Km Pragati Chaturvedi *et al*, International Journal of Pharmaceutical Sciences and Medicine (IJPSM), Vol.9 Issue. 6, June- 2024, pg. 76-84

ISSN: 2519-9889
Impact Factor: 5.9

A NOVEL APPROACH ON THE TRANSDERMAL PATCHES: A REVIEW

Km Pragati Chaturvedi[1]*; Priya Kanaujiya[2]; Manish Kumar Patel[3]; Prashant Kumar Katiyar[4]

[1]*Research Scholar, Kanpur Institute of Technology and Pharmacy, Kanpur, UP
[2,3]Assistant Professor, Kanpur Institute of Technology and Pharmacy, Kanpur, UP
[4]Professor & Director, Kanpur Institute of Technology and Pharmacy, Kanpur, UP

Corresponding author:
Km Pragati Chaturvedi
[1]*Research Scholar, Kanpur Institute of Technology and Pharmacy, Kanpur, UP

DOI: 10.47760/ijpsm.2024.v09i06.008

ABSTRACT:
In transdermal drug delivery, the property of protecting barriers of the skin plays a role of major issue as skin does not allow passing the drug. The complex structure of skin is responsible for this issue. The present review was based on the recent updates on transdermal patches. An additional method of administering medications through the skin layer is transdermal drug delivery. A transdermal patch is a medicated patch that can be applied topically to provide medication at a specified rate directly into the bloodstream via the layers of skin. Actually, the most practical way to administer is via patches. In general, there are four main types of transdermal medical patches (drug-in adhesive, reservoir, matrix, and micro-reservoir systems). It concluded that transdermal patches hold promise as a convenient and efficient drug delivery method for a range of conditions; however, there are a number of obstacles that need to be addressed. These include the potential for self-inflicted toxicity due to incorrect dosing, poor adhesion, low drug penetration, potential trigger for skin irritation, or patch failure. In order to maximise the safety and effectiveness of this delivery system, all of this calls for additional study and development.

Keywords: Transdermal patches, marketed transdermal pathces, merits, demerits, limitations, methods of preparations

ISSN: 2519-9889
Impact Factor: 5.9

INTRODUCTION

In transdermal drug delivery, the property of protecting barriers of the skin plays a role of major issue as skin does not allow passing the drug. The complex structure of skin is responsible for this issue. The outermost layer of the skin is stratum corneum which is made up of keratin and lipid that makes it capable to stop loosing water content and moisture and passing of any chemical, skin came in contact. The total diffusional pathlength stand in the range of 300 to 500 mm in which 20 mm is the thickness of stratum corneum. The drug has to diffuse across the sequentially, repeated structure of the bilayers as this structure is suitable for the hydrophilic as well as lipophilic drugs [1].

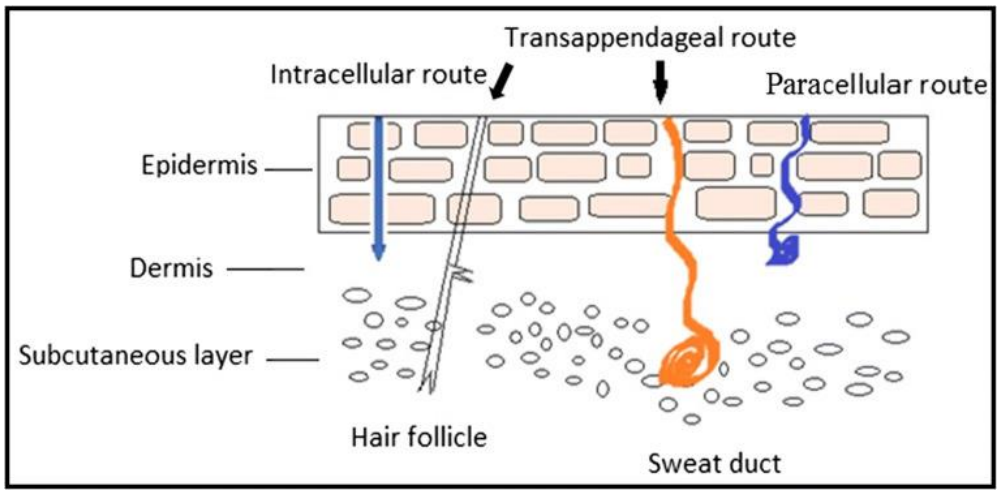

Fig.1. Drug Delivery Pathways through the Skin

Transdermal patch

An additional method of administering medications through the skin layer is transdermal drug delivery [2]. The medication enters the bloodstream through the epidermis and travels across the body's systems before arriving at the intended location [3]. Compared to alternative administration methods, the transdermal medication delivery approach offers a number of advantages. Some examples are the capacity to avoid first-pass metabolism in the liver, the ability to avoid the digestive tract, and the capacity to administer continuous dosages of medications over a prolonged length of time [4]. Other methods of administering drugs, such intravenous, may hurt and raise the risk of infection. However, the oral route is ineffective, and it is challenging to regulate the amount when using the inhalation approach. Transdermal administration is a popular method of drug delivery for chronic pain, motion sickness, smoking cessation, and hormone replacement treatment because of its advantages over other routes [5][6][7].

ISSN: 2519-9889
Impact Factor: 5.9

A transdermal patch is a medicated patch that can be applied topically to provide medication at a specified rate directly into the bloodstream via the layers of skin. Actually, the most practical way to administer is via patches. They can be stopped at any time, and the course of treatment can last for several days because they are non-invasive. They have various sizes and are made up of several ingredients. Through diffusion processes, the patch can introduce active substances into the systemic circulation once it is put to the skin. High concentrations of active ingredients that stay on the skin for a long time can be found in transdermal patches. The nitroglycerin patch was one of the earliest transdermal patches created in 1985. The patch is based on a rate-controlling ethylene vinyl acetate membrane that was created by Gale and Berggren. At the moment, a number of medications are offered as transdermal patches, including nicotine, scopolamine (hyoscine), fentanyl, clonidine, and estradiol combined with norethisterone acetate. Depending on the drug's therapeutic category, the application location may change [8]. For instance, one can apply estradiol to the abdomen or buttocks and nitroglycerin to the chest. Moreover, the length of the drug's release is contingent upon usage, ranging from the shortest (up to 9 hours) to the longest (up to 9 days).

Components of transdermal patch

Transdermal patches are usually made up of many layers with the purpose of delivering the medication into the bloodstream through the skin. A medicated patch's fundamental components are shown in Fig. 2. Depending on the medication being administered and the intended rate of drug release, the patch's precise shape and composition may change. The patch's outermost layer, known as the backing layer, shields the inner layers from the elements. Typically, a flexible, waterproof substance like polyethylene or polypropylene is used to create this layer. The purpose of the adhesive layer is to adhere and maintain the patch's position on the skin. Usually, it is composed of a skin-friendly, hypoallergenic adhesive that is robust. Drugs that are absorbed through the skin are found in the drug layer. It is designed to release the medications gradually and at a steady pace. The rate at which the medications are released from the patch is managed by the rate-controlling membrane. Typically, semi-permeable materials are used to create membranes, which enable regulated medication passage through the membrane. The patch and adhesive are shielded by the linen. Prior to being placed to the skin's surface, the patch needs to be taken off [9].

ISSN: 2519-9889
Impact Factor: 5.9

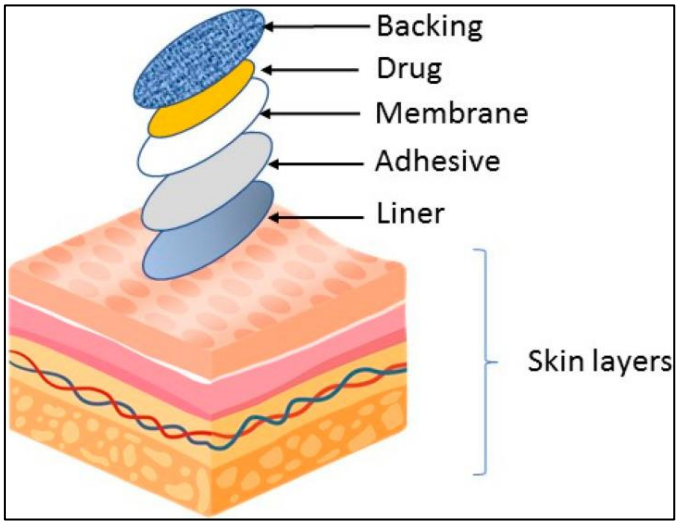

Fig. 2 Components of transdermal patch

Advantages [10]

- It avoids first pass metabolism.
- It avoids gastro intestinal incompatibility.
- Improved patient compliance and comfort through noninvasive drug delivery, painless and simple application.
- Undesirable side effects can also be minimized by the application of transdermal patch.
- The drug with the short half-lives and narrow therapeutic window can easily incorporated in the patches.
- It increases the therapeutic efficacy.
- With patch removal, Drug administration stops.
- Patients who are not able to take oral medications, it is an alternate route.
- Therapeutic activity and extended release can be predicted.

Disadvantages [11]

- Only small, lipophilic drugs can be delivered via transdermal patches.
- Patch size has limit amount of drug, so drug molecule must be potent i.e. must have lowdose.
- Drugs with lowest or high partition coefficient fail to reach blood circulation.
- The drug, adhesive or other excipients can cause Erythema, itching and local edema in the patch formulation

Limitations [12]

- Ionic drugs cannot be delivered by transdermal patches.
- High drug levels in blood/plasma cannot be achieved by transdermal patches.
- Those drugs having large molecular size, cannot be developed into patch formulation.
- If drug or formulation causes irritation/inflammation to skin, transdermal patches cannot develop.

ISSN: 2519-9889
Impact Factor: 5.9

Above mentioned limitations of transdermal patches can be overcome by using innovative approaches recognized as the name Iontophoresis, electroporation and ultrasound.

Transdermal patches available in the market

Table 1. Transdermal patches Available in the Markets [13][14][15]

Brand name	Drug	Manufacture	Diagnosis
Alora	Estradiol	Proctol& Gamble Thera Tech	Postmenstrual symptoms
Androderm	Testosterone	Glaxo smith kline Thera Tech	Hyogonadism
Catapres TTS®	Clonidine	Alza	Hypertension
Clinderm	Estradiol	Wyeth ayerest	Postmenstrual symptom
Deponit	Nitroglycerin	Schwarz Pharma	Heart disorder like angina pectoris
Duragesic ®	Fentanyl	Alza	Moderate Pain
Habitraol	Nicotine	Novartis	Anti-smoking
Minitran	Nitroglycerin	3M Pharmaceutical	Heart Disorder (angina pectoris)
Nicoderm ®	Nicotine	Glaxo smith kline	Anti-smoking
Transdermscop®	Scopolamine	Novartis	Motion sickness

Types

In general, there are four main types of transdermal medical patches (drug-in adhesive, reservoir, matrix, and micro-reservoir systems). Most commercially available patches are categorized as reservoir or matrix systems [16].

Drug-in-Adhesive System

The most basic type of membrane permeability control system is this one. This system's adhesive layer, which holds the many layers together, is drug-containing. The backing and liner are layered with the medication combination.

Reservoir System

The medicine is delivered through the microporous rate-controlling membrane of this device, which is sandwiched between the backing layer and the drug reservoir. Within the reservoir chamber, the medicine may be disseminated in a solid polymer matrix or exist in the forms of a gel, suspension, or solution.

ISSN: 2519-9889
Impact Factor: 5.9

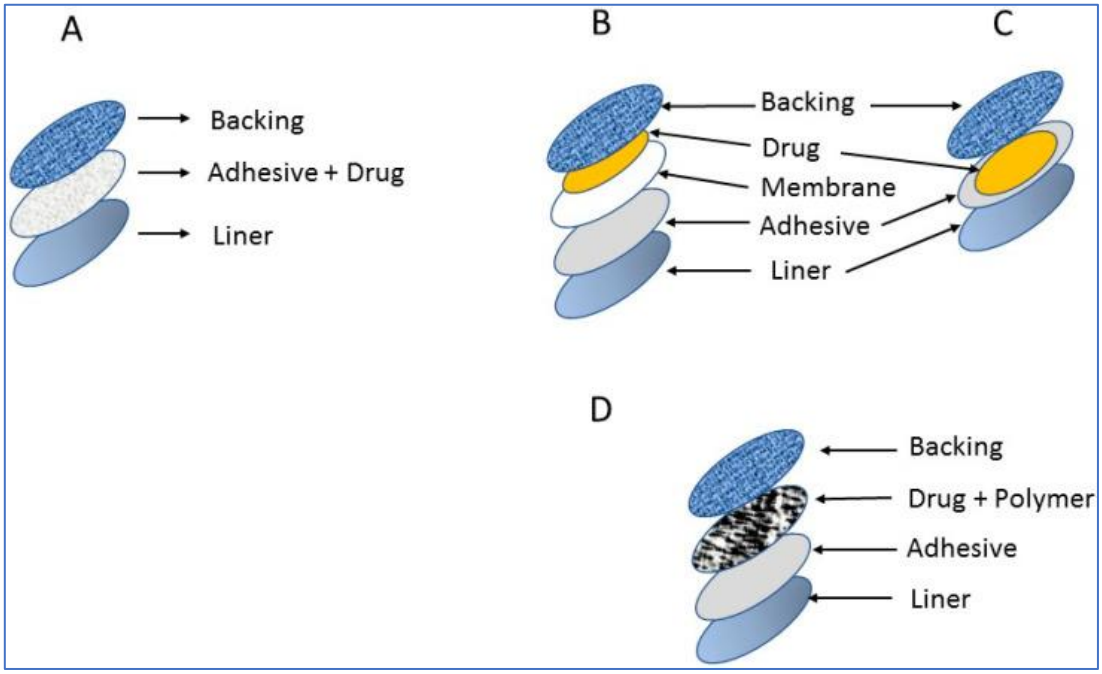

Fig 3. Types of transdermal patches

Matrix System

Drugs are evenly distributed within polymer matrices that are hydrophilic or lipophilic. Affixed to drug-containing discs with regulated thickness and surface area is the resultant drug-containing polymer.

Micro-Reservoir System

This system combines a matrix dispersion system with a reservoir. In order to construct thousands of non-leaching tiny drug reservoirs, the drug is prepared here by first suspending drug solids in an aqueous solution of a water-soluble liquid polymer and then uniformly dispersing the solution in a lipophilic polymer.

Methods of Preparation

- **Mercury Substrate Method**

In this procedure, the necessary quantity of medication is dissolved in a fixed volume of polymer solution together with plasticizer. The aforementioned solution should be mixed for a while to create a uniform dispersion, then left until all air bubbles are gone before being poured into a glass ring that is set over the mercury surface in a glass petri dish. An inverted funnel placed above the petri dish regulates the solvent's rate of evaporation. It is necessary to preserve the dried films in a desiccator [17-21].

ISSN: 2519-9889
Impact Factor: 5.9

- **Circular Teflon Mould Method**

  An organic solvent is used to dissolve solutions that include polymers in different ratios. Half as much of the same organic solvent is used to dissolve the calculated amount of medication. adding plasticizer to the solution of drug polymer. After stirring the entire mixture, pour it into a circular Teflon mould. And the teflon mould was used to place an inverted glass funnel to control the pace of solvent vaporisation. For a whole day, the solvent is left to evaporate. A desiccator is required to keep the dried films [22][23].

- **Glass Substrate Method**

  After allowing the polymeric solutions to expand, the necessary amount of plasticizer and medication solution are added, and everything is mixed for ten minutes. In order to remove any trapped air, it is also left aside for a while before being poured into a dry, clean anumbra petriplate. To regulate the solvent evaporation rate, place a glass funnel upside-down over the petriplate. The dried films are removed and kept in a desiccator after being left overnight [24–26].

- **Using IPM Membranes Method**

  Using a magnetic stirrer, the medication is dissolved in a solution of water and propylene glycol that contains carbomer 940 polymers, and the combination is agitated for a duration of 12 hours. Triethanolamine is to be added to the dispersion in order to neutralise it and make it viscous. If the drug's solubility in aqueous solution is extremely low, solution gel can be created using buffer pH 7.4. The IPM membrane will incorporate the gel that has developed [27].

- **Using EVAC Membranes Method**

  Polyethylene (PE), ethylene vinyl acetate copolymer (EVAC) membranes, and 1% carbopol reservoir gel can all be utilised as rate control membranes to prepare the desired transdermal therapeutic system. Gel is made with propylene glycol if the medication is not soluble in water. Propylene glycol is used to dissolve the drug; carbopol resin is then added to the mixture and neutralised with a 5% w/w sodium hydroxide solution. The medication (in gel form) is applied to a backing layer sheet that covers the designated area. To create a leak-proof device, a rate-regulating membrane will be placed over the gel and the edges will be heated to seal [28].

- **Aluminium Backed Adhesive Film Method**

  If the loading dose for a transdermal drug delivery system is more than 10 mg, unstable matrices may be produced. The adhesive film approach with aluminium backing is appropriate. Since the majority of medications and adhesives are soluble in chloroform, it is the solvent of choice for preparing the same. Adhesive substance is added to the drug solution and dissolved once the drug is dissolved in chloroform. Aluminium foil is used to line a specially constructed aluminium former, and cork blocks that fit firmly are used to blank off the ends [29].

ISSN: 2519-9889
Impact Factor: 5.9

- **Asymmetric TPX Membrane Method**

A heat-sealable polyester film (type 1009, 3m) with a 1cm diameter concave can be used as the backing membrane to create a prototype patch. The drug sample is injected into the concave membrane, sealed with an adhesive, and coated with an asymmetric TPX {poly (4-methyl-1-pentene)} membrane [30].

CONCLUSION

With numerous benefits over alternative administration methods, transdermal patch technology is a useful drug delivery technique. Patches can deliver continuous drug dosing for a longer amount of time by avoiding the first-pass metabolism and digestive system. They are frequently used to administer medications for a range of conditions, including hormone replacement therapy, chronic pain, and motion sickness. Transdermal patch technology has advanced significantly in recent years, with the creation of smart, biodegradable/solvent, high-loading/release, and 3D-printed patches among its numerous innovations.

It concluded that transdermal patches hold promise as a convenient and efficient drug delivery method for a range of conditions; however, there are a number of obstacles that need to be addressed. These include the potential for self-inflicted toxicity due to incorrect dosing, poor adhesion, low drug penetration, potential trigger for skin irritation, or patch failure. In order to maximise the safety and effectiveness of this delivery system, all of this calls for additional study and development.

FUNDING

Nil.

CONFLICT OF INTEREST

Authors declared for none conflict of interest.

REFERENCES

[1]. Selvam RP, Singh AK, Sivakumar T, "Transdermal drug delivery systems forantihypertensive drugs - A review", Int J Pharm Biomed Res 2010, 1(1), 1-8.
[2]. Chien Y.W., Liu J.C. Transdermal drug delivery systems. *J. Biomater. Appl.* 1986;1:183–206.
[3]. Lasagna L., Greenblatt D.J. More than skin deep: Transdermal drug-delivery systems. *N. Engl. J. Med.* 1986;314:1638–1639.
[4]. Berner B., John V.A. Pharmacokinetic characterisation of transdermal delivery systems. *Clin. Pharmacokinet.* 1994;26:121–134.
[5]. Kopper N.W., Gudeman J., Thompson D.J. Transdermal hormone therapy in postmenopausal women: A review of metabolic effects and drug delivery technologies. *Drug Des. Dev. Ther.* 2009;2:193–202.
[6]. Kumar L., Verma S., Singh M., Chalotra T., Utreja P. Advanced Drug Delivery Systems for Transdermal Delivery of Non-Steroidal Anti-Inflammatory Drugs: A Review. *Curr. Drug Deliv.* 2018;15:1087–1099.
[7]. Thirunavukkarasu A., Nithya R., Jeyanthi J. Transdermal drug delivery systems for the effective management of type 2 diabetes mellitus: A review. *Diabetes Res. Clin. Pract.* 2022;194:109996.

ISSN: 2519-9889
Impact Factor: 5.9

[8]. Al Hanbali O.A., Khan H.M.S., Sarfraz M., Arafat M., Ijaz S., Hameed A. Transdermal patches: Design and current approaches to painless drug delivery. *Acta Pharm.* 2019;69:197–215.
[9]. Vamshi Vishnu Y, Chandrasekhar K, Ramesh G and Madhusudan Rao Y, Development of Mucoadhesive Patches for Buccal Administration of Carvedilol, Current Drug Delivery, 2007, 4, 27-39.
[10]. Monika B, Roy A, Bahadur S, Banafar A, Patel M, Turkane D, "Transdermal Drug Delivery System with Formulation and Evaluation Aspects: Overview", Research J. Pharm. and Tech. September 2012, 5(9), 1168-1176.
[11]. Yadav PK, Mishra S, "Transdermal patch of an Antihypertensive drug: its Development and Evaluation", WJPR, 2017, 6(4), 1355-1374.
[12]. Patel D, Chaudhary SA, Parmar B, Bhura N, "Transdermal Drug Delivery System: A Review", 2012, 1(4), 66-75.
[13]. Won Fen Wong, Kuan Ping Ang, Gautam Sethi, and Chung Yeng Looi. Recent Advancement of Medical Patch for Transdermal Drug Delivery. Medicina (Kaunas). 2023 Apr; 59(4): 778.
[14]. Rozenbaum H., Birkhauser M., De Nooyer C., Lambotte R., Pornel B., Schneider H., Studd J. Comparison of two estradiol transdermal systems (Oesclim 50 and Estraderm TTS 50). I. Tolerability, adhesion and efficacy. *Maturitas.* 1996;25:161–173.
[15]. Youngkin E.Q. Estrogen replacement therapy and the estraderm transdermal system. *Nurse Pract.* 1990;15:19–26, 31.
[16]. Wokovich A.M., Prodduturi S., Doub W.H., Hussain A.S., Buhse L.F. Transdermal drug delivery system (TDDS) adhesion as a critical safety, efficacy and quality attribute. *Eur. J. Pharm. Biopharm.* 2006;64:1–8.
[17]. Mohamed Aqil, Yasmin Sultana and Asgar Ali, Matrix Type Transdermal Drug Delivery Systems of Metoprolol Tartrate, *In- vitro* Characterization, Acta Pharm, 2003,53, 119-125.
[18]. Basubramanian V, Iyer and Ravindra C, Vasavada, Evaluation of Lanolin alcohol flims and Kinetics of Triamcinolone Acetonide Release, Journal of Pharmaceutical Sciences, 1979, 68(6),119-125.
[19]. Chowdary K.PR and Naidu R.A.S, Preparation and Evaluation of Cellulose Acetate Films as Rate Controlling Membranes for Transdermal use, Indian Drugs, 1991, 29 (7), 312-315.
[20]. Mamatha T, Venkateswara Rao J, Mukkanti K, Development of Matrix Type Transdermal Patches of Lercanidipine Hydrochloride, Physicochemical and *in-vitro*Characterization, DARU, 2010, 18 (1), 9 -16.
[21]. Sridevi S, Chary M.G, Krishna D.R, Prakash V, Diwan, Pharmacodynamic Evaluation of Transdermal Drug Delivery System of Glibenclamide in Rats, Indian Journal of Pharmacology, 2000, 32, 309-312.
[22]. Sharma Teja, Rawal Gaurav, Transdermal Therapeutic Systems, An overview, International Journal of Pharmaceutical & Biological Archives, 2011, 2(6),1581-1587.
[23]. Wiechers J, Use of Chemical Penetration Enhancers in Transdermal Drug Delivery-Possibilities and Difficulties, Acta Pharm, 1992, 4, 123.
[24]. Ryan F, Donnelly, Paul A, McCarron, Design and Physicochemical Characterization of a Bioadhesive Patch for Dose-Controlled Topical Delivery of Imiquimod, International Journal of Pharmaceutics, 2006, 307,318-325.
[25]. Hemangi J, Patel, Jitendra S, Patel, Keyur D, Patel, Transdermal Patch for Ketotifen Fumarate as Asthmatic Drug, IJPR, 2009,l(1),1297-1304.
[26]. Shalu Rani, Kamal Saroha, Navneet Syan, Transdermal Patches a successful tool in Transdermal Drug Delivery System: An overview, Der Pharmacia Sinica, 2011, 2 (5),17-29.
[27]. Azhar Ahmed, Nirmal Karki, Rita Charde, Manoj Charde, Bhushan Gandhare, Transdermal Drug Delivery Systems, An overview, International Journal of Biomedical and Advance Research, 2011, 02(01),38-56.
[28]. Kanikkannan N, Jayaswal S.B and Singh J, Transdermal Delivery of Indomethacin: Release Profile of Drug from Polymeric Patches, Indian Drugs, 30(9), 441-445.
[29]. Kavitha K and More Mangesh Rajendra, Design and Evaluation of Transdermal Films of Lornoxicam, IJPBS, 2011, 2(2), 54-62.
[30]. Shalu Rani, Kamal Saroha, Navneet Syan, Pooja Mathur, Transdermal Patches A Successful Tool In Transdermal Drug Delivery System: An overview, Der Pharmacia Sinica, 2011, 2 (5), 17-29.

