

# A REVIEW ON HERBAL TRANSDERMAL PATCH USED IN WOUND HEALING

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**Abstract:** This review focuses on the application of herbal transdermal patches in wound healing. These patches deliver therapeutic agents directly through the skin, enabling sustained drug release and improved healing outcomes. Polyherbal formulations combining plant extracts with suitable excipients offer benefits such as reduced inflammation, pain control, and infection prevention. Compared to conventional wound dressings, transdermal patches provide a controlled and patient-friendly approach for managing acute and chronic wounds.

**Keywords -** Transdermal patches, Patches, Wound Healing, Transdermal.

## 1. INTRODUCTION

Wounds are injuries that result in damage to the skin, leading to a loss of its normal structure and protective function. Proper wound healing is essential to restore the anatomical integrity and functional capacity of the affected tissue. Healing is a complex and well-coordinated biological process that begins immediately after injury and involves a series of cellular and biochemical events. These events occur in overlapping phases, namely inflammation, proliferation, and remodeling, each contributing to tissue repair and regeneration. Effective wound healing relies on minimizing tissue damage, maintaining adequate blood circulation and oxygen supply, ensuring proper nutritional support, and providing a moist environment that promotes optimal tissue recovery and functional restoration. [1-4]

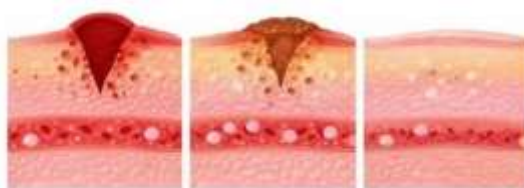


Fig 1:- Wound Healing

## 1.1 WOUND HEALING

Wound formation and subsequent healing occur in all tissues and organs of the body. Wound healing is a complex and dynamic biological process that involves the coordinated interaction of immune responses and cellular activities. Tissue repair following injury progresses through a series of overlapping and time-dependent phases, including hemostasis, inflammation, proliferation, and remodeling, each contributing to the restoration of tissue structure and function. [5-7]

## 1.2 WOUND HEALING PROCESS

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## 1.3 Stages of Wound Healing

- A. **Hemostasis:-** Immediately after injury, the body initiates hemostasis to prevent excessive blood loss. Platelets accumulate at the site of injury and promote clot formation by releasing substances that constrict blood vessels. This clot acts as a temporary barrier, sealing the damaged vessels and providing a foundation for subsequent healing processes. [8,9]
- B. **Inflammation:-** The inflammatory phase follows hemostasis and represents the body's natural defense response to tissue damage. During this stage, chemical mediators released at the wound site cause blood vessels to dilate and become more permeable. Immune cells migrate into the wound area to remove dead tissue, debris, and invading microorganisms, thereby reducing the risk of infection and preparing the tissue for repair. [9]
- C. **Proliferation:-** The proliferative phase is characterized by the formation of new tissue and typically occurs after or alongside inflammation. During this stage, fibroblasts synthesize collagen, while new blood vessels and lymphatic channels grow into the wound. These events lead to the development of granulation tissue, which fills the wound and supports tissue regeneration. [10]
- D. **Maturation (Remodelling):-** The final phase of wound healing involves tissue remodeling, during which unnecessary blood vessels regress and collagen fibers reorganize and strengthen. This process enhances the tensile strength of the

repaired tissue. Although healing may begin within weeks, complete remodeling can take several months to years, with the healed tissue regaining most of its original strength. <sup>[11]</sup>

## 2. TRANSDERMAL DRUG DELIVERY SYSTEM (TDDS)

Transdermal drug delivery is an important approach within modern novel drug delivery systems, in which therapeutic agents are administered through the skin using medicated patches. This method is non-invasive, easy to use, and generally painless, making it more acceptable to patients. By delivering drugs directly into systemic circulation, transdermal systems help reduce gastrointestinal side effects and bypass hepatic first-pass metabolism <sup>[12]</sup> In addition, these systems are designed to regulate the rate of drug release, ensuring sustained delivery and maintenance of effective drug levels in the body over an extended period. <sup>[13-14]</sup>

### 2.1 Advantages of Transdermal Drug Delivery System:- <sup>[15,16]</sup>

1. Transdermal drug delivery systems offer several therapeutic benefits that improve treatment outcomes and patient compliance.
2. These systems reduce the need for frequent dosing by providing sustained drug release, which can enhance bioavailability while allowing the use of lower drug doses.
3. Since drugs are absorbed through the skin, issues related to gastrointestinal degradation, food interactions, and liver metabolism are minimized.
4. The non-invasive nature of transdermal patches eliminates the discomfort associated with injections and allows easy self-administration.
5. Additionally, drug therapy can be quickly discontinued by removing the patch, which improves safety.
6. Overall, transdermal systems provide prolonged therapeutic action, reduce systemic drug interactions, and contribute to better patient adherence during long-term treatment.

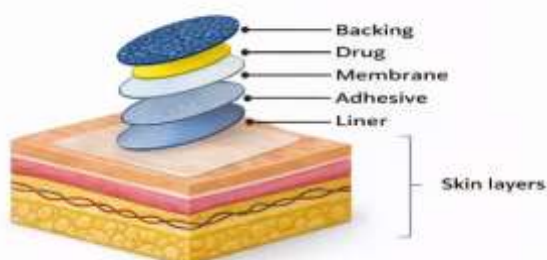
## 3. TRANSDERMAL PATCHES

Transdermal patches represent a modern drug delivery approach designed to overcome the limitations associated with oral and injectable dosage forms. These systems allow drugs to be administered through the skin in a controlled manner, helping to maintain consistent plasma drug levels while reducing the need for repeated dosing. <sup>[17,18]</sup> By bypassing gastrointestinal degradation and hepatic first-pass metabolism, transdermal patches can enhance drug availability and minimize patient discomfort related to injections. <sup>[19,20]</sup> An additional safety advantage is that drug delivery can be promptly discontinued by removing the patch. Owing to these benefits, transdermal patches have gained widespread acceptance for the delivery of various therapeutic agents, including nicotine patches <sup>[21,22,23]</sup>, lidocaine patches, ketoprofen patches <sup>[24]</sup>, meloxicam patches <sup>[25]</sup>, and other analgesic or anti-inflammatory drugs. <sup>[26-29]</sup>



**Fig 2:-** Transdermal Patch

The transdermal delivery of many therapeutic agents is often limited or ineffective due to the complex and variable barrier presented by the stratum corneum. Herbal drugs, however, hold potential to play a significant role in the treatment of various skin disorders. <sup>[30]</sup> Medicinal herbs contain bioactive compounds capable of positively influencing human physiology, which has contributed to the growing popularity of herbal medicine as a healthcare approach. Nevertheless, it is important to recognize that herbs differ fundamentally from conventional pharmaceuticals. While some herbal extracts have demonstrated measurable effects for specific conditions, their efficacy cannot be assumed without proper validation. Rigorous clinical trials using standard methodologies are necessary to confirm their benefits, ensuring that herbal therapies are both safe and effective.



**Fig 3:-** Basic Components of transdermal Patch

### 3.1 Types of Transdermal Patches

**1. Single-Layer Drug-in-Adhesive:-** In this type, the adhesive layer not only secures the patch to the skin but also facilitates the release and penetration of the drug. All components, including the active pharmaceutical ingredient (API) and excipients, are incorporated into a single adhesive layer. This design allows the drug to be released immediately upon application. <sup>[31]</sup>

**2. Multi-Layer Drug-in-Adhesive:-** This system is similar to the single-layer patch but contains multiple adhesive layers to achieve controlled or sequential drug release. Typically, one layer provides immediate release, while additional layers are formulated for sustained or predetermined drug delivery. <sup>[32,33]</sup>

**a) Reservoir System:-** In the reservoir system, the drug is contained in a separate compartment, usually as a solution or suspension, which is separated from the skin by a semipermeable membrane. An adhesive layer ensures the patch stays in place and allows the drug to diffuse gradually into the skin. <sup>[34,35]</sup>

**b) Matrix System (Monolithic System):** In the matrix system, the drug is dispersed within a semisolid matrix that is surrounded by an adhesive layer. This design ensures the patch adheres to the skin while allowing the drug to be released steadily over time.

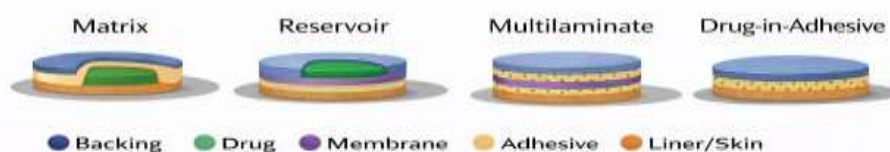


Fig 4:- Types of Transdermal Patches

## 4. HERBAL MEDICINE IN TRANSDERMAL PATCHES

According to the World Health Organization, traditional medicine refers to healthcare practices and therapeutic methods that have been used for centuries, long before the advent of modern medicine, and continue to be applied today. These practices are often based on the accumulated knowledge and experiences of indigenous medical practitioners. <sup>[36]</sup>

Herbal transdermal patches represent a fusion of time-honored herbal remedies with contemporary transdermal drug delivery technology. Using transdermal systems for herbal medicines can enhance their effectiveness while minimizing side effects. Such patches are increasingly applied for managing conditions like muscle pain, anxiety, microbial infections, wound repair, sleep disturbances, and even weight control. <sup>[37]</sup>

### 4.1 Commonly Used Medicinal Plants in Wound Healing

#### 1. Aloe vera

Aloe vera, also called Kumari, is a medicinal plant commonly found across India. It has a short stem, shallow roots, and thick, succulent leaves, often growing wild in arid regions. <sup>[38,39]</sup>

The plant contains over 100 bioactive compounds that contribute to its therapeutic effects, including antibacterial, anti-inflammatory, antioxidant, anticancer, and wound healing properties. <sup>[40]</sup> Research indicates that Aloe vera leaf pulp can promote faster wound repair compared to conventional treatments like 5% Povidone Iodine ointment. <sup>[41,42]</sup>

Histological studies show that Aloe vera gel enhances epithelialization, new blood vessel formation, and wound contraction. <sup>[43]</sup> Its mucilage strengthens collagen cross-links without altering their structure, further supporting tissue regeneration. <sup>[44,45]</sup>

#### 2. Calendula (*Calendula officinalis*)

Calendula, or pot marigold, is a garden plant native to southern Europe, growing up to 60 cm tall with bright yellow or orange flowers. The flowers are the primary medicinal part, used for treating dermatological conditions. Its bioactive compounds, mainly triterpenoids, exhibit anti-inflammatory and wound healing effects.

Calendula can enhance angiogenesis and stimulate collagen, nucleoprotein, and glycoprotein metabolism, which improves local blood circulation and promotes granulation tissue formation. <sup>[46]</sup>

#### 3. Turmeric (*Curcuma longa*)

Turmeric, derived from the root of *Curcuma longa* and a member of the ginger family (Zingiberaceae), has been used in traditional medicine for centuries. Curcumin, its main active compound, possesses wound healing, anti-inflammatory, antioxidant, antimicrobial, and anticancer properties. <sup>[47]</sup> It supports multiple stages of wound repair by promoting granulation tissue formation, collagen deposition, tissue remodeling, and wound contraction. <sup>[48]</sup>

Curcumin also influences growth factor production and cellular processes involved in healing, and its effects are dose-dependent, stimulating repair at lower concentrations while potentially inhibiting it at higher levels. <sup>[49,50]</sup>

#### 4. Neem (*Azadirachta indica*)

Neem, a fast-growing tree in the Meliaceae family, is native to India and tropical regions of Southeast Asia. Various parts of the tree—including leaves, seeds, and bark—are used to treat skin diseases, infections, asthma, ulcers, and other conditions.

Neem extracts have demonstrated antimicrobial activity, helping prevent secondary infections in wounds, while also exhibiting anti-inflammatory effects that contribute to tissue repair. Alcoholic extracts of neem are commonly applied to eczema, ringworm, and scabies. <sup>[51]</sup>

## 5. Tulsi (*Ocimum sanctum*)

Tulsi, or holy basil, is a widely distributed plant in India and other regions, belonging to the Lamiaceae family. It shows anti-inflammatory, analgesic, immunostimulatory, antimicrobial, and free radical-scavenging activities, which collectively support wound healing. Key chemical constituents include cirsilineol, circimaritin, isothymusin, apigenin, rosmarinic acid, and eugenol. Studies suggest that aqueous extracts from Tulsi leaves can enhance wound closure and tissue regeneration. <sup>[52]</sup>

## 5. COMPARISON BETWEEN

Traditional medicine (TRM) refers to the collective body of knowledge, skills, and healthcare practices developed within different cultures and passed down through generations. These practices are applied for health maintenance as well as for the prevention, diagnosis, and treatment of physical and mental disorders. <sup>[53]</sup> According to estimates by the World Health Organization, a significant proportion of the population in developing countries relies primarily on traditional and herbal medicines for healthcare needs. <sup>[54,55]</sup>

In recent years, there has been a noticeable global rise in interest toward traditional medical systems and herbal therapies. This trend is particularly evident in regions where access to advanced medical technologies is limited. <sup>[56]</sup> At the same time, populations in developed countries have also shown growing acceptance of herbal medicines and alternative practices such as acupuncture. Several studies have highlighted the expanding use of Complementary and Alternative Medicine (CAM). Surveys conducted in the United States revealed a steady increase in CAM utilization during the 1990s, along with substantial consumer spending on alternative therapies and herbal products, reflecting their increasing economic and therapeutic significance worldwide. <sup>[57-59]</sup>

More recently, attention has shifted toward the development of integrative medicine, which combines conventional medical treatments with evidence-based complementary therapies. Integrative medicine emphasizes the selective and rational incorporation of CAM practices into standard diagnostic and therapeutic approaches. <sup>[60]</sup> In developed nations, this typically involves blending alternative therapies with modern medicine, whereas in developing countries it may also include the formal inclusion of traditional medical systems within national healthcare frameworks. The successful integration of herbal medicine into modern therapeutic practices requires a scientific evaluation of quality, safety, and efficacy. <sup>[61]</sup>

### 6.1 Advantages

Herbal transdermal patches offer several potential benefits: <sup>[62-65]</sup>

- 1) They provide a controlled and sustained release of herbal constituents over extended periods.
- 2) Absorption through the skin allows active compounds to bypass gastrointestinal degradation and hepatic first-pass metabolism, improving bioavailability.
- 3) Patches enable easy and non-invasive administration, enhancing patient compliance.
- 4) Drug delivery can be terminated immediately by removing the patch if adverse effects occur.
- 5) Continuous and prolonged therapeutic action can be achieved.
- 6) Reduced systemic drug interactions and gastrointestinal irritation are observed.
- 7) Self-administration is possible, making them suitable for long-term therapy.
- 8) They can enhance the transport of polar and high-molecular-weight substances.

### 6.2 Disadvantages <sup>[67]</sup>

Despite their advantages, transdermal patches have certain limitations:-

- 1) Hydrophilic and ionic drugs often exhibit poor skin permeability.
- 2) Skin-related adverse reactions such as redness, swelling, and itching may occur.
- 3) They are generally unsuitable for acute medical conditions.
- 4) Sudden release of a large drug dose (dose dumping) may take place under certain conditions.
- 5) Transdermal systems are typically more expensive than conventional dosage forms.

### 6.3 Applications <sup>[68-70]</sup>

Transdermal patches are widely used in various therapeutic areas: -

- 1) They deliver drugs such as hormones and analgesics in a controlled manner.
- 2) Oestrogen patches are used to manage menopausal symptoms and post-menopausal osteoporosis.
- 3) Nicotine patches assist in smoking cessation by reducing withdrawal symptoms.
- 4) Local anaesthetic patches provide pain relief during minor procedures.
- 5) Antihypertensive agents, such as clonidine, are also available in transdermal formulations.

## 7. FUTURE CHALLENGES AND PROSPECTS

Transdermal drug delivery is a non-invasive and patient-friendly approach that reduces discomfort compared to injections and avoids the hepatic first-pass metabolism associated with oral medications. <sup>[71]</sup> Despite these advantages, its effectiveness is often limited by the skin's strong barrier properties, which restrict the penetration of many drugs based on their physicochemical characteristics. <sup>[72]</sup>

Recent studies have highlighted the growing potential of bacterial cellulose in wound care and skin regeneration. Owing to its excellent biocompatibility, porous structure, and mechanical stability, bacterial cellulose closely resembles the skin's extracellular

matrix, supporting cell attachment and tissue repair. Additionally, it can serve as an effective carrier for therapeutic agents and functional additives, allowing enhancement of its antibacterial activity, which is otherwise limited in its natural state.<sup>[73]</sup>

Plant-based medicines have been used for centuries, with cannabis being a notable example of a natural therapeutic agent historically employed in pharmaceutical formulations. Although the use of such natural compounds declined with the development of synthetic drugs, renewed interest has emerged due to concerns over drug resistance, safety, and long-term adverse effects associated with synthetic therapies.<sup>[74]</sup>

The skin plays a crucial role in protection and temperature regulation, yet wound healing remains a complex and time-consuming process.<sup>[75]</sup> Factors such as prolonged inflammation, slow tissue regeneration, and increased infection risk emphasize the need for advanced wound dressings and innovative transdermal delivery systems. These challenges underline the importance of continued research into biocompatible materials and novel therapeutic strategies for effective wound management.

## 8. CONCLUSION

Herbal transdermal patches enable the sustained and controlled delivery of therapeutic agents while avoiding hepatic first-pass metabolism and reducing systemic side effects, making them advantageous over conventional oral and injectable formulations. This review highlights key formulation strategies, delivery mechanisms, and technological innovations that have improved the performance of these systems.

Advances in nanotechnology, biodegradable polymers, and responsive delivery platforms have enhanced drug penetration, stability, and therapeutic efficacy. The use of natural permeation enhancers and hydrogel-based systems has further improved skin absorption and patient compliance. However, limitations such as low skin permeability, potential irritation, and regulatory challenges continue to restrict widespread clinical and commercial use.

Future research should focus on improving bioavailability, developing advanced polymeric carriers, conducting robust clinical studies, and standardizing herbal extracts in line with regulatory requirements. Overall, continued innovation in herbal transdermal patch technology holds strong promises for establishing a safe, effective, and sustainable alternative for herbal drug delivery across various medical applications.

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