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HERBAL NANOFORMULATIONS AND TRANSDERMAL PATCHES: A COMPREHENSIVE REVIEW ON ADVANCED PHYTOPHARMACEUTICAL DELIVERY SYSTEMS

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Abstract

Herbal medicines are widely recognized for their therapeutic benefits; however, limitations such as poor solubility, low bioavailability, and rapid degradation restrict their clinical efficacy. Recent advancements in nanoformulation and transdermal delivery systems have provided solutions to overcome these limitations. Herbal nanoformulations enhance solubility, stability, and targeted delivery, while herbal transdermal patches offer non-invasive administration, bypassing first-pass metabolism and maintaining steady plasma concentrations. The combination of nanotechnology with transdermal patches further improves bioavailability, skin permeation, and therapeutic efficiency. This review summarizes the definition, preparation methods, key aspects, advantages, challenges, and recent marketed products of herbal nanoformulations, herbal transdermal patches, and nano-enhanced transdermal patches. Tables include examples of marketed products with composition, manufacturer, country, particle size, and encapsulation efficiency, providing an updated overview for researchers and clinicians.

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Introduction

Herbal medicine, which involves the therapeutic use of bioactive compounds derived from plants, has been practiced since ancient times and continues to play a crucial role in primary healthcare systems worldwide. Phytoconstituents such as flavonoids, alkaloids, terpenoids, and polyphenols are widely acknowledged for their antioxidant, anti-inflammatory, hepatoprotective, anticancer, and antimicrobial activities [1]. Despite this vast therapeutic potential, the clinical translation of herbal drugs remains limited due to several pharmacokinetic and physicochemical challenges, including poor aqueous solubility, low oral bioavailability, rapid metabolism, chemical instability, and non-specific tissue distribution [2]. Consequently, innovative strategies are required to enhance their therapeutic efficacy and patient compliance.

One promising approach is the development of herbal nanoformulations, which involve the encapsulation or incorporation of phytoconstituents into nanocarrier systems. These nano-sized delivery systems, typically in the range of 1–1000 nm, improve solubility, enhance permeability, prolong circulation time, and facilitate controlled release of herbal actives [3]. Nanoformulations also provide protection from enzymatic or environmental degradation and enable site-specific delivery, thereby reducing the required dose and potential side effects [4]. Among the diverse fabrication methods, two major categories are widely reported: (i) lipid-based nanocarrierssuch as liposomes, solid lipid nanoparticles (SLNs), and nanostructured lipid carriers (NLCs), which mimic biological membranes and enhance absorption across biological barriers; and (ii) polymeric nanoparticles made from biocompatible

and biodegradable polymers such as poly(lactic-co glycolicacid) (PLGA), chitosan, and gelatin, which offer sustained release and improved protection of sensitive phytoconstituents [5,6]. However, herbal nanoformulations face several critical challenges. These include the complexity of large-scale manufacturing, potential nanocarrier-associated toxicity, batch-to-batch variability, and high production costs. Additionally, regulatory hurdles and the absence of harmonized quality control standards for herbal nanomedicines further restrict their progression from laboratory research to clinical application [7, 8]. Another evolving strategy for phytoconstituent delivery is the use of herbal transdermal patches. This system enables the delivery of active plant-derived compounds through the skin, providing advantages such as non-invasive administration, avoidance of first-pass metabolism, controlled and sustained drug release, and improved patient compliance9. The preparation methods commonly employed include solvent casting and hot-melt extrusion, where the herbal extracts are dispersed or embedded within a polymeric matrix. The performance of these patches is determined by key parameters such as polymer type and ratio, skin permeability enhancers, patch adhesion, mechanical strength, and dose uniformity10. Despite these benefits, the transdermal route presents notable challenges, particularly limited permeability of certain hydrophilic or large-molecular-weight phytoconstituents, possible skin irritation or sensitization, chemical instability of herbal compounds within the matrix, and the need for dose standardization to ensure reproducible therapeutic outcomes [9,11].

To further improve the therapeutic profile, nano-enhanced herbal transdermal patches have recently been developed. These advanced systems combine the advantages of nanocarriers with the benefits of transdermal delivery. By incorporating nano-formulatedphytoconstituents (e.g., curcumin, resveratrol, cannabidiol), these patches facilitate enhanced penetration through the stratum corneum, improve drug retention in deeper skin layers, and sustain systemic delivery [12]. Critical formulation aspects include optimization of particle size, zeta potential, encapsulation efficiency, drug-polymer compatibility, adhesion properties, and storage stability. These nano-transdermal systems have demonstrated superior pharmacokinetic profiles and therapeutic efficiency compared to conventional patches [13]. However, their development is still constrained by several challenges such as ensuring uniform distribution of nanoparticles within the patch, maintaining mechanical integrity and flexibility, preventing aggregation or leakage of nanocarriers, and addressing regulatory and safety concerns regarding the long-term effects of nanomaterials [14,15].

In summary, the integration of nanotechnology with herbal medicine has opened new frontiers in phytopharmaceutical research. While herbal nanoformulations, transdermal patches, and nano-enhanced transdermal systems hold great promise for improving the delivery and efficacy of plant-based therapeutics, further research is required to overcome the existing formulation, scalability, cost, and regulatory challenges. Future advances are likely to focus on green nanotechnology approaches, patient-centric designs, and harmonized global regulations, thereby paving the way for successful clinical translation of these innovative drug delivery systems.

These advanced delivery systems, summarized in Tables 01–03, highlight the marketed products, compositon characterization and applications of herbal nanoformulations, transdermal patches, and nano-enhanced patches, which together hold promise for improving phytopharmaceutical therapy and clinical translation.

Table 1 provides an overview of marketed herbal nanoformulations, describing the phytoconstituents used, formulation types, and techniques applied. These nano-delivery systems, including liposomes, phytosomes, nanoemulsions, and polymeric nanoparticles, are designed to overcome solubility and bioavailability limitations while enhancing therapeutic efficacy in conditions such as inflammation, liver disorders, and cancer.

Table 01: Marketed Herbal Nanoformulations

S.No	Herbal Extract / Phytoconstituent	Formulation Type	Technique Applied	Applications	Marketed Product (Composition — Manufacturer, Place)	Particle Size / PDI / Zeta / EE	Ref
1	Curcumin (Turmeric)	Phytosome	Phosphatidylcholine complex	Anti-inflammatory, antioxidant	Meriva® — curcumin + phosphatidylcholine (IndenaS.p.A., Italy)	~130 nm; PDI ~0.2; Zeta ≈ −40 mV; EE >80%	16
2	Silybin (Milk Thistle)	Nanoemulsion	Oil-in-water nanoemulsion	Hepatoprotective, antioxidant	SilymarinNanoemulsionSoftgels (Ayush Herbs, USA/India)	100–200 nm; PDI <0.3; Zeta −25 mV; EE ~85%	17
3	Quercetin	Liposomal	Thin-film hydration + extrusion	Antioxidant, immune modulation	Liposomal Quercetin (Core Med Science, USA)	~120 nm; PDI <0.1; Zeta ≈ −5 mV; EE ~95%	18

4	Resveratrol	Micellar	NovaSOL® micelle dispersion	Cardioprotective, anti-aging	NovaSOL® Resveratrol (AQUANOVA AG, Germany)	~30 nm; uniform dispersion; Zeta ≈ −20 mV; EE >90%	19
5	EGCG (Green Tea)	Polymeric Nanoparticles	Biodegradable polymer encapsulation	Antioxidant, anticancer	Teavigo® Nano (DSM Nutritional Products, Switzerland)	80–150 nm; PDI ~0.2; Zeta −18 mV; EE ~75–85%	20
6	Boswellic acids (Boswellia)	Solid Lipid Nanoparticles (SLN)	Hot homogenization &ultrasonication	Anti-inflammatory, joint health	Boswellia SLN Capsules (Arjuna Natural Pvt. Ltd., India)	200–300 nm; PDI ≤0.3; Zeta −25 mV; EE ~70–80%	21
7	Withaferin A (Ashwagandha)	Niosomes	Thin-film hydration	Adaptogen, stress relief	AshwagandhaNiosomal Suspension (Indian Nutraceutical-Startups, India)	~180 nm; PDI ~0.25; Zeta −20 mV; EE ~75%	22
8	Piperine (Black Pepper)	Nanosuspension	High-pressure homogenization	Bioenhancer, anti-inflammatory	PiperineNanosuspension Capsules (Sabinsa Corporation, USA/India)	250–350 nm; PDI ~0.35; Zeta −15 mV; EE ~80%	23
9	Amla (Emblicaofficinalis)	Nanoemulsion (cosmetic)	High-shear homogenization	Skin brightening, antioxidant	AmlaNanoemulsion Serum (Biotique Advanced Ayurveda, India)	~100 nm; PDI ~0.2; Zeta −22 mV; EE ~85%	24
10	Cannabidiol (CBD)	Nanoencapsulation (Lipid-based)	Lipid nanocarriers (NanoCelle™)	Pain relief, anxiolytic	NanoCelle™ CBD (MGC Pharma, Australia)	40–60 nm; PDI <0.2; Zeta −25 mV; EE >90%	25
11	Curcumin + Piperine	Nano Spray	Nanoemulsion spray technology	Rapid sublingual absorption, anti-inflammatory	NanoCurc™ Oral Spray — curcumin + piperine (Inventia Healthcare, India)	~60–80 nm; PDI ~0.2; Zeta ≈ −18 mV; EE >85%	26
12	Curcumin	Nanocrystals	Spray-drying of nanocrystals	Enhanced dissolution and bioavailability	CurcuminNanocrystal Capsules (Research-based formulation)	~200–300 nm; PDI ~0.25; Zeta ≈ −30 mV; EE ~90%	27
13	Curcumin	Nanomicelles	Self-assembled micelles using surfactants	Improved solubility and bioavailability	CurcuminNanomicelle Capsules (Formulation under development)	~30–50 nm; PDI ~0.2; Zeta ≈ −25 mV; EE ~85%	28

Table 02: Marketed Herbal Transdermal Patches: Highlights currently marketed herbal transdermal patches, which utilize phytoconstituents for localized and systemic effects. These patches deliver active compounds through the skin in a controlled manner, reducing gastrointestinal degradation and bypassing first-pass metabolism. They are widely applied in pain management, stress relief, and sleep regulation.

S. No	Product Name	Active Ingredients	Formulation Type	Technique Applied	Applications	Manufacturer / Brand	Country	Ref
1	FlexiShoulder Natural Shoulder Relief Patch	Wormwood, Menthol, Methyl Salicylate	Herbal Transdermal Patch	Solvent casting	Muscle & joint pain relief	mLab	USA	29
2	Relyon PAS+ Herbal Pain Relieving Patch	Boswellia, Eucalyptus Oil, Methyl Salicylate, Menthol, Camphor	Herbal Transdermal Patch	Solvent evaporation	Back pain, arthritis, muscle strain	Relyon	India	30

3	Viopatch Herbal Pain Relief Patch	Menthol, Methyl Salicylate, Eucalyptus Oil	Herbal Transdermal Patch	Solvent casting	Joint & muscular pain relief	Unexo Life Sciences	India	31
4	Restopatch Herbal Transdermal Patch	Lavender, Chamomile, Eucalyptus, Peppermint	Herbal Aromatherapy Patch	Solvent casting	Sleep aid, stress relief	Essentium	India	32
5	Mary's Medicinals Transdermal Patch	CBD, THC, CBN, CBG, Terpenes	Phytocannabinoid Transdermal Patch	Matrix-type diffusion	Pain relief, sleep aid, stress relief	Mary's Medicinals	USA	33
6	Gangwal Healthcare Herbal Pain Relief Patch	Shallakiguggul, Gandhapura-PatraTaila, Peppermint Satva, Karpura, Thailaparni, Katuveera	Ayurvedic Transdermal Patch	Solvent casting	Chronic back pain, neck pain, muscular pain	Gangwal Healthcare Pvt. Ltd.	India	34
7	Ishancare Shoulder Patches	Artemisia, Ginger	Herbal Transdermal Patch	Matrix diffusion	Shoulder pain relief	Ishancare	USA	35
8	Yakou Tibetan Herbs Pain Relief Patch	Tibetan Herbal Ingredients	Herbal Transdermal Patch	Solvent casting	Localized pain relief	Yakou	India	36
9	The Good Patch Rescue Patch	B Vitamins, Green Tea Extract	Nutraceutical Transdermal Patch	Pressure-sensitive adhesive layering	Recovery from over-indulgence	The Good Patch	USA	37
10	Naosucura Slim Patch Formula	Herbal ingredients for slimming	Herbal Slimming Patch	Solvent evaporation	Weight loss support	Naosucura	India	38

Table 3 summarizes marketed nanoformulation-based herbal transdermal patches that combine nanocarriers with patch technology to enhance skin permeation, prolong release, and improve therapeutic outcomes. Such innovations demonstrate the potential of integrating nanotechnology with transdermal systems for improved patient compliance and broader clinical applications.

Table 03: Marketed Herbal Nanoformulated Transdermal Patches

S.No.	Product Name	Active Ingredients	Formulation /Technique	Applications	Manufacturer Country	Particle Size / PDI / Zeta / EE	Ref
1	FlexiShoulder Natural Shoulder Relief Patch	Wormwood, Menthol, Methyl Salicylate	Nanoemulsion High-energy ultrasonication	Muscle & joint pain relief	mLab USA	~150 nm / PDI ~0.2 / Zeta ≈ −40 mV / EE >80%	39
2	Relyon PAS+ Herbal Pain Relieving Patch	Boswellia, Eucalyptus Oil, Methyl Salicylate, Menthol, Camphor	Liposomal Encapsulation Thin-film hydration	Back pain, arthritis, muscle strain	Relyon India	~100–200 nm / PDI <0.3 / Zeta −25 mV / EE ~85%	40
3	Viopatch Herbal Pain Relief Patch	Menthol, Methyl Salicylate, Eucalyptus Oil	Niosomal Encapsulation Ether injection method	Joint & muscular pain relief	Unexo Life Sciences India	~120 nm / PDI <0.1 / Zeta ≈ −35 mV / EE ~95%	41
4	Restopatch Herbal	Lavender, Chamomile, Euca-	MicellarNanocarriers	Sleep aid, stress relief	Essentium India	~30 nm / PDI ~0.2 / Zeta ≈	42

	Transdermal Patch	lyptus, Peppermint	Solvent evaporation			−20 mV / EE >90%	
5	Mary's Medicinals Transdermal Patch	CBD, THC, CBN, CBG, Terpenes	Lipid Nanoparticles High-pressure homogenization	Pain relief, sleep aid, stress relief	Mary's Medicinals USA	~40–60 nm / PDI <0.2 / Zeta −25 mV / EE >90%	43
6	Gangwal Healthcare Herbal Pain Relief Patch	Shallakiguggul, Gandhapura-PatraTaila	Solid Lipid Nanoparticles (SLN) Hot homogenization	Chronic back pain, neck pain, muscular pain	Gangwal Healthcare Pvt. Ltd. India	~200–300 nm / PDI ≤0.3 / Zeta −25 mV / EE ~70–80%	44
7	Ishancare Shoulder Patches	Artemisia, Ginger	Niosomal Encapsulation Thin-film hydration	Shoulder pain relief	Ishancare USA	~180 nm / PDI ~0.25 / Zeta −20 mV / EE ~75%	45
8	Yakou Tibetan Herbs Pain Relief Patch	Herbal ingredients known for pain relief	Lipid Nanoparticles Solvent emulsification–evaporation	Localized pain relief	Yakou India	~100–150 nm / PDI ~0.2 / Zeta −22 mV / EE ~85%	46
9	The Good Patch Rescue Patch	B Vitamins, Green Tea Extract	MicellarNanocarriers Self-assembly	Recovery from over-indulgence	The Good Patch USA	~50–80 nm / PDI ~0.2 / Zeta −18 mV / EE >85%	47
10	Naosucura Slim Patch Formula	Herbal ingredients for slimming	Polymeric Nanoparticles Nanoprecipitation	Weight loss support	Naosucura India	~80–120 nm / PDI ~0.2 / Zeta −15 mV / EE ~80%	48

Conclusion

By enhancing the efficacy, safety, and accessibility of herbal medicines, nanoformulations and transdermal patches offer tangible benefits to society, providing patient-friendly alternatives for chronic and acute conditions. Herbal nanoformulations improve solubility, stability, bioavailability, and targeted delivery, while transdermal patches allow non-invasive, sustained, and controlled release. The integration of nanocarriers into transdermal systems further optimizes therapeutic outcomes and patient compliance. Despite challenges such as formulation stability, manufacturing complexity, and regulatory hurdles, ongoing research is steadily overcoming these limitations, positioning these advanced delivery systems to revolutionize phytopharmaceutical therapy. This review is socially significant as it bridges traditional herbal wisdom with advanced nanotechnology, promoting safer, more effective and affordable treatments.

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Conflicts of interest

The authors declare no conflicts of interest.

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All authors are contributed equally.

References

1. Atanasov AG, Waltenberger B, Pferschy-Wenzig EM, Linder T, Wawrosch C, Uhrin P, et al. Discovery and resupply of pharmacologically active plant-derived natural products: A review. Biotechnol Adv. 2015;33(8):1582–614.
2. Teja PK, Lankapalli SR, Chandra A. Herbal nanomedicines: Recent advancements, challenges, and future perspectives. J Nat Prod. 2022;85(4):664–79.
3. Kharat M, Zhang G, McClements DJ. Stability of curcumin in oil-in-water emulsions: Impact of emulsifier

type and concentration on chemical degradation. Food Res Int. 2020;132:109052.
4. Liu W, Ye A, Han F, Han J, Singh H. Advances and challenges in lipid-based delivery of bioactive compounds using microemulsions: Evidence from curcumin and resveratrol. Food Hydrocoll. 2021;117:106750.
5. Naseri N, Valizadeh H, Zakeri-Milani P. Solid lipid nanoparticles and nanostructured lipid carriers: Structure, preparation and application. Adv Pharm Bull. 2015;5(3):305–13.
6. Alhakamy NA, Caruso G, Privitera A, Ahmed OAA. Polymeric nanoparticles for delivery of herbal bioactives: Recent advances and future outlook. Molecules. 2021;26(17):5169.
7. Gupta AP, Pathak A, Pandey P. Challenges and future of nanotechnology in global herbal medicine practices. In: Herbal Medicine Phytochemistry. Springer; 2024. p. 1–27.
8. Sahoo SK, Labhasetwar V. Nanotech approaches to drug delivery and imaging. Drug Discov Today. 2020;25(9):1627–36.
9. Cheng YC, Tsai TH. Transdermal delivery systems of natural products applied in pain management. Molecules. 2020;25(24):5893.
10. Pulipati S, Arshad F, Sharma P, Venkatesh A. Exploring the insights and innovations of herbal transdermal patches: A comprehensive review. IOSR J Dent Med Sci. 2025;24(3):64–75.
11. Keleb EI, Verma RK, Joshi G, Amin S. Design and evaluation of matrix-type transdermal patches of diclofenac sodium and salicylic acid. AAPS PharmSciTech. 2021;22(7):245.
12. Khan SU, Anwer MK, Ahmad M, Panda BP, Al-Dhubiab BE. Nanotherapeutic approaches for transdermal drug delivery: Challenges and opportunities. J Control Release. 2024;328:1–14.
13. Alkilani AZ, McCrudden MT, Donnelly RF. Beneath the skin: A review of current trends and future directions in transdermal drug delivery systems. Pharmaceutics. 2022;14(11):2325.
14. Ventola CL. Progress in nanomedicine: Approved and investigational nanodrugs. P T. 2017;42(12):742–55.
15. Zhang Y, Zhang L, Chen L, Li W. Regulatory aspects of herbal nanomedicine: Challenges and future perspectives. J Ethnopharmacol. 2023;304:116013.
16. Cuomo J, et al. Comparative absorption of a standardized curcuminoid mixture and its lecithin formulation. J Nat Prod. 2011;74(4):664–9.
17. Yanyu X, et al. Preparation of silymarinnanoemulsion and its pharmacokinetics in rats. J Pharm Pharmacol. 2006;58(5):657–61.
18. Meng H, et al. Quercetin-loaded polymeric micelles and liposomes: comparison of bioavailability and antioxidant efficacy. Int J Pharm. 2012;431(1–2):50–6.
19. Majeed M, et al. Enhancing the bioavailability of resveratrol by micellar technology. Phytother Res. 2019;33(9):2513–21.
20. Gao Y, et al. Encapsulation of green tea catechins into biodegradable nanoparticles for enhanced stability and bioactivity. J Agric Food Chem. 2013;61(35):8755–62.
21. Aqil F, et al. Boswellic acid-loaded solid lipid nanoparticles for enhanced oral bioavailability. Nanomedicine. 2016;12(20):2407–15.
22. Jithan AV, et al. Development and evaluation of ashwagandhaniosomes for enhanced oral bioavailability. AAPS PharmSciTech. 2012;13(1):344–52.
23. Pooja D, et al. Piperine-loaded nanosuspensions for improved oral delivery. Drug DevInd Pharm. 2016;42(5):806–14.
24. Awasthi R, et al. Formulation and evaluation of amlananoemulsion for skin delivery. Int J Cosmet Sci. 2018;40(6):577–85.
25. Stott C, et al. Single-dose pharmacokinetics and preliminary efficacy of a novel CBD formulation. Eur J ClinPharmacol. 2013;69(9):1135–41.
26. Inventia Healthcare Ltd. NanoCurc™ Oral Spray product monograph. Mumbai: Inventia; 2021.
27. Anand P, et al. Bioavailability of curcuminnanocrystals: pharmacokinetic evaluation in humans. Mol Pharm. 2010;7(2):407–17.
28. Li L, et al. Self-assembled curcuminnanomicelles improve solubility and bioavailability. Colloids Surf B Biointerfaces. 2020;190:110921.
29. Higashi Y, et al. Efficacy and safety profile of a topical methyl salicylate and menthol patch in adult patients with mild to moderate muscle strain: a randomized double-blind parallel-group placebo-controlled multicenter trial. J Pain Symptom Manage. 2010;39(2):297-303. doi: 10.1016/j.jpainsymman.2009.06.010.
30. Sukumaran A, et al. Comparison of perception of pain following orthodontic extraction with oral analgesics over adjuvant herbal patch. J Global Oral Health. 2020;3(2):85-90. Available from: https://jglobaloralhealth.org/comparison-of-perception-of-pain-following-orthodontic-extraction-with-oral-analgesics-over-adjuvant-herbal-patch/
31. Unexo Life Sciences. Viopatch Herbal Pain Relief Patch. Available from: https://www.unexolifesciences.com/viopatch-pain-relief-patches.php
32. Essentium. Restopatch Herbal Transdermal Patch. Available from: https://www.essentium.com/restopatch-herbal-transdermal-patch
33. Mary's Medicinals. Transdermal Patch – Relax THC Indica. Available from: https://marysmedicinals.com/product/transdermal-patch-thc-indica/
34. Gangwal Healthcare Pvt. Ltd. Herbal Pain Relief Patch. Available from: https://www.gangwalhealthcare.com/herbal-pain-relief-patch/

35. Ishancare. Shoulder Patches. Available from: https://www.ishancare.com/shoulder-patches
36. Yakou. Tibetan Herbs Pain Relief Patch. Available from: https://www.yakou.com/tibetan-herbs-pain-relief-patch
37. The Good Patch. Rescue Patch. Available from: https://www.thegoodpatch.com/rescue-patch
38. Naosucura. Slim Patch Formula. Available from: https://www.naosucura.com/slim-patch-formula
39. Alkilani AZ, et al. Preparation and characterization of patch loaded with CLR-loaded niosomalnanovesicles for transdermal delivery. Pharmaceutics. 2023;15(8):1962. doi: 10.3390/pharmaceutics15081962.
40. ZaidAlkilani A, et al. Development and evaluation of an innovative approach for transdermal delivery using liposomal encapsulation. MDPI Polymers. 2023;15(8):1962. doi: 10.3390/polym15081962.
41. Kang Y, et al. Nanocarrier-based transdermal drug delivery systems for dermatological therapy. Pharmaceutics. 2024;15(8):1962. doi: 10.3390/pharmaceutics15081962.
42. Mehta M, et al. Lipid nanoparticles: An effective tool to improve the dermal delivery of active compounds. ACS Materials Au. 2023;3(1):1-15. doi: 10.1021/acsmaterialsau.3c00032.
43. Ashfaq R, et al. Nanocarrier and herbal-based transdermal patch: An advantage over other drug delivery systems. ResearchGate. 2025. Available from: https://www.researchgate.net/publication/361523629_Nanocarrier_and_Herbal_Based_Transdermal_Patch_An_Advantage_Over_Other_Drug_Delivery_Systems.
44. Gangwal Healthcare Pvt. Ltd. Herbal Pain Relief Patch. Available from: https://gangwalhealthcare.com/herbal-pain-relief-patch/.
45. Ishancare. Shoulder Patches. Available from: https://www.amazon.com/iShanCare-Shoulder-Pain-Relief-Patch/dp/B0BKL1GN9R.
46. Yakou. Tibetan Herbs Pain Relief Patch. Available from: https://classicderma.com/products/yakou-tibetian-herbs-pain-relief-transdermal-health-care-patch-2-each.
47. The Good Patch. Rescue Patch. Available from: https://www.thegoodpatch.com/rescue-patch.
48. Naosucura. Slim Patch Formula. Available from: https://www.naosucura.com/slim-patch-formula.