*, 1Bhusnure O. G., 2Bhosale P. H., 3Phutke P. B, A Systematic Review on Transdermal Patches, International Journal of Pharmaceutical Sciences Review and Research, Int. J. Pharm. Sci. Rev. Res, 2017; 45(2): 08, 36 – 47. www.globalresearchonline.net.

11. Nikhil Sharma, Geta Agarwal, A. C. Rana, Zulfiqar Ali Bhat, Dinesh Kumar, "A Review: Transdermal Drug Delivery System: A Tool For Novel Drug Delivery System", International Journal of Drug Development & Research, July-September, 2011; 3, 3: ISSN 0975-9344, www.ijddr.in.
12. Karan Razdan, V.R. Sinha, and Kamalinder K.Singh, New Paradigms in the Treatment of Skin Infections: Lipid Nanocarriers to the Rescue May, 2020. DOI:10.1007/978-981-15-1664-1_11 In book: Nanomedicine for Bioactives (pp.317-339), www.researchgate.com
13. Keng Wooi Ng†, and Wing Man Lau‡, Skin Deep: The Basics of human skin structure and drug penetration, January, 2015, DOI:10.1007/978-3-662-45013-0_1, www.researchgate.com
14. Richa Sachan, Meenakshi Bajpai, TRANSDERMAL DRUG DELIVERY SYSTEM: A REVIEW, International Journal of Research and Development in Pharmacy and Life Sciences, December - January, 2013; 3, 1: 748-765ISSN: 2278-0238, http//www.ijrdpl.com