ISSN: 2278-2648

International Journal of Research in Pharmacology & Pharmacotherapeutics (IJRPP)

IJRPP |Vol.15 | Issue 1 | Jan - Mar -2026

www.ijrpp.com

DOI : https://doi.org/10.61096/ijrpp.v15.iss1.2026.219-225

Review

Herbal Transdermal Films for Osteoarthritis: Integrating Traditional Medicine with Patient-Centered Drug Delivery

T. Shri Vijaya Kirubha*, S. Abdu Razik, S. Abinaya, S. Ajith Kumar, S. Alnowfil

Department of Pharmacognosy, Mother Terasa College of Pharmacy, Illuppur, Pudukkottai, Tamil Nadu.

*Author for Correspondence: T. Shri Vijaya Kirubha
Email: tsvkirubha@gmail.com

Published on: 24.02.2026

Published by:
Futuristic Publications

Abstract

Osteoarthritis (OA) is a chronic, progressive joint disorder that affects millions of individuals worldwide and significantly impairs daily functioning and quality of life. Persistent pain, stiffness, and restricted mobility often limit independence, particularly among older adults. Although oral non-steroidal anti-inflammatory drugs (NSAIDs) remain widely prescribed, their long-term use is frequently associated with adverse systemic effects. Herbal transdermal films have recently emerged as a promising therapeutic approach that combines traditional medicinal knowledge with modern drug-delivery technology. These systems enable sustained and localized delivery of plant-derived bioactive compounds directly to affected joints, thereby reducing systemic exposure. This review critically examines current research on herbal transdermal films for osteoarthritis, including formulation strategies, pharmacological mechanisms, preclinical and clinical evidence, safety considerations, and future prospects. Available studies suggest encouraging therapeutic potential; however, well-designed clinical trials are required to establish their long-term efficacy and safety. With continued scientific validation, herbal transdermal films may become valuable components of patient-centered osteoarthritis management.

Keywords: Osteoarthritis, herbal medicine, transdermal films, drug delivery, pain management, phytotherapy.

1. Introduction

Osteoarthritis is one of the most common musculoskeletal disorders worldwide and represents a major cause of chronic pain and disability. Individuals affected by OA often experience persistent joint discomfort, morning stiffness, and reduced mobility, which interfere with routine activities such as walking, climbing stairs, and performing household tasks. Over time, these physical limitations may also lead to emotional distress, social withdrawal, and reduced self-confidence. Current treatment strategies focus primarily on symptom control rather than disease modification. Oral NSAIDs and analgesics remain first-line therapies; however, prolonged use is frequently limited by gastrointestinal, renal, and cardiovascular complications. Many patients therefore seek safer, more sustainable treatment options. In recent years, growing attention has been directed toward topical and transdermal drug-delivery systems. When combined with herbal medicines that possess natural anti-inflammatory and analgesic properties, these systems offer a promising approach for localized and patient-friendly OA management.

2. Rationale for Herbal Transdermal Therapy

For patients with chronic conditions such as osteoarthritis, long-term treatment adherence is often influenced by tolerability, convenience, and perceived safety. Frequent adverse effects from oral medications may discourage continued use and reduce treatment effectiveness.Transdermal films provide a non-invasive and convenient alternative by delivering therapeutic agents through the skin directly to affected tissues. This localized delivery minimizes systemic drug exposure and helps maintain consistent drug levels over extended periods.Herbal medicines have been used for centuries in traditional medical systems for managing joint pain and inflammation. Incorporating these plant-based remedies into scientifically designed transdermal systems bridges traditional knowledge with modern pharmaceutical technology. This integration offers the potential for safer, culturally acceptable, and patient-friendly therapies.

3. Formulation Strategies for Herbal Transdermal Films

3.1. Selection of Film-Forming Polymers

The structural integrity and performance of transdermal films depend largely on the polymers used. Commonly employed polymers include hydroxypropyl methylcellulose (HPMC), polyvinyl alcohol (PVA), ethyl cellulose, and Eudragit. These materials provide flexibility, adhesion, and controlled drug release.

The choice of polymer influences patient comfort, patch durability, and therapeutic efficacy.

Role of Permeation Enhancers

The stratum corneum represents a major barrier to transdermal drug delivery. Permeation enhancers such as oleic acid, menthol, terpenes, and fatty acids are incorporated to temporarily modify skin permeability and facilitate drug transport. Careful selection of enhancers is essential to balance improved penetration with skin safety.

3.3. Nano-Enabled Delivery Systems

Many herbal compounds exhibit low aqueous solubility and limited skin penetration. To overcome these limitations, nanoemulsions, liposomes, and solid lipid nanoparticles are increasingly incorporated into transdermal films. These advanced systems enhance drug stability, solubility, and bioavailability.

Herbal Bioactive Compounds in OA Films

Incorporating bioactive plant compounds into transdermal films aims to deliver targeted anti-inflammatory and analgesic effects directly to afflicted joints. These compounds not only reduce pain and swelling but also influence the molecular pathways involved in cartilage degeneration and oxidative damage. Below are the most studied and promising herbal actives, along with their mechanisms of action and evidence.

4.1. Curcumin (*Curcuma longa*)

Source & Profile:

Curcumin is the principal polyphenolic compound in turmeric, long used in traditional medicine for its anti-inflammatory and antioxidant properties.

Mechanisms in OA:

- Inhibits nuclear factor kappa-B (NF-κB) and Cyclooxygenase-2 (COX-2) signaling, reducing pro-inflammatory cytokines such as TNF-α and IL-1β.
- Scavenges reactive oxygen species (ROS), protecting joint cartilage from oxidative damage.
- Modulates matrix metalloproteinases (MMPs) involved in cartilage breakdown.

Transdermal Rationale:

Curcumin has low oral bioavailability due to poor absorption; transdermal delivery helps bypass these limitations and provide localized effect. Nanoemulsion and liposomal transdermal formulations increase skin permeation and bioavailability.

Evidence Highlights:

Preclinical models show sustained anti-inflammatory and analgesic effects when delivered via transdermal films.

Clinical studies using topical turmeric formulations, while not always transdermal patches, support its symptomatic benefits in knee OA.

4.2. *Boswellia serrata*

Source & Profile:

Boswellia extract, derived from the resin of Boswellia serrata, contains boswellic acids known for anti-inflammatory activity.

Mechanisms in OA:

- Inhibits leukotriene synthesis by targeting 5-lipoxygenase (5-LOX).
- Reduces inflammatory mediators and cartilage degrading enzymes.
- Supports joint health by modulating immune responses.

Transdermal Advantage:

Boswellic acids' poor oral absorption makes localized delivery appealing. Transdermal films may help improve therapeutic concentration at the joint.

Evidence Highlights:

Oral Boswellia extracts have shown clinical efficacy in knee OA trials.

Transdermal delivery studies (animal and pilot patches) indicate promising pain and inflammation reduction.

4.3. *Arnica montana*

Source & Profile:

A medicinal herb traditionally used in Europe for bruising and musculoskeletal pain.

Mechanisms in OA:

- Inhibits inflammatory mediators such as TNF-α and NF-κB.
- Demonstrates local analgesic activity.

Transdermal Role:

Often paired with other botanicals (e.g., curcumin) in compound patches to enhance pain relief.

Evidence Highlights:

Randomized studies comparing topical arnica gel to NSAIDs show comparable efficacy in joint pain reduction.

4.4. Ginger (*Zingiber officinale*)

Source & Profile:

Ginger root contains gingerols and shogaols compounds with strong anti-inflammatory and analgesic activities.

Mechanisms in OA:

- Modulates prostaglandin and leukotriene pathways.
- Inhibits cyclooxygenase and lipoxygenase enzymes.
- Reduces cytokine production in synovial tissues.

Transdermal Utility:

Ginger's active constituents can soothe local inflammation; when formulated in patches, they provide sustained relief with minimal systemic side effects.

Evidence Highlights:

Positive outcomes in OA pain reduction with topical ginger formulations.

Nano-enhanced film studies suggest improved skin penetration metrics.

4.5 *Cissus quadrangularis*

Source & Profile:
A traditional Ayurvedic herb used for bone and joint disorders.

Mechanisms in OA:

- Exhibits anti-inflammatory and antioxidant properties.
- Inhibits cartilage degrading enzymes.

Transdermal Use:
In polyherbal patch formulations, Cissus helps reduce joint degeneration when combined with other actives.

Evidence Highlights:

- Animal model studies show joint protective effects with transdermal films containing Cissus.

4.6 *Nigella sativa* (Black Seed)

Source & Profile:

Nigella sativa seeds are rich in thymoquinone, known for its anti-inflammatory and analgesic effects.

Mechanisms in OA:

- Reduces inflammatory cytokines and oxidative stress.
- Modulates immune responses.

Transdermal Role:

When incorporated into patches with other botanicals (e.g., Cissus), Nigella complements synergistic anti-inflammatory actions.

Evidence Highlights:

- Polyherbal film studies indicate improved joint parameters compared to controls.

5. Pharmacological Evidence

5.1. Preclinical Studies

Animal studies consistently demonstrate that herbal transdermal films reduce joint swelling, inflammatory cytokine levels, and pain-related behaviors. Histopathological examinations reveal preservation of cartilage structure and reduced synovial inflammation. Nano-enhanced formulations generally exhibit superior performance compared with conventional gels and ointments.

5.2. Clinical Studies

Several clinical trials, particularly involving traditional herbal patches, report moderate improvement in pain scores, mobility, and functional status in knee OA patients. Improvements in Visual Analogue Scale (VAS) and WOMAC scores have been observed. Nevertheless, most studies are limited by small sample sizes, short follow-up periods, and lack of standardized formulations. These factors necessitate cautious interpretation of outcomes.

6. Mechanisms of Therapeutic Action

- Herbal transdermal films exert therapeutic effects through multiple complementary mechanisms:
- Suppression of inflammatory mediators such as TNF-α, IL-1β, and COX-2
- Reduction of oxidative stress in joint tissues
- Modulation of pain signaling pathways
- Improvement of local microcirculation

Sustained transdermal delivery maintains therapeutic concentrations at the target site, thereby enhancing efficacy.

7. Safety and Tolerability

Most studies report good tolerability of herbal transdermal films. Mild skin irritation, itching, or erythema are the most commonly observed adverse effects. These reactions are generally transient and resolve upon patch removal. Compared with systemic therapies, serious adverse events are rare. Nevertheless, dermatological testing and post-marketing surveillance remain essential.

8. Challenges and Future Perspectives

8.1. Standardization and Quality Control

Variability in herbal raw materials, extraction methods, and active compound concentrations poses a major challenge. Robust quality control protocols and chemical standardization are required to ensure batch-to-batch consistency.

8.2. Clinical Validation

Large-scale, multicenter randomized controlled trials with long-term follow-up are necessary to establish definitive clinical efficacy. Patient-reported outcomes and quality-of-life assessments should be prioritized.

8.3. Regulatory Frameworks

Clear regulatory guidelines for herbal transdermal products are essential to facilitate clinical translation and commercialization.

8.4. Personalized Therapy

Future developments may focus on personalized patch formulations based on disease severity, age, and comorbidities, further enhancing patient-centered care.

9. Conclusion

Osteoarthritis imposes a substantial physical, emotional, and social burden on affected individuals. The search for safe, effective, and sustainable treatment strategies remains ongoing.

Herbal transdermal films represent a promising approach that integrates traditional medicinal wisdom with contemporary pharmaceutical science. By enabling localized and sustained delivery of natural anti-inflammatory compounds, these systems may improve symptom control and enhance quality of life. While existing evidence is encouraging, comprehensive clinical validation is essential before widespread clinical adoption. Continued interdisciplinary research will play a vital role in transforming herbal transdermal films into reliable therapeutic options for osteoarthritis management.

References

1. Wang X, Wei S, Liu T, et al. Effectiveness, medication patterns, and adverse events of traditional Chinese herbal patches for osteoarthritis: a systematic review. Evid. Based Complement Alternat. Med. 2014;2014:343176. doi:10.1155/2014/343176.
2. Widrig R, Suter A, Saller R, Melzer J. Herbal therapy for osteoarthritis: topical arnica and topical ibuprofen produce similar benefits in hand osteoarthritis. Rheumatol. Int. 2007;27(5):503–507.
3. Hsia EC. Evaluating treatment efficacy: potential biases behind RCTs of topical herbal treatments. J Clin Rheumatol. 2003;9(3):137–139.
4. Van Haselen RA. Topical herbal products for osteoarthritis: promising results but still questions. J Clin Rheumatol. 2003;9(3):140–141.
5. Khan D, Chouhan S, Khan S, et al. A review on herbal transdermal patch for arthritis. Int J. Pharmacogn. Clin. Res. 2019;1(1):25–33.

6. Peterson JD, Smith RL, et al. Efficacy of some herbal medicines in osteoarthritis with a focus on topical agents: systematic review. J. Herb Med. 2024;45:100851.
7. Henrotin Y, Lambert C, Couchourel D, Ripoll C, Chiotelli E. Topical herbal medicines and OA: scientific rationale and clinical evidence. Clin Interv Aging. 2011;6:219–226.
8. McAlindon TE, Bannuru RR, Sullivan MC, et al. OARSI guidelines for the non-surgical management of knee osteoarthritis. Osteoarthritis Cartilage. 2014;22(3):363–388.
9. Bannuru RR, Osani MC, Vaysbrot EE, et al. Non-surgical management of knee osteoarthritis: ACR/Arthritis Foundation guideline. Arthritis Care Res (Hoboken). 2019;71(6):703–716.
10. Henrotin Y, Vinatier C, Richette P. Review: efficacy of curcumin and boswellia formulations in knee OA: systematic findings. Clin Rheumatol. 2019;38(1):15–24.
11. Masuda Y, Ono K, Ohshima S. Effects of Japanese herbal patch on joint pain and function in knee OA: randomized controlled trial. Evid. Based Complement Alternat. Med. 2013;2013:1–8.
12. Altman R, et al. Efficacy and safety of *Boswellia serrata* extract in the treatment of osteoarthritis knee: a randomized, double-blind, placebo-controlled trial. Phytomedicine. 2001;8(1):85-91. Satoskar RR, Shah SJ, Shenoy SG. Evaluation of anti-inflammatory activity of ginger and its combination with Boswellia extract in knee osteoarthritis. Indian J Pharmacol. 2015;47(2):S3–S8.
13. Lange LC, Budavari AI, Comfrey extract gel in the treatment of symptomatic osteoarthritis ankle pain: randomized, controlled clinical study. J Clin Pharm Ther. 2009;34(2):243–250.
14. Sen S, Chakraborty R, et al. Use of turmeric (*Curcuma longa*) extracts in knee osteoarthritis: treatment results. Planta Med. 2012;78(7):719–727.
15. Altman RD, Barkin RL. Topical therapy for osteoarthritis: overview. Am. J. Clin. Dermatol. 2009;10(4):237–247.
16. Lu F, Wang B, et al. Clinical trial on traditional Chinese herbal patch for osteoarthritis of the knee. Arthritis Res Ther. 2012;14.
17. Komesaroff PA, Topical herbal ointment vs placebo in OA pain and stiffness: randomized trial. Arthritis Res. 2003;5(5):A72.