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A REVIEW ON HERBAL ANTI-ACNE TRANSDERMAL PATCH CONTAINING TURMERIC

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ABSTRACT

Transdermal drug delivery systems (TDDS) are advanced pharmaceutical formulations designed to deliver drugs through the skin into systemic circulation in a controlled and sustained manner. These systems offer several advantages over conventional oral and injectable dosage forms, including improved patient compliance, avoidance of first-pass metabolism, reduced dosing frequency, and minimized side effects. Herbal-based transdermal patches have gained increasing attention due to their therapeutic effectiveness, safety, and non-invasive nature. The present review focuses on the formulation and evaluation of a turmeric-based transdermal patch. Turmeric, scientifically known as Curcuma longa, belongs to the Zingiberaceae family and contains curcumin as its major active constituent, which possesses significant anti-inflammatory, antioxidant, and wound-healing properties. The review highlights the biological source, chemical constituents, and medicinal importance of turmeric. Soxhlet extraction using ethanol was employed for the extraction of curcumin from turmeric rhizomes. The prepared extract was incorporated into a polymeric matrix containing HPMC, plasticizers, preservatives, antioxidants, and penetration enhancers to formulate the transdermal patch. The formulation process involved solvent casting, drying, cutting, and packaging of the patches. The study emphasizes the potential of turmeric transdermal patches as an effective herbal drug delivery system with sustained therapeutic action and improved patient convenience.

KEYWORDS: Herbal Anti-Acne Transdermal Patch, Turmeric (Curcuma

longa),Transdermal Drug Delivery System (TDDS), Curcumin, Anti-inflammatory Activity, Antioxidant Activity, Wound Healing, Soxhlet Extraction, Ethanol Extraction, HPMC (Hydroxypropyl Methylcellulose), Polymer Matrix, Penetration Enhancers. Sustained Drug Release, Herbal Drug Delivery.

INTRODUCTION

1. Acne

Acne vulgarism is one of the most common chronic inflammatory skin disorders, affecting nearly 80% of adolescents and young adults worldwide. Although it is not a life-threatening disease, acne can significantly affect a patient's quality of life by causing pain, permanent scarring, low self-esteem, anxiety, and depression. Acne develops due to multiple factors, including excessive sebum production, follicular Possible spelling mistake found., bacterial colonization, and inflammation. The major microorganisms associated with acne are Eubacterium acres, Staphylococcus aureus, and Staphylococcus epidermidis. These microorganisms stimulate inflammatory reactions that lead to the formation of comedones, papules, pustules, nodules, and cysts.

Conventional treatments for acne include topical antibiotics, retinoids, benzoyl peroxide, and oral therapies. However, long-term use of these medications may cause side effects such as skin irritation, dryness, redness, antibiotic resistance, and poor patient compliance. Therefore, there is increasing interest in herbal and transdermal approaches for acne management due to their improved safety profile and sustained drug delivery properties.[1]

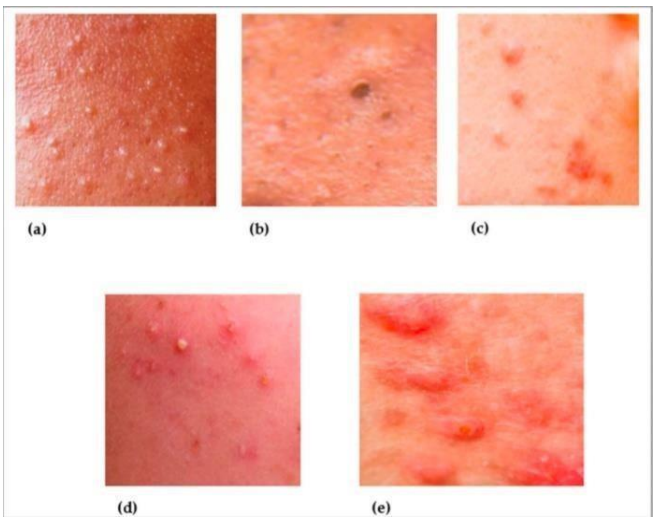

Fig No. 1: Acne.

2. Transdermal patch

Transdermal drug delivery systems (TDDS) are pharmaceutical formulations designed to deliver therapeutic agents across the skin and into systemic circulation at a controlled rate. For successful systemic delivery, it is important to understand the skin's morphological, physicochemical, and biophysical characteristics, as these factors influence drug permeation through the skin barrier. Compared with oral and injectable dosage forms, transdermal delivery offers several advantages, including improved patient compliance, avoidance of hepatic first-pass metabolism, and sustained release of drugs over an extended period. These systems help maintain relatively constant plasma drug concentrations, especially for drugs with short biological half-lives, thereby minimizing fluctuations and reducing adverse effects associated with sudden drug release.

The development of advanced drug delivery technologies, such as controlled-release systems, transmucosal delivery systems, and transdermal therapeutic systems, has significantly improved therapeutic effectiveness. Among these, transdermal patches have gained considerable attention because they provide a non-invasive, painless, and convenient method of drug administration. Drug absorption through the skin can be confirmed by measuring drug concentrations in blood, detecting metabolites in urine, or observing the therapeutic response in patients.

A transdermal patch is a medicated adhesive preparation that delivers drugs through the skin into the bloodstream in a regulated manner. These patches can remain attached to the skin for several hours or even days, depending on the formulation, and treatment can be terminated easily by removing the patch. Transdermal patches are available in different sizes and may contain one or more active pharmaceutical ingredients. Drug release generally occurs through diffusion mechanisms that enable the medication to penetrate the skin layers and enter systemic circulation. In some formulations, a large amount of drug remains within the patch and is released gradually over time.

The first FDA-approved transdermal therapeutic system was introduced in 1979 for the prevention of nausea and vomiting. Later, nitroglycerin patches, introduced in 1985, became an important milestone in transdermal drug delivery technology. Researchers such as Gale and Berggren further advanced patch design by incorporating rate-controlling membranes made from ethylene vinyl acetate. Currently, a wide range of drugs are administered through transdermal patches, including nicotine, fentanyl, clonidine, scopolamine, estradiol, and estradiol combined with norethisterone acetate.

The site of application for a transdermal patch depends on the therapeutic purpose and the drug being administered. For example, estradiol patches are commonly applied to the abdomen or buttocks, whereas nitroglycerin patches are generally placed on the chest. The duration of drug release from these systems varies considerably and may range from a few hours to several days, depending on the formulation and therapeutic requirement. [2]

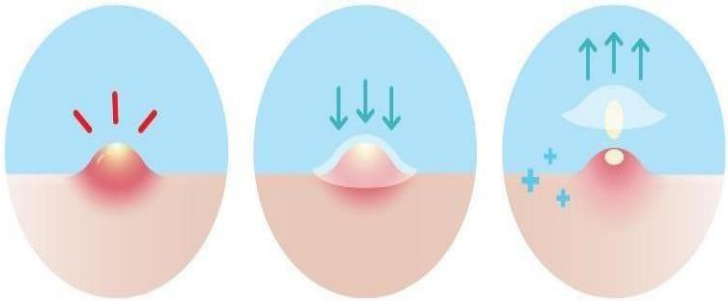

Fig No. 2: transdermal patch.

Advantages

- Continuous dosing, multi-day treatment
- Bypass the digestive system
- Avoid first-pass metabolism
- Can be terminated anytime
- Less invasive[3]

Disadvantages

- Limited type of medication
- Skin irritation
- Inconsistent absorption
- Patch failure
- Limited dosing option[3]

Uses of transdermal patches

1. Treatment of Acne Lesions

Turmeric transdermal patches help reduce pimples, papules, pustules, and inflammatory acne lesions by delivering active compounds directly to the affected area. Curcumin, the main constituent of turmeric, exhibits antimicrobial activity against acne-causing bacteria such as *Cutibacterium acnes*.

2. Anti-Inflammatory Action

The patches reduce redness, swelling, pain, and irritation associated with acne because turmeric possesses strong anti-inflammatory properties. Curcumin inhibits inflammatory mediators and helps soothe irritated skin.

3. Antibacterial Effect

Turmeric acts against acne-causing microorganisms and helps prevent bacterial growth on the skin surface, thereby reducing infection and recurrence of acne.

4. Reduction of Acne Scars and Marks

Continuous use of turmeric patches may help lighten post-acne hyperpigmentation and blemishes due to the antioxidant and skin-brightening properties of curcumin.

5. Controlled Drug Delivery

Transdermal patches provide sustained and controlled release of turmeric extract over a prolonged period, improving therapeutic effectiveness and minimizing frequent application.

LITERATURE REVIEW

1. Nascimento T., Gomes D., Simões R., and Miquel M.G. discussed the effectiveness of Tea Tree Oil in the treatment of acne vulgaris. The review explained that Tea Tree Oil possesses antibacterial, anti-inflammatory, and antioxidant properties which help in reducing acne lesions and skin irritation. The authors suggested it as a natural and safer option for acne therapy.

2. Punia S., Preeti K., Yadav R., and Chaurasiya M. designed an antimicrobial transdermal patch using Azadirachta indica and curcumin. Their study reported that the prepared patches showed good physical characteristics, controlled drug release, and effective antimicrobial activity. The formulation was considered beneficial for topical therapeutic applications.

3. Wong W.F., Ang K.P., Sethi G., and Looi C.Y. reviewed recent developments in medical patches for transdermal drug delivery. The article focused on advanced technologies used to improve skin permeation, drug stability, and patient convenience. The review highlighted transdermal patches as an emerging and effective drug delivery system.

4. Sheth N.S. and Mistry R.B. prepared transdermal patches and investigated the permeation enhancement effect of eugenol. The study demonstrated that eugenol improved drug penetration across the skin and enhanced the overall efficiency of the formulation. The research supported the role of permeation enhancers in transdermal delivery systems.

5. Druge S.K., Dugad R.S., Chaudhari S.G., Wankhade O.S., and Kharat V.M. developed herbal transdermal patches containing turmeric extract for topical use. The formulated patches exhibited suitable flexibility, stability, and sustained release behavior. The study indicated that turmeric-based patches may be useful in managing skin-related conditions.

6. Ahmad R.S., Hussain M.B., Sultan M.T., Arshad M.S., and co-authors reviewed the biochemical composition and medicinal importance of turmeric. The paper described the antioxidant, antimicrobial, anti-inflammatory, and anticancer activities of curcumin along with its clinical applications. The authors emphasized turmeric as a valuable medicinal herb with wide therapeutic potential.

7. Alhat S. and Waghmare D. formulated and evaluated curcumin transdermal patches for controlled drug delivery. Their findings showed that the patches possessed satisfactory physicochemical properties and provided sustained release of the drug. The study concluded that transdermal delivery could improve the therapeutic performance of curcumin.

8. Kharane K.L., Bhawane B.S., Korde P.P., Chore G.S., and Kharat V.M. prepared herbal patches containing turmeric extract for topical application. The developed patches demonstrated acceptable mechanical strength and prolonged drug release characteristics. The study supported the use of turmeric in herbal transdermal drug delivery systems.

9. Ravindran P.N., Nirmal Babu K., and Sivaraman K. in the book “Turmeric: The Genus Curcuma” explained the medicinal significance, phytochemistry, and traditional uses of turmeric. The book provides detailed knowledge regarding curcumin and its pharmacological properties. It is considered an important reference source for turmeric research studies.

10. Benzie I.F.F. and Wachtel-Galor S. in “Herbal Medicine: Biomolecular and Clinical Aspects” described the scientific basis and therapeutic applications of herbal medicines.

The book discusses bioactive compounds, mechanisms of action, and clinical importance of medicinal plants. It serves as a useful reference for understanding herbal formulations and natural therapies.

Basic components of transdermal drug delivery system

A Transdermal Drug Delivery System (TDDS) is designed to deliver drugs through the skin in a controlled manner. The major components of TDDS are as follows:

1. Polymer Matrix: The polymer matrix controls the release of the drug from the patch and provides structural support. Polymers used in TDDS may be natural, synthetic, or synthetic elastomers. Commonly used polymers include cellulose derivatives, gelatin, polyvinyl alcohol, polyethylene, silicone rubber, and Possible spelling mistake found.. The selection of polymer affects the drug release rate, stability, and flexibility of the patch.
2. Drug: The drug selected for transdermal delivery should possess suitable physicochemical properties. Ideally, it should have low molecular weight, balanced basophilic and hydrophilic characteristics, good potency, short half-life, and should not irritate the skin. For herbal acne patches, turmeric-derived curcumin is considered a promising active ingredient due to its anti-inflammatory and antimicrobial properties.
3. Permeation Enhancers: Permeation enhancers are substances that improve drug penetration through the stratum corner by altering skin permeability. They interact with skin lipids and proteins to enhance drug absorption. Common enhancers include solvents, surfactants, and natural compounds. Eugenol is a widely used natural permeation enhancer because of its low toxicity and minimal skin irritation.
4. Adhesives: help the patch remain attached to the skin for a prolonged period. An ideal adhesive should provide strong adhesion, easy removal, and should not cause irritation or leave residue on the skin. It must also be compatible with the drug and other ingredients.
5. Backing Membrane: The backing membrane is the outer protective layer of the patch. It prevents drug loss from the surface and protects the formulation from environmental factors such as moisture and contamination. Materials such as aluminum foil, polyurethane films, and plastic laminates are commonly used.[4]

Types of Transdermal Drug Delivery System

1. Single layer TDDS
2. Multi layer TDDS
3. Reservoir system

4. Matrix system

PLANT PROFILE

TURMERIC

Turmeric, also known as Curcuma longa, is a plant from the Zingiberaceae family and is widely used in herbal medicine.

The name comes from the Arabic word "Kourkoum," which means saffron, because of its bright yellow color. This plant is native to Southeast Asia and thrives in warm, humid climates, especially in countries like India, China, and Indonesia. It has large leaves and a short stem, and the rhizomes, which are the underground stems, are harvested for both medicinal and cooking purposes. The main active ingredient in turmeric is curcumin, which gives it its yellow color and offers anti-inflammatory and antioxidant properties.

SYNONYMS: Indian Saffron, Yellow Ginger, Haldi, Kunyit

BIOLOGICAL SOURCE: Turmeric comes from the dried or fresh rhizome of the plant Curcuma longa Linn., which belongs to the Zingiberaceae family.[5]

Fig. No. 3: Turmeric.

Chemical Components

Carbohydrates (69.4%), protein (6.3%), fat (5.1%), minerals (3.5%), alpha-phellandrene (1%), zingiberene (25%), sabinene (0.6%), cineole (1%), and sesquiterpenes (53%).Also present is a mix of three curcuminoids: curcumin I ($C_{21}H_{20}O_6$, diferuloylmethane, 94%), curcumin II ($C_{20}H_{18}O_5$, demethoxycurcumin, 6%), and curcumin III ($C_{19}H_{16}O_4$, bis-demethoxycurcumin, 0.3%).

MOA of Turmeric

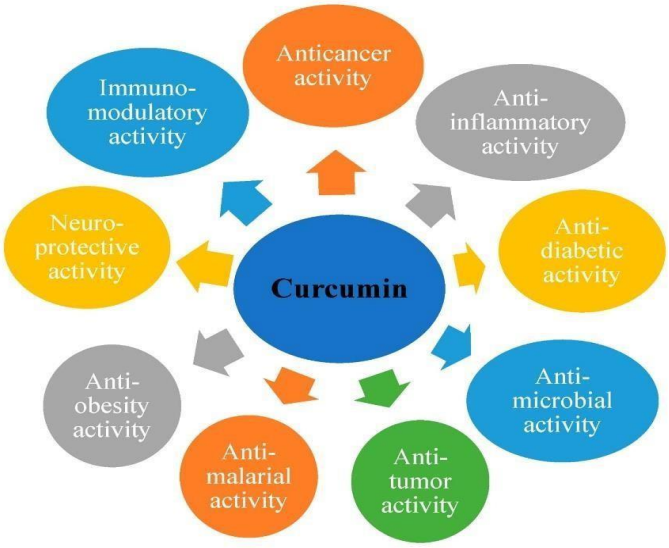

Fig No. 4: MOA of turmeric.[6]

1. **Anticancer Activity:** Curcumin exhibits significant anticancer properties by inhibiting the growth and proliferation of cancer cells. It suppresses tumor initiation, progression, and metastasis through modulation of multiple cell signaling pathways such as NF-κB, STAT3, and AP-1. Curcumin also induces apoptosis (programmed cell death) in various cancer cells including breast, colon, lung, and prostate cancers.
2. **Anti-inflammatory Activity:** Curcumin is well known for its potent anti-inflammatory action. It inhibits inflammatory mediators such as cyclooxygenase-2 (COX-2), lipoxygenase (LOX), tumor necrosis factor-alpha (TNF-α), and interleukins. Therefore, curcumin may help in managing chronic inflammatory disorders such as arthritis, inflammatory bowel disease, and psoriasis.
3. **Antidiabetic Activity:** Curcumin helps regulate blood glucose levels and improves insulin sensitivity. It reduces oxidative stress and inflammation associated with diabetes mellitus. Studies suggest that curcumin may prevent diabetic complications such as nephropathy, neuropathy, and retinopathy.
4. **Antimicrobial Activity:** Curcumin possesses antimicrobial properties against a variety of bacteria, fungi, and viruses. It disrupts microbial cell membranes and inhibits microbial growth. Due to this property, curcumin is investigated for wound healing and anti-acne formulations.
5. **Antitumor Activity:** Curcumin suppresses tumor formation by preventing angiogenesis (formation of new blood vessels supplying tumors) and inhibiting tumor cell proliferation. Its antioxidant activity also protects cells from DNA damage that can lead to tumor development.

6. **Antimalarial Activity:** Curcumin has shown activity against Plasmodium species, the causative organisms of malaria. It interferes with parasite growth and enhances the efficacy of conventional antimalarial drugs when used in combination therapy.
7. **Anti-obesity Activity:** Curcumin may reduce obesity by regulating lipid metabolism, suppressing adipogenesis, and reducing inflammation in adipose tissue. It also helps decrease body weight gain and improve metabolic health.
8. **Neuroprotective Activity:** Curcumin demonstrates neuroprotective effects by reducing oxidative stress and neuroinflammation in the brain. It may help in preventing neurodegenerative disorders such as Alzheimer's disease, Parkinson's disease, and depression by protecting neuronal cells from damage.
9. **Immunomodulatory Activity:** Curcumin modulates both innate and adaptive immune responses. It regulates the activity of immune cells such as macrophages, T-cells, B-cells, and natural killer cells. This property contributes to its beneficial effects in autoimmune and inflammatory diseases.[9,10]

Ingredients used

Table No. 1[5]

Sr. No.	Ingredient	Quantity	Function / Role
1	Turmeric Extract	2 ml	Active ingredient with anti-inflammatory activity
2	HPMC (Hydroxypropyl Methylcellulose)	1000 mg	Matrix-forming polymer and controlled drug release agent
3	PEG 200 (Polyethylene Glycol 200)	0.2 ml	Plasticizer
4	Menthol	0.25 mg	Cooling agent and penetration enhancer
5	Methyl Paraben	0.25 mg	Preservative
6	Glycerine	2–4 drops	Humectant and skin moisturizing agent
7	Vitamin E	0.25 mg	Antioxidant
8	Ethanol	q.s.	Solvent and permeation enhancer

Extraction Method

The Soxhlet extraction method is a common way to get bioactive compounds, like curcumin from turmeric, using a solvent.

Materials Needed

a) Turmeric powder

b) Solvent (such as ethanol, methanol, or acetone)
c) Soxhlet extractor setup
d) Heating source (like a heating mantle)
e) Round-bottom flask
f) Condenser
g) Thimble (to hold the turmeric powder)
h) Filter paper
i) Glass jar with a tight lid

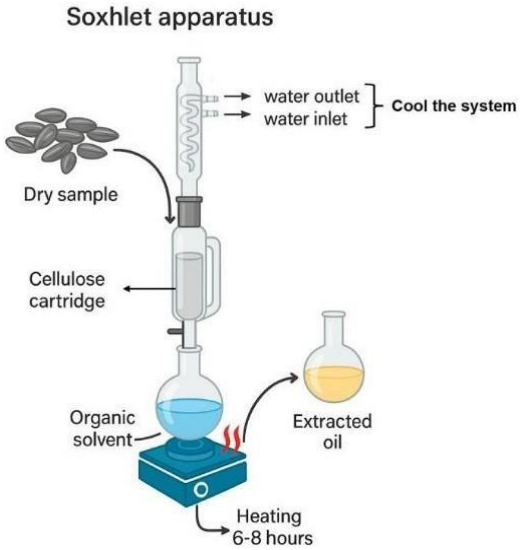

Fig No. 5: Soxhlet apparatus.

Process

1. **Prepare the turmeric powder:** If you're using fresh turmeric roots, first dry them and grind them into a fine powder. The smaller the particles, the more surface area there is for better extraction.

2. **Set up the Soxhlet apparatu**

- Include a round-bottom flask (RBF), a Soxhlet extractor, and a condenser.
- Make sure all the connections are tight and the setup is properly ventilated.

3. **Add the solvent and turmeric powder**

- Use a ratio of 1:20 for turmeric powder to solvent.
- Add 200ml of ethanol into the RBF.
- Weigh 10mg of turmeric powder and put it into the thimble.

- Place the thimble inside the Soxhlet extractor, but don't fill it too much; leave room for the solvent to circulate.

4. Connect the condenser

- Attach the condenser to the Soxhlet extractor.
- The condenser helps cool the solvent vapors, so they can condense and go back into the extractor.

5. Start the extraction cycle

- Heat the solvent in the RBF using a heating mantle or a water bath.
- When the solvent boils, the Soxhlet extractor will begin to work.
- The solvent will go up into the condenser, cool down, and drip back into the extractor.
- The extractor will fill with solvent, and the turmeric powder will be extracted.
- The extracted liquid will then go back into the RBF.

6. Repeat the extraction

- Continue the cycle for several hours, usually 4 to 6 hours.
- Keep an eye on the process and adjust the heat if needed.

7. Collect and evaporate the extract

- After the extraction is done, take the collected solution from the RBF.
- Using 10mg of turmeric powder and 200ml of ethanol, you should get about 120ml of extract.[7]

Formulation

To make the turmeric transdermal patches, follow these steps:

Step 1: Mix the polymer.

- Start by dissolving HPMC in ethanol, and keep stirring until it becomes clear.

Step 2: Add the additives.

- Add methyl paraben as a preservative and mix it in.
- Then add Vitamin E as an antioxidant and menthol as a penetration enhancer.
- Dissolve them in ethanol and mix well.

Step 3: Add the plasticizers.

- Add PEG 200 and glycerine to improve the flexibility of the patch.

- Mix everything thoroughly.

Step 4: Add the drug.

- Take the turmeric extract in liquid form and mix it into the polymer solution.
- Stir continuously to ensure it is evenly mixed.

Step 5: Pour the solution.

- Place the solution in a petri dish or a glass dish covered with a backing material like polyethylene or aluminum foil.
- Let the solution spread out to get an even thickness.

Step 6: Let it dry.

- Keep the patch in a dry place at room temperature until it is fully dry, which takes about 24 to 48 hours.

Step 7: Cut the patch.

- Carefully separate the dried layer and cut it into the desired size and shape, such as 2x2 cm squares.

Step 8: Pack the patch.

- Store the patches in airtight containers or wrap them in aluminum foil to keep them from moisture and light.[8]

Fig. No. 6: General patch formulation.

RESULT

The turmeric transdermal patch was successfully formulated using the solvent casting method

with HPMC as the polymeric base. The prepared patches showed uniform appearance, smooth surface, good flexibility, and adequate thickness. The incorporation of PEG 200 and glycerine improved the elasticity and folding endurance of the patches, while menthol enhanced drug permeation through the skin. The turmeric extract was uniformly distributed throughout the polymer matrix without visible aggregation. The patches demonstrated satisfactory drying characteristics and could be easily removed from the casting surface without damage. The formulated transdermal patches exhibited acceptable physical properties, stability, and potential for sustained drug release. The use of turmeric extract containing curcumin provided additional anti-inflammatory and antioxidant activity, indicating its suitability for transdermal therapeutic applications.

CONCLUSION

The present review concludes that turmeric-based transdermal patches represent a promising and effective herbal drug delivery system. The transdermal route offers several advantages such as avoidance of first-pass metabolism, sustained drug release, improved patient compliance, and non-invasive administration. Turmeric (Curcuma longa) possesses significant medicinal properties due to the presence of curcumin, which exhibits anti-inflammatory, antioxidant, and therapeutic activities. The prepared patches using HPMC, plasticizers, preservatives, and penetration enhancers showed satisfactory physical characteristics and formulation stability. Overall, turmeric transdermal patches have the potential to provide controlled and prolonged therapeutic action and may serve as an alternative approach for herbal drug delivery in future pharmaceutical applications.

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