Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 12 [5]April 2023 : 260-268

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

ORIGINAL ARTICLE **OPEN ACCESS**

Transdermal Drug Delivery System by Making Use of Herbal Transdermal Patch: A Review

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ABSTRACT

Transdermal drug delivery system (TDDS) is a systemic drug delivery method that is applied topically and takes the form of patches that release medication at a set rate. A transdermal patch is a sticky pad that is used to apply medication to the top layer of skin in order to gradually release medication into the bloodstream. Following application to the skin, it is intended to continuously release the active component over a period of many hours to days. Transdermal medicine patches have been demonstrated to be an effective way to administer medications of herbal origin. There are herbal transdermal patches available to help people stop smoking, reduce stress, boost their sexuality, detoxify their bodies, revitalize men, and delay menopause. Recent research has shown that some medicinal herbs are useful for treating age-related diseases as well as intervening with or preventing aging. The therapeutic components of the herbs employed in anti-aging programs stimulate the body's critical organs and restore their natural function. Numerous them have antioxidant qualities. This review article examines transdermal medication delivery systems with regard to their kind, manufacturing process, mechanism, and component used to create transdermal patches.

Keywords: *Transdermal drug delivery system, Transdermal patch, , Herbal Therapy, Anti Aging*

Received 15.01.2023 Revised 21.03.2023 Accepted 28.04.2023

INTRODUCTION

Due to their immediate therapeutic effects and lack of adverse effects, herbal pharmaceuticals are considered safe medications. They can be made from any part of the plant, including seeds, berries, leaves, roots, bark, flowers, and blooming tops. These are also referred to as phytomedicine or herbal medicine. Since ancient times, herbal remedies have been used to treat a range of illnesses. Alkaloids, glycosides, aromatic, phenolic compounds, and derivatives, as well as tannins, are just a few of the chemicals that many plants produce that have pharmacological effects. The World Health Organization estimates that about 35% of medicines are derived from plant materials. Herbal treatments have a number of advantages, including few side effects and flexibility to any dosage form. Herbal medicines can also be produced using allopathic techniques as pills, capsules, liquids, infusions, ointments, and extracts. The main negative is how long it takes to treat diseases.[1]

Why utilize herbal remedies: [2]

The use of herbs for their therapeutic or medicinal value is known as herbal medicine, sometimes known as herbalism or botanical medicine. An herb is a plant or plant component that is prized for its therapeutic, savory, or fragrant properties. Herb plants produce and contain a wide range of chemicals that have physiological effects. Since it is among the oldest medical practices still in use today, it has been used by all historical cultures. Herbalism has played a crucial role in the rise of contemporary civilization. In fact, a large portion of the pharmacopoeia of scientific medicine dates back to the early 20th century and is based on native peoples' herbal knowledge. Nowadays, a lot of regularly used medications have herbal origins. The majority of prescription medications prescribed will contain at least. At least one active component derived from plant matter will be present in about 25% of the prescription medications prescribed. Such active medications are either derived from plant extracts or created synthetically to resemble a natural substance.[3]

Transdermal drug delivery system

One of the most encouraging or powerful medication conveyance frameworks presently utilizes the transdermal course. The transdermal prescription conveyance framework is currently recognized as an essential part of state of the art drug conveyance frameworks. [4]

As of late, there has been a resurgence in interest in making new techniques for conveying current therapeutic builds. The production of an imaginative conveyance strategy for previously existing medication atoms altogether increments patient consistence, by and large remedial advantage, and the viability and wellbeing of the treatment.[5] Transdermal Medication Conveyance Framework (TDDS) are discrete, independent measurements shapes that are likewise alluded to as "patches" [6,7]. At the point when patches are put to sound skin, the medication is delivered into the circulatory system at a controlled rate through the skin. [8]

These days, 74% of meds are consumed orally and are not generally so significant as the most pursued. Transdermal medication conveyance frameworks were created to progress such characteristics. Transdermal medication conveyance framework (TDDS) arose as a huge part of inventive medication conveyance frameworks with the improvement of the present drug measurements structures. As a result of their extraordinary advantages, transdermal measurements structures — while even more costly than conventional plans — are filling in fame. Effortless and less aftereffects, improved bioavailability, controlled retention, more uniform plasma levels A few possible advantages of transdermal medication conveyance incorporate usability and the capacity to stop drug organization by just eliminating the fix from the skin. A few specialized headways have been made as of late in the space of medication conveyance. One of the most mind-blowing strategies for novel medication conveyance frameworks is transdermal medication conveyance. It is lovely, effortless, and forestalls G.I. poisonousness and hepatic first pass digestion. The volume of medication delivery can be productively overseen by these medication conveyance frameworks. The transdermal medication conveyance frameworks keep up with drug plasma levels in the remedial window for a more drawn out timeframe and discharge the medication through the skin into the circulatory system at a nonstop or modified pace. [9]

Transdermal medication conveyance frameworks' essential objective is to convey meds into the body's course through the skin at a set rhythm with little between and intrapatient change. At present, one of the most encouraging ways to deal with controlling medications is transdermal organization.[10] It lessens the burden that taking medication orally frequently places on the liver and digestive system. It improves patient compliance, reduces negative drug side effects brought on by transient overdoses, and is convenient for transdermal treatments that only need a single weak application.[11]

Classification of transdermal drug delivery system

Single-Layer Drug-in-Adhesive

The drug is additionally present in this framework's tacky layer. In this sort of fix, the cement layer is likewise responsible for the medication discharge as well as holding the different layers of the framework to the skin and sticking them generally together. A transitory liner and a sponsorship layer encompass the cement layer. The utilization of glue patches considers the controlled arrival of medicine through the skin throughout a foreordained time span [12-14]. The rate at which the fluid medication held in the repository inside the skin fix can saturate the skin and enter the circulation system is constrained by a skin fix utilizing a unique layer. A few drugs should be taken with different substances, including liquor, to further develop their skin infiltration rate [15-17]. Skin patches can be utilized to convey prescriptions like scopolamine for movement affliction, nicotine for stopping smoking, estrogen for menopause and osteoporosis avoidance after menopause, dynamite for angina, and lidocaine for shingles torment (herpes zoster). Particles of insulin and numerous different substances, nonetheless, are too huge to even consider going through the skin.[18-20]

Multi-Layer Drug-in-Adhesive

Latent conveyance procedure is utilized in both single-layer drug-in-cement and multi-facet drug-in-glue transdermal framework plans. In uninvolved transdermal frameworks, the medication diffuses through the skin and can either have a nearby or fundamental impact by entering the vessels. Because of the skin's regular obstruction capabilities, aloof strategies are best for managing small atom meds. More modest atomic substances, which are among the easiest substances to disperse by transdermal strategies, are utilized in Medication in-Cement (DIA) frameworks. Each compound's cement is adjusted to keep up with consistent conveyance rates over the course of time. The gadgets needn't bother with a repository seal or an overlay. Subsequently, contrasted with frequently awkward gel framework or repository plans, the medication in-glue engineering is more modest, more slender, outwardly engaging, and more lovely. Like the single-layer approach, the multi-facet drug-in cement fix in like manner delivers the medication through both of its tacky layers. However, the multi-facet approach contrasts in that it remembers an

extra layer of medication for glue that is frequently isolated from the others by a film (yet not in all cases). This fix likewise includes a long-lasting support and a momentary liner layer.[21-24].

Matrix Type TDDS

In a framework made of hydrophilic or lipophilic polymers, the drug is consistently spread. The compartment for this medication containing polymer circle is produced using a medication impermeable support layer and is connected onto an occlusive base plate. Rather than spreading the cement on the medication supply's face, do it around the edge to make an edge of glue.[25,26]

A semisolid medication layer in the framework contains a medication arrangement or suspension. This fix's drug layer is to some extent covered by a glue layer that encompasses it. It is depicted a prescription conveyance grid for transdermal frameworks. Without the need of saturation enhancers, the lattice, which is made of a skin-glue acrylate copolymer, accomplishes high paces of medication conveyance. In ideal executions, water-solvent polymers may likewise be added to the lattice, which is used to regulate chemicals, especially estradiol. [27-29].

Reservoir Type TDDS

The medication repository in this gadget is embedded between an impermeable sponsorship layer and a rate-directing film (layer controlled). Just the rate-controlling layer, which could possibly be penetrable, permits the medication to deliver. The medication might be spread in a strong polymer framework, in arrangement, suspension, or gel structure in the medication repository compartment. It is feasible to apply a slim layer of medication viable, hypoallergenic tacky polymer to the polymeric film's external surface [30-32]. The dynamic fixing in layer controlled (repository) gadgets is contained in a center that is encompassed by a slender, uniform polymer film. Drug dispersion through the rate-restricting layer brings about drug discharge into the climate. The repository transdermal framework contains a different medication layer as opposed to the single-layer and multi-facet Medication in-glue frameworks. The cement layer fills in as an actual boundary between the medication layer and a fluid compartment holding a medication arrangement or suspension. The sponsorship layer likewise upholds this fix. The pace of delivery in this sort of framework is zero request. [33-35].

Transdermal patches

A to direct a particular portion of drug into the circulation system through the skin, transdermal fixes or skin patches are sedated cement cushions that are applied to the upper skin. The most famous transdermal frameworks available today depend for the most part on semi-penetrable films, at times known as patches. These days, transdermal patches are every now and again utilized as transdermal, effective, and restorative conveyance frameworks. These patches are a huge consequence of advances in skin science, innovation, and information that have been made by means of experimentation, clinical perception, and proof based research returning to the earliest human records.[36]

History

To regulate a particular portion of prescription into the circulatory system through the skin, transdermal fixes or skin patches are cured cement cushions that are applied to the upper skin. The most famous transdermal frameworks available today depend generally on semi-penetrable films, some of the time known as patches. These days, transdermal patches are often utilized as transdermal, effective, and restorative conveyance frameworks.

These patches are a huge consequence of advances in skin science, innovation, and information that have been made through experimentation, clinical perception, and proof based research returning to the earliest human records. Items planned to deliver fundamental results (e.g., Emplastrum aromaticum, which contained peppermint and other fragrant oils focused on for the treatment of the stomach; Emplastrum belladonnaefrom Atropa belladonna leaves, which was expected for the treatment of tuberculosis and cancers; Emplastrum opiatu) and glue items (e.g., Emplastrum adhaesivum, which contained oleic corrosive, lead oxide, and colo (for example Emplastrum hydrargyri with unadulterated mercury for treating effective swellings and diseases, Emplastrum cantharidum ordinarium, a vesicant, Emplastrum picis irritans and Emplastrum fuscum for managing effective contaminations).[39]

By estimating medicine levels in blood, pee, and dung, mid twentieth hundred years in vivo examinations showed foundational retention following skin treatment. [40] The principal logical methods were completely subjective, and they included looking at the deliberate example's tone, corrosiveness, or thickness to a standard example to recognize the presence of a medication in the blood or pee. [41] Mercury was perhaps the earliest restorative substance to be distinguished and estimated in human excreta. It was initially recognized in pee after mixture based inunction treatment for syphilis (for example Reinsch test). [42] Later, more exact scientific methods considered the quantitative assurance of 5 mg of mercury in 1 L of arrangement (utilizing an aligned narrow cylinder, for instance). [43] Colorimetric strategies were broadly utilized. By estimating drug levels in blood, pee, and defecation, mid twentieth 100 years in vivo examinations showed fundamental assimilation following skin treatment.

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CLASSIFICATION OF TRANSDERMAL PATHCES: [47-50]

Single layer drug-in-Adhesive Patches

In this method, the prescription keeps in touch with the skin-joined tacky layer. The tacky layer in the skin the two guides in the arrival of the medication and effectively grips to the skin's various layers.

1. **Multi-Layer Drug-in-Adhesive Patches**

The single layer drug in cement patches, in which the medication is embedded straightforwardly into the glue layer, and the multi-facet drug in glue patches are indistinguishable. These patches have a super durable sponsorship and a transient liner layer, and one layer in a split second lets the drug out of the repository.

2. **Reservoir Patches**

In opposition to single layer and multi-facet drug in-glue, repository patches have an alternate medication layer. A part of the compartment holds the prescription suspension or arrangement. These frameworks utilize zero request energy to deliver the medicine.

3. **Matrix Type Patches**

These are comprised of a semisolid grid with a medication layer on top that contains the medication as an answer or suspension. In these frameworks, the medication layer is to some extent encompassed by the tacky layer.

4. **Vapor Type Patches**

The adhesive layer in this kind of patch system not only holds the various layers together but also lets out vapour. These brand-new patches are widely used to release essential oils for up to 6 hours. These patches are mostly utilized in cases of decongestion and release essential oils. There are many different kinds of vapour patches on the market that are used to increase sleep quality and decrease cigarette smoking.

Method of preparation of transdermal patches

Solvent Casting Method

In this strategy, a little measure of dissolvable is added to a container containing a polymer (like HPMC/Ethyl Cellulose). Different polymers, like PVA, are then added, and 2/3 of the dissolvable is mixed while they are persistently blended at a low speed and afterward at a higher speed. When the plasticizer has been added and completely blended in, the medication has been totally consolidated, and the volume has been made. The arrangement is then filled a pre-arranged glass shape and dried at 40 oC in the stove. The careful edge is utilized to cut the movies. For sometime in the future, the dry movies are bundled in margarine paper and kept in desiccators.[51]

1. **Mercury Substrate Method**

The prescription, alongside plasticizers and different fixings, is just broken down in the arrangement of the polymer in the mercury substrate approach. This combination is completely mixed and twirled for 10 to 15 minutes, then, at that point, it is placed into a glass ring and set over a glass petri dish. A petri dish is covered with an upset pipe to deal with the dissolvable vanishing.[52]

2. **Circular Teflon Method**

A big part of the natural dissolvable is utilized to disintegrate the decided measure of drug, and the leftover half is used to break down the entrance enhancer. Then, at that point, the two arrangements are consolidated. In the wake of being entirely blended, the material is set into a Teflon shape that is round. By putting a topsy turvy pipe over the Teflon form, the dissolvable vanishing could be controlled. These dried movies are kept in the desiccators with the velocity set at 0.5 m/s for 24 hours.[53]

3. **By Using EVAC Membrane Method**

The transdermal medication conveyance framework is regularly made utilizing the EVAC layer approach. As rate control layers, you can likewise use 1% Carbopol repository gel, polyethylene (PE) films, and ethylene vinyl acetic acid derivation copolymer (EVAC) films. Propylene glycol is used in the production of gels when a drug isn't dissolvable in water. Propylene glycol is utilized as a dissolvable to disintegrate the medicine. Carbopol sap will then be added to the fluid above, and 5% sodium hydroxide arrangement will be added to kill the gel. The drug is put inside the support cover sheet in gel structure. To make a

watertight gadget, the rate-controlling EVAC film is then applied over the gel. The fix edges are then warmed to seal them.[54]

4. **Aluminum Backed Adhesive Film Method**

The stacking portion of in excess of 10 mg might cause temperamental frameworks while utilizing TDDS. Since most prescriptions and glues are effectively dissolvable in chloroform, it is habitually used in this methodology as a dissolvable. The prescription is first disintegrated in chloroform, trailed by the expansion and disintegration of tacky substance. At long last, patches are made utilizing an exceptionally produced aluminum previous fixed with aluminum foil.[55]

5. **By Using IPM Membrane**

The medicine is broken down in a propylene glycol and water dissolvable arrangement containing carbomer 940 polymers and twirled persistently on an attractive stirrer for 12 hours in the IPM layer strategy. Triethanolamine should be made gooey and killed in the combination referenced above before it very well may be added for the scattering. The support pH 7.4 can be utilized to make arrangement gel assuming the medication's solvency in a watery arrangement is extremely low. The created gel will next be applied on the IPM layer.[51,55]

Mechanism of action of transdermal patches

There are a few strategies for applying transdermal fixes and permitting the dynamic restorative fixing to enter the circulatory system through the skin.

1. Iontophoresis

Utilizing the terminal to keep in touch with the definition to be conveyed, a low-level electric flow is applied to a particular region of the skin in this strategy. In this system, the iontophoretic conveyance of lidocaine is believed to be a savvy procedure for the fast beginning of sedative, while the conveyance of pilocarpine is utilized to prompt sweat in the conclusion of cystic fibrosis.[56]

2. **Electroporation**

High-voltage beats are utilized in this strategy to cause skin issues. Most commonly, high voltage and brief treatment times are utilized, which makes the skin more porous on the grounds that electroporation makes short lived pores. With the assistance of this procedure, atoms with shifting lipophilicity and sizes, for example, biopharmaceuticals and particles with sub-atomic loads higher than 7 KDA, have had their skin penetrability expanded.[57]

3. Ultrasounds

Sonophoresis, a strategy that utilizations low recurrence ultrasound to work on transdermal conveyance of different medications including macromolecules, is utilized in this methodology. The layer corneal lipids should likewise be burst for the prescription to go through the organic boundary.[58]

4. Electro-osmosis

The permeable film that goes through electro-assimilation is depicted as having some charge, a voltage contrast, a volume stream, or a mass liquid that happens without focus inclinations. From anode to cathode, electro-osmotic stream expands the transition of decidedly charged prescriptions and makes it workable for unbiased drugs to saturate.[57,58]

5. Magnetophoresis

This technique involves an attractive field as an outside power to build a diamagnetic solute's dissemination over the skin. Attractive field openness to the skin additionally causes primary changes that might increment penetrability. Benzoic corrosive, a diamagnetic particle, was picked as a remedial competitor in this one of a kind strategy to improving prescription vehicle over the natural obstruction. The impact of magnet field strength on drug material dispersion motion was displayed to increment with application strength.[59]

Evaluation of transdermal patches [60-63]

1. Thickness of Patch

At different areas along the film, the thickness of the transdermal fix is estimated utilizing a voyaging magnifying lens, a computerized micrometer, a screw check, and a dial measure. To ensure that the pre-arranged fix has a uniform thickness, the Standard deviation and normal thickness are determined for something very similar.

2. Weight Uniformity

The produced drug-stacked patches are dried at 60 oC for 4 hours preceding testing. The dried patches are separated into different segments, every one of which is then weighted on a computerized equilibrium to decide the typical weight and standard deviation.

3. Percentage Moisture Content

The subsequent medication stacked films are weighed independently and put away for 24 hours at room temperature in desiccators containing anhydrous calcium chloride. The movies are rechecked the next day at an exact time until they show a consistent weight. % dampness content equation is:

% Moisture content= [Initial Weight–Final Weight/Final Weight] x100

4. Drug content

A specific region of the made fix is exactly gauged, then broke down in a reasonable dissolvable in which the medication is solvent, and the blend is then consistently shaken for 24 hours utilizing a shaker hatchery. The next day, the arrangement is sonicated and sifted, and the separated arrangement is then appropriately weakened and exposed to a suitable strategy for examination (UV, HPLC, etc.).

5. Folding endurance

The pre-arranged fix's assigned locale is cut uniformly and over and over collapsed until it breaks. Preceding the fix breaking, the quantity of collapsing is recorded. The significance of collapsing perseverance will be shown.

6. Percentage moisture uptake

Every one of the pre-arranged films is gauged prior to being put in a desiccator with a soaked potassium chloride answer for 24 hours. The movies are rechecked the following day to compute the rate dampness take-up utilizing this equation.

% Moisture uptake= [Final Weight-Initial Weight/Initial Weight] x100

Advantages of transdermal patches

Transdermal patches are pressure-sensitive adhesives that deliver medications through the skin and into the bloodstream to the site of action. Some of its benefits include:

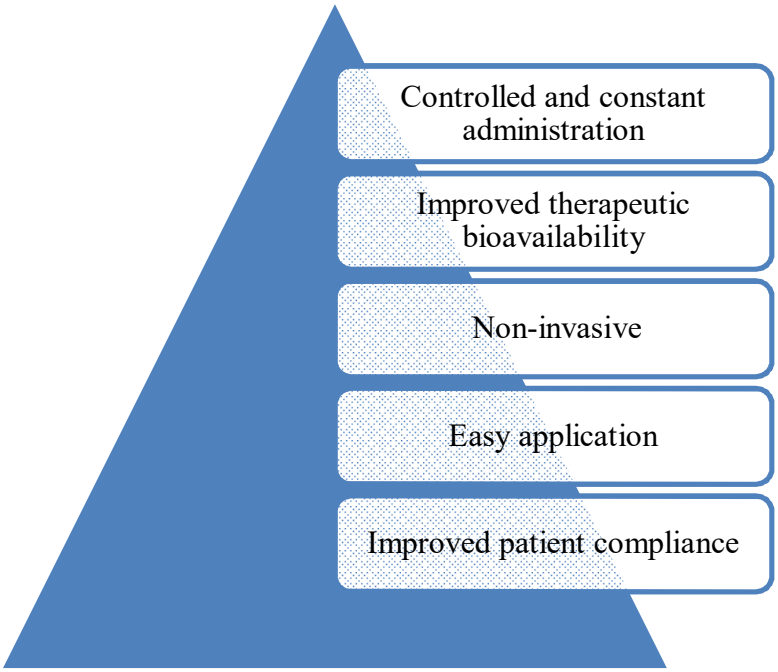

Figure 1. Advantages of transdermal patches

Aging as disease

Aging (likewise alluded to as natural maturing) is described by a complex interconnected organization of moderate practically pernicious phenotypic deviations (regarding the youthful grown-up aggregate) that underlie natural maturing and cause a decrease in individuals' strength, flexibility, and physical and mental capability. There are banters about whether or not maturing ought to be viewed as an infection. Maturing ought to be tended to like a sickness, as per various specialists. [64-66] For the motivations behind the eleventh ICD correction, the WHO made the accompanying meaning of illness: "A sickness is an assortment of irregularities in at least one of the natural frameworks as portrayed by:

1. The pattern of signs, symptoms, and associated findings is known as symptomatology.
2. Aetiology: a root cause or fundamental explanation
3. A clear pattern of development throughout time can be seen in the course and outcome.
4. The response to treatment: a typical pattern of reaction to treatments
5. Relationship to genetic characteristics, such as genotypes and gene expression patterns
6. Connection to interrelated environmental factors.[67]

Role of transdermal patch in ageing

The use of transdermal patches has various benefits. Medication levels in blood plasma stay more consistently distributed because drug absorption through the skin is a continuous process. As a result, pain can be managed more consistently and with less erratic intensity. [68]

Because patches can be changed every three days, drug administration is not required as frequently. This can psychologically imply that there are less reminders of deteriorating health. As they rely less on a family member or paid caregiver, the person's self-esteem may be restored. While using a syringe driver might be more challenging, it is possible to wash or take a bath while wearing a patch. This is especially important for older adults who want to live independently in their homes for as long as feasible. The discomfort and anxieties related to needles and injections are also avoided while using patches. [69] The use of syringe drivers for parenteral delivery is typically well tolerated. [70] However issues with their use include needles detaching unintentionally, a lack of equipment, safe transport, and service.[71]

CONCLUSION

Starting from the beginning of man, effective conveyance frameworks have been applied to treat different circumstances and as beauty care products. The characterizing of fitting medication contender for transdermal conveyance and the following advancement of inactive and dynamic innovations have further developed conveyance, expanded drug dosing precision, and better addressed individual issues over the long haul. g. Because of current innovation enhancements and the accessibility of pharmacological activity without skin break, it is a conveyance system for the up and coming age of medications. Future medication organization of a wide reach is guaranteed without the utilization of needles. Transdermal rate-controlled drug conveyance has a brilliant future, and its natural applications are growing too.

The utilization of transdermal organization gadgets, particularly transdermal patches, in pediatric patients is rising. For instance, the methylphenidate fix for the treatment of consideration deficiency hyperactivity jumble is one of various transdermal patches (i.e., around 10 meds) that have been used in kids. For more established kids and term newborn children who require more modest doses than grown-ups, transdermal circulation may be viewed as a convenient painless course of prescription conveyance; in any case, plan gives actually exist for untimely youngsters who have an immature skin boundary.

Lately, transdermal patches have become all the more generally utilized as a strategy for drug organization. Patches can possibly settle a significant number of the issues that more established individuals face while accepting meds as coordinated, including the need to open childproof holders and the intricacy of medication regimens.

ACKNOWLEDGEMENT

The origination and composing of this survey was enormously helped by the above authors in general.

CONFLICT OF INTEREST

The authors proclaim no irreconcilable situation

REFERENCES

1. R. Rathva, N. N. Patel, V. Shah, U. M. Upadhyay. (2012). Herbal Transdermal Patches: A Review. IJDDR. 2: 397-402.
2. Patel P. (2012). Herbal Excipients: An Emerging Field as A Penetration Enhancer in Transdermal Drug Delivery System. IJPRD. 4: 58–68l.
3. Benzie IFF, (2011). Wachtel-Galor S, editors. Herbal Medicine: Biomolecular and Clinical Aspects. 2nd edition. Boca Raton (FL): CRC Press/Taylor & Francis..
4. Ahmed A, Karki N, Charde M, Ganghare B. (2011). Transdermal drug delivery system an overview. International Journal biomed Adv Res,; 2: 38- 56.
5. Jalwal P, Jangra A, Dhaiya L, Sangwan Y, Saroha R.(2010). A review on transdermal patches. Pharm Res. J. 3:139-149.
6. Bhowmik D, Chiranjib, Chandira M, Jayakar B, Sampath KP. Recent advances in transdermal drug delivery system. Int. J Pharm Tech Res. 2010; 2(1):68-77.
7. Kumar A, Pullankandam N, Prabhu SL, Gopal V. Transdermal drug delivery system: an overview. Int. J Pharm Sci. Review Res. 2010;3(2):49-54.
8. Divya A, Rao MK, Gnanprakash K, Sowjanya A, Vidyasagar N, Gobinath M. (2012). A review on current scenario of transdermal drug delivery system. Int. J Res. Pharm Sci. 3(4):494-502.
9. Dipen Patel, Sunita A. Chaudhary, Bhavesh Parmar and Nikunj Bhura. (2012). Transdermal Drug Delivery System: A Review. The Pharma Innovation, 2012; 1(4): 66-75.
10. Rani S, Saroha K, Syan N, Mathur P. (2011). Transdermal patches a successful tool in transdermal drug delivery system. Plegia Res. Lib. 2(5):17-29.
11. Dhawan S, Aggarwal G.(2009). Development, fabrication and evaluation of transdermal drug delivery system- a review. Pharm info.net. 1-25.
12. Mutalik S, Udupa N. (2006). Pharmacological evaluation of membrane moderated transdermal system of glipizide. Clin Exp Pharmacol Physiol; 33 (1-2): 17-26.

13. Mutalik S, Udupa N. (2005). Formulation development, in vitro and in vivo evaluation of membrane controlled transdermal systems of glibenclamide. J Pharm Pharm Sci; 8: 26-38.
14. Bagyalakshmi J, Vamsikrishna RP, Manavalan R, Ravi TK, Manna PK.(2007). Formulation development and in vitro and in vivo evaluation of membrane-moderated transdermal systems of ampicillin sodium in ethanol: pH 4.7 Buffer solvent system. AAPS Pharm Sci Tech; 8 (1): 7.
15. Padula C, Nicoli S, Colombo P, Santi P.(2007). Single-layer transdermal film containing lidocaine: Modulation of drug release. Eur J Pharm Biopharm; 66(3): 422-428.
16. Aqil M, Sultana Y, Ali A. (2006). Transdermal delivery of beta-blockers. Expert Opin Drug Deliv6; 3(3): 405-418.
17. Langer R. Transdermal drug delivery: Past progress, current status and future prospects. Adv Drug Deliv Rev 2004; 56: 557-558.
18. Prausnitz MR, Mitragotri S, Langer R. Current status and future potential of transdermal drug delivery. Nat Rev 2004; 3: 115-124.
19. Jain N, Talegonkar S, Jain NK. (2004). New ways to enter the blood stream: Emerging strategies in transdermal drug delivery. Pharm Rev; 41-59.
20. Barry B. Transdermal drug delivery. In: Aulton EM, Ed. (2002). Pharmaceutics. The science of dosage forms design. Churchill Livingstone, New York, Harcourt Publishers: 499-433.
21. Kumar R, Philip A. (2007). Modified transdermal technologies: Breaking the barriers of drug permeation via the skin. Trop J Pharm Res; 6(1): 633-644.
22. Chien YW. (1992). Novel drug delivery systems. Drugs and the pharmaceutical Sciences. New York, Marcel Dekker; p. 797.
23. Finnin CB. (2003). Transdermal drug delivery-What to expect in the near future. Bus briefing: Pharma Tech; 16 (1): 192-193.
24. Chien YW. (1992). Transdermal drug delivery and delivery system; Marcel Drugs and the pharmaceutical sciences. New York, Marcel Dekker; pp. 301-381.
25. Mutalik S, Udupa S, Kumar S, Agarwal S, Subramanian G, Ranjith AK. (2006). Glipizide matrix transdermal systems for diabetes mellitus: Preparation, in vitro and preclinical studies. Life Sci ; 79(16): 1568-1577.
26. Csóka G, Pásztor E, Marton S, Zelkó R, Antal I, Klebovich I. (2007). Formulation of thermoresponsive transdermal therapeutic systems using cellulose derivatives. Acta Pharm Hung; 77(2): 102- 107.
27. Aqil M, Sultana Y, Ali A. (2003). Matrix type transdermal drug delivery systems of metoprolol tartrate: in vitro Characterization. Acta Pharm; 53(2): 119-125.
28. Kakubari I, Sasaki H, Takayasu T, Yamauchi H, Takayama S, Takayama K. (2006). Effects of ethylcellulose and 2-octyldodecanol additives on skin permeation and irritation with ethylene-vinyl acetate copolymer matrix patches containing formoterol fumarate. Biol Pharm Bull; 8: 1717-1722.
29. Ubaidulla U, Reddy MVS, Ruckmani K, Ahmad FJ, Khar RK. (2007). Transdermal therapeutic system of carvedilol: Effect of hydrophilic and hydrophobic matrix on in vitro and in vivo characteristics. AAPS Pharm Sci Tech; 8(1): 2-6.
30. Tanwar Y, Chauhan C, Sharma A. (2007). Development and evaluation of carvedilol transdermal patches. Acta Pharm; 57: 151-159.
31. Gannu R, Kishan YV, Rao YM. (2007). Development of nitrendipine transdermal patches: in vitro and ex vivo characterization. Curr Drug Deliv; 4: 69-76.
32. Kawahara K, Tojo K. (2007). Skin irritation in transdermal drug delivery systems: A strategy for its reduction. Pharm Res; 24(2): 399- 408.
33. Aqil M, Chowdhary BI, Sultana Y, Talegaonkar S, Ahmad FJ, Ali MM. (2008). Transdermal therapeutic system of enalapril maleate using piperidine as permeation enhancer. Curr Drug Deliv; 5(2): 148-152.
34. Gupta SP, Jain SK. (2006). Transdermal atenolol releasing system: An approach towards its development. J Drug Target; 9: 607-613.
35. Aqil M, Sultana Y, Ali A, Dubey K, Najmi AK, Pillai KK. (2004). Transdermal drug delivery systems of a beta blocker: Design, in vitro and in vivo characterization. Drug Deliv; 1: 27-31.
36. Jincy V Varghese, K Krishnakumar, Dineshkumar B, Smitha K Nair. (2017). Transdermal patch a review. Int J of Adv Sci and Research, 2(4): 01- 04.
37. Kramer SN (1963). The Sumerians: Their History, Culture, and Character. The University of Chicago Press: Chicago and London
38. Henshilwood CS, d'Errico F, van Niekerk KL, Coquinot Y, Jacobs Z, Lauritzen SE et al. (2011). A 100 000-year-old ochre-processing workshop at Blombos Cave, South Africa. Science 334: 219–222
39. Morgan WF (1866). Poisoning by the external application of belladonna. Br Med J 2: 621.
40. Malkinson FD, Rothman S (1963). Percutaneous absorption. In: Jadassohn J (ed.). Handbuch der Haut und Geschlecht Skrauberten, Normale, und Pathologische Physiologic der Haut. Springer: Berlin, pp. 90–156.
41. Scheuplein RJ, Blank IH (1971). Permeability of the skin. Physiol Rev 51: 702–747
42. Wile UJ, Elliott JA (1917). Mode of absorption of mercury in the inunction treatment of syphilis: preliminary report. JAMA 68: 1024–1028
43. Cole HN, Gammel JA, Rauschkolb JE, Schreiber N, Sollmann T (1926). Excretion of mercury after intramuscular injection of mercuric bromide, inunction and rectal suppositories. Arch Derm Syphilol 14: 683–692.
44. Zondek B, Shapiro B, Hestrin S (1943). Application of the Millon reaction to the determination of chlorophenols in body fluids and tissues. Biochem J 37: 589–591.

45. Brown EW, Scott WO (1934). The absorption of methyl salicylate by the human skin. J Pharmacol Exp Ther 50: 32–50.
46. Nadkarni MV, Meyers DB, Carney RG, Zopf LC (1951). Clinical studies in percutaneous absorption. AMA Arch Derm Syphilol 64: 294–300.
47. Patel DS, Patel MV, Patel BA, Patel PA. Transdermal Patches: A Complete Review on Transdermal Drug Delivery System. Int J Pharm Res Scholars. 2012; 1: 55-71.
48. Sharma T, Rawal G. Transdermal Therapeutic Systems: An Overview. Int J Pharm Bio Arch. 2011; 2: 1581-1587.
49. Patel D, Chaudhary SA, Parmar B, Bhura N. Transdermal Drug Delivery System: A Review. The Pharma Innov. 2012; 1: 78-87.
50. Rani S, Saroha K, Syan N, Mathur P. Transdermal Patches a Successful Tool in Transdermal Drug Delivery System: An Overview. Der Pharmacia Sinica. 2011; 2: 17-29.
51. Swati Hardainiyan, Bankim Chandra Nandy, Nakuleshwar Dut Jasuja, Pritesh Vyas, Pramod K Raghav. (A Review on recent innovations in Transdermal drug delivery system for herbal therapy). J of Boimedical and Pharm Res, 2014; 3(3): 88-101.
52. Sharma A. (2012). Transdermal Approach of Antidiabetic Drug Glibenclamide- A Review. Int J of Pharm Res Dev, 2012; 3: 25-32.
53. Ghinaiya M. (2013). Formulation and evaluation of Transdermal Patch of an Antihypertensive Drug. Int J Pharm Sci, 2013; 4: 3664-3682.
54. Shalu Rani, Kamal Saroha, Navneet Syan, Pooja Mathaur. (Transdermal Patches a successful tool in Transdermal Drug Delivery: An overview). Pelagia Reseach Library, 2011; 2(5): 17-29.
55. Murugan BK, Prem Kumar P. (Transdermal drug delivery system: a novel approach). World J of Pharmacy & Pharm Sci, 2014; 3(8): 277-292.
56. Rasheed SH, Haribabu R, Mohiddin Md. K, Vineela J, Teja AR, Pathuri RK et al. (Transdermal drug delivery system. Simplified Medication Regimen- A Review). Res J Pharm Boi Chem Sci, 2011; 2: 223-238.
57. Bhowmik D, Duraival S, Kumar KPS. (Recent Trend in Challenge and Opportunities in Transdermal drug delivery system). The Pharm Innovation, 2012; 1: 9-23.
58. Patil AS, Salunke SP, Jagtap PS, Wagh RD. (A Review on Transdermal drug delivery system). Int J of Pharma Scholars, 2012; 1: 129-137.
59. Nagappagari M, Bhargav E, Manne A, Ravi V, Ramesh K. (Transdermal drug delivery system- A Review). World J of Pharm Sci, 2013; 3: 170-186.
60. Shila L, Pandey S, Udupa N. (2006). Design and evaluation of matrix type membrane controlled Transdermal drug delivery system of nicotine suitable for use in smoking cessation. Indian J of Pharm Sci, 2006; 68: 179-184.
61. Ankush Rana, Varunjot Kaur and Shreya Kasushal. (2018). A review on Transdermal drug delivery system). World J of Pharm. Research, 7(11): 229-235.
62. Patel NK, Patel KH, Patel AV. (2012). Formulation and characterization of drug in adhesive transdermal patches of diclofenac acid). Int J of Pharmacy and Pharm Sci, 4(1): 297.
63. Manvi F.V, Dandagi P.M, Gadad A.p, Mastiholimat V.S and Jagdeesh T. (2003). Formulation of Transdermal drug delivery system of Ketotifen Fumarate. Int J of Pharm Sci, 65(3): 239- 243.
64. Yadav. V, **Yadav**.V.K, Jain.S. K, Singh.V.K, Prajapati. S.K, (2011). **"**Phytochemical Analysis and comparative Anticonvulant Activity Celastrus Paniculatus Willd. MES Induced Seizure in Mice**"** Assian J. Research Chem ; 4(10): 1553-1556.
65. Bulterijs, S., Hull, R.S., Björk, V.C.E., Roy, A.G.,(2015). It is time to classify biological aging as a disease. Front. Genet. 6, 205.
66. de Grey, A., Rae, M., (2007). Ending aging: The rejuvenation breakthroughs that could reverse human aging in our lifetime. St. Martin's Press, NY.
67. Lakatta, E.G., (2015). So! What's aging? Is cardiovascular aging a disease? J. Mol. Cell. Cardiol. 83, 1–13.
68. Yadav.V, Dubey.V, Mishra. M.K., Shukla. A.K., "Development and Characterization Studies of Emulgel for the Topical Delivery of 5-Fluorouracil for the Treatment of Skin Cancer" Crimson Publishers**,** 2023 **:** Volume 14 - Issue 2, Pages 1-16.
69. World Health Organization, (2011). ICD-11 alpha. Content model reference guide. 11th Revision World Health Organization, Geneva
70. Julien RM (1998) A Primer of Drug Action. (8th Edition). New York. Freeman & Co
71. Ahmendzai S et al (1994) Transdermal Fentanyl in cancer pain. Journal of Drug Development, 6, 3, 93-97.
72. Gorman D (1991) Opioid analgesics in the management of pain relief in patients with cancer; an update. Palliative Medicine, 5, 277-294
73. David J (1995) Cancer Care: Prevention, Treatment and Palliation, London. Chapman and Hall.

CITATION OF THIS ARTICLE

V K Singh, S Kumar, V K Yadav, K Shafat, J Sawale, R Yadav· Transdermal Drug Delivery System by Making Use of Herbal Transdermal Patch: A Review. Bull. Env.Pharmacol. Life Sci. Vol 12[5] April 2023: 260-268.