International Journal of Pharmaceutical Research and Development

ISSN Print: 2664-6862
ISSN Online: 2664-6870
Impact Factor: RJIF 8.55
IJPRD 2025; 7(2): 230-232
www.pharmaceuticaljournal.net
Received: 15-06-2025
Accepted: 19-07-2025

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Evaluation of herbal extract (Geranium) loaded transdermal patch for the management of eczema

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DOI: https://doi.org/10.33545/26646862.2025.v7.i2c.184

Abstract
Eczema, also known as atopic dermatitis (AD), is a persistent, recurrent, and itchy inflammatory skin condition that affects a large portion of the population, particularly children. Conventional therapies such as topical corticosteroids are widely used but are associated with side effects like skin thinning, visible blood vessels, and systemic absorption after long-term use [1]. These drawbacks can reduce patient adherence and raise safety concerns, thereby necessitating alternative, safer, and more tolerable treatment approaches. Herbal medicines, due to their anti-inflammatory, antimicrobial, immune-modulating, and antioxidant effects, have emerged as promising options. Pelargonium graveolens L'Hér. (Geranium) extract is recognized for its wound-healing and anti-inflammatory activities but faces limitations such as poor solubility, low skin permeability, and high volatility. Transdermal drug delivery systems (TDDS), particularly matrix-type patches, provide an effective method for controlled release, improved bioavailability, avoidance of first-pass metabolism, and better patient compliance [3]. This review summarizes the formulation and evaluation of a novel transdermal patch containing geranium extract for eczema management. The patch, produced via solvent evaporation, utilized a combination of hydrophilic (HPMC E5) and pH-sensitive (Eudragit L100) polymers to optimize its performance. Pre-formulation assessments such as solubility, FTIR, and UV spectroscopy confirmed extract integrity and compatibility with excipients. The optimized patch (F19) exhibited uniformity, skin-friendly pH (5.23), high drug content (96.25%), strong mechanical properties, and a sustained drug release over 24 hours, best described by the Higuchi diffusion model. This work concludes that the formulated geranium extract-loaded transdermal patch presents a promising herbal alternative for long-term eczema treatment, offering benefits over both steroidal therapies and crude herbal applications [1-14].

Keywords: Atopic dermatitis, pelargonium graveolens, transdermal patch, herbal medicine, sustained release, hpmc, eudragit l100, phytotherapy, topical drug delivery

Introduction

Eczema overview

Eczema, or atopic dermatitis, is one of the most common forms of dermatitis, influenced by genetic predisposition and environmental triggers. Although it can occur at any age, it is more prevalent among children. Patients usually experience dry, itchy skin prone to irritation and infection, often referred to as the "itch that rashes." The word "eczema" is derived from the Greek terms "ek" (out) and "zema" (to boil out). This condition accounts for nearly 30% of dermatology consultations in Western Europe. It affects both sexes equally and is observed across all ethnic groups [2]. Symptoms include redness, dryness, itching, and scaling that follow a pattern of flare-ups and remission. The pathogenesis involves genetic, immune, and environmental factors. A family history of asthma or hay fever increases susceptibility due to immune system overactivity [4-5]. Impaired skin barrier function contributes to moisture loss and higher sensitivity to allergens and microbes. Triggers such as stress, temperature changes, specific soaps, allergens, and diet can worsen symptoms. Persistent itching, especially at night, leads to scratching, skin thickening (lichenification), and risk of secondary infections [26-27].

Transdermal patch

A transdermal patch is an adhesive dosage form applied to the skin that facilitates systemic drug absorption through controlled release.

The medication may be embedded in the adhesive or contained in a reservoir, diffusing gradually through the skin barrier. Compared to oral or injectable routes, patches improve patient convenience and can reduce dosing frequency. However, only molecules with suitable physicochemical properties can cross the skin, which serves as a strong protective barrier [25].

Materials and Methods

Instrumentation

The study employed various instruments, including a Shimadzu UV/VIS Spectrophotometer, Ohaus electronic balance, ultrasonic bath, vortex mixer, FTIR spectrophotometer, pH meter, magnetic stirrer, and cooling centrifuge, among others.

Chemicals

Key materials used were Pelargonium graveolens extract, ethanol, methanol, dichloromethane, HPMC, Eudragit L100, propylene glycol, and phosphate buffer.

Formulation

Patches were prepared using the solvent evaporation technique. Polymers (HPMC E5 and Eudragit L100) were dissolved in a volatile solvent such as ethanol or methanol. Geranium extract was added with continuous stirring, followed by a plasticizer (propylene glycol) to enhance patch flexibility. The solution was cast in petri dishes and dried under controlled conditions to form thin films, later cut into 2×2 cm patches.

Results and Discussion

Preformulation studies

The extract displayed brown color, crystalline form, and slight bitterness. Solubility testing revealed low solubility in dichloromethane, moderate solubility in ethanol and methanol, and high solubility in water and phosphate buffer. FTIR confirmed functional groups consistent with the extract's composition. UV spectroscopy showed an absorption peak at 283 nm, with linear calibration (R^2 = 0.999), enabling accurate quantification.

Patch characterization

Formulations were uniform with thickness between 0.133 mm and 0.22 mm. Skin-compatible pH (5.11–5.94), good folding endurance, and consistent weight were observed. Drug content ranged between 71.58% and 96.25%, with formulation F19 performing best.

In vitro release and kinetics

F19 patches demonstrated sustained drug release of 97.67% over 24 hours, compared to the rapid release of unformulated extract. Drug release followed Higuchi kinetics (R^2 = 0.982), indicating diffusion-controlled mechanisms, with additional polymer relaxation effects.

Conclusion

The optimized transdermal patch (F19) containing Pelargonium graveolens extract achieved sustained, controlled release, favorable physicochemical characteristics, and patient-friendly design. This delivery system provides an effective and safer herbal alternative for managing eczema compared to steroids or unformulated herbal extracts. Further studies, including in vivo efficacy and stability testing, are recommended.

Acknowledgements

The authors sincerely thank Dr. Avneet Gupta, Principal of LR Institute of Pharmacy, Jabli-Kyar, Solan, Himachal Pradesh, India, for his support and infrastructure. Special gratitude is extended to Ms. Diksha Devi for her guidance and critical insights. Appreciation is also due to the faculty and staff of LR Institute of Pharmacy for their assistance, and to all researchers whose work was referenced in this article.

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