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Natural Approaches & Transdermal Innovations for Foot Corns: A Comprehensive Review

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Abstract

Skin diseases are among the most prevalent health concerns worldwide, affecting billions. Foot corns, also known as clavus, are a significant issue within this category. These thickened skin lesions, marked by a cone-shaped keratin core, arise from repetitive friction or pressure, often due to poor-quality or ill-fitting footwear. Women are disproportionately affected, largely because of specific footwear choices. Corns and calluses, although similar, have distinct features and locations, both causing discomfort and leading many to seek podiatric care. Foot corns affect 14% to 48% of the population, underscoring the need for effective treatments. Transdermal drug delivery systems have emerged as a promising solution, offering controlled, targeted medication delivery through self-contained patches, which minimizes systemic side effects. Recent research indicates the potential of combining natural remedies such as turmeric, neem, aloe vera, and tea tree oil with Transdermal drug delivery system for treating foot corns. These natural ingredients, known for their therapeutic properties, enhance treatment outcomes when used with advanced drug delivery technology. This combination not only increases the effectiveness of managing foot corn but also improves the quality of life for affected individuals. The success of the Transdermal drug delivery system in treating foot corns highlights the need for further research to optimize these systems and ensure their accessibility. For individuals with chronic foot issues, where traditional treatments may be inadequate, Transdermal drug delivery combined with natural remedies represents a significant advancement. This innovative approach offers a more effective and practical solution for managing foot corns and other skin conditions, providing hope and relief to millions worldwide.

Keywords: Skin, Corn, Natural Remedies, Transdermal

Introduction

Skin diseases rank among the most prevalent health issues affecting humans, with thousands of different conditions identified, impacting nearly one billion people worldwide [1-4]. Despite this vast prevalence, most skin diseases are manageable through treatment methods. These methods can be categorized into five primary types: Topical treatments, systemic therapies, surgical interventions, physical therapies, and phototherapy [5].

Foot Corn

Corns are a common type of skin lesion that forms on the plantar surface of the sole due to excessive pressure concentrated on a small area. Corn is characterized by a hardened central region of localized thickened skin (hyperkeratinization). The lesion typically has a broad surface and a tapered, deeper base, giving it a cone-like shape. Corns are often painful and highly sensitive to touch. While hard corns are the most common, soft corns can also develop between the toes [6]. Foot corn can develop due to various factors, including wearing high heels or tight footwear, skipping socks, being overweight, having bunions, hammer toes, or foot deformities like bone spurs. They may also result from prolonged pressure and repeated friction caused by frequent foot movements. Common symptoms include redness, a firm and rough patch of raised skin, dry and flaky skin, pain while walking, and limitations in daily activities due to discomfort [7].

Foot corn, also known as clavus, heloma durum, or intractable forefoot hyperkeratosis, is a dense, localized hyperkeratotic lesion characterized by a cone-shaped core of keratin. Corns are typically caused by friction and can develop on various parts of the body in both humans and animals [8]. However, they are rarely identified by medical professionals because they often do not cause significant issues. Interestingly, corn can both protect and harm individuals. Wearing inappropriate footwear worsened the condition [9].

Research indicates that these illnesses are more prevalent among girls. Contributing factors to hyperkeratosis diseases include walking barefoot, removing shoes for religious practices, injuries from ballet dancing, and wearing low-quality shoes [10]. Between 20% to 65% of people aged 65 and older experience hyperkeratotic lesions, such as corns and calluses, on their feet. Though these keratotic lesions are often seen as a minor issue, they can lead to significant discomfort and damage [11].

Impact on Quality of Life

Foot problems and associated pain are widespread, with corns affecting between 14% and 48% of individuals. Studies highlight the high prevalence of corns and calluses among those seeking podiatry care [12]. For instance, nearly half of the 111 patients at a podiatry clinic were found to have these conditions. Similarly, a review of 392 participants at an Australian podiatry clinic identified nails, corns, and calluses as the most frequently reported foot issues [13].

Broader surveys reinforce these findings, revealing that 57% of 76,475 individuals visiting dermatology or general practice clinics suffered from various foot conditions and metatarsal corns [14]. Foot problems not only cause significant pain but also negatively impact quality of life [15]. Among older adults aged 65 and above, severe foot pain caused by conditions like corns and calluses often hampers mobility and interferes with daily activities [16]. Corns and calluses, which are among the leading contributors to foot pain, can be managed by removing the thickened tissue using a scalpel, which provides significant pain relief. However, poorly fitting footwear has been identified as a major contributing factor to these issues [17].

A survey of 176 older adults found a higher prevalence of foot problems among those wearing shoes that were too narrow for their feet [18]. Overall, foot pain and related conditions such as corns and calluses are common and significantly affect physical well-being and daily functioning, particularly among older adults and women. Proper management, including addressing footwear choices and providing appropriate treatments, can help reduce these problems and improve quality of life [19].

Human Skin

Human skin is a complex and multifunctional organ that acts as a protective shield against the external environment, with a highly organized and detailed structure [20]. The varying conditions across different areas of the skin significantly influence the types and amounts of microorganisms present [21]. For example, warm and humid regions like the armpits, groin, and spaces between the toes provide ideal conditions for fungal and microbial growth, resulting in a higher concentration of microorganisms. In contrast, drier areas such as the forearms and legs tend to support less microbial diversity [22].

The skin is composed of distinct layers, and fungal infections typically target specific layers. Antifungal medications are designed to penetrate these three key layers to combat the infection effectively [23]. Fungal infections affecting the outer layers of the skin often cause symptoms such as redness, itching, scaling, or rashes. Common examples include conditions like athlete's foot, ringworm, and jock itch, which flourish in warm, moist environments [24].

The primary layers of the skin are:

a) Epidermis
b) Dermis
c) Hypodermis

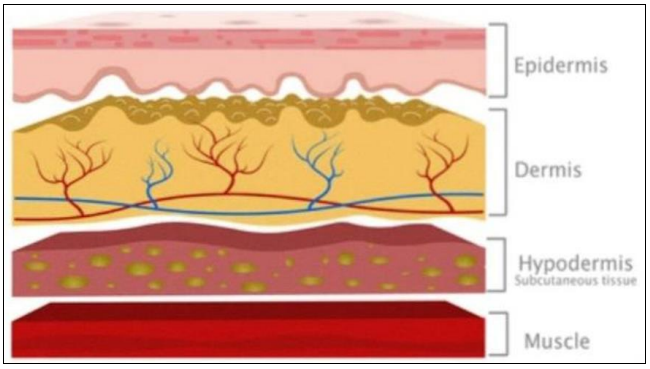

Fig 1

Types

- ***Soft Corns***

These typically develop on the sensitive skin located on the sides or between the toes. They feel squishy and rubbery and are more whitish-grey rather than yellow.

- ***Hard Corns***

Generally forming on the tips of your toes where bone pressure is exerted, these corns are dense and firm.

- ***Seed Corns***

Usually found in clusters on the bottom of the foot, seed corns are smaller and form due to pressure and friction, similar to hard and soft corns [25].

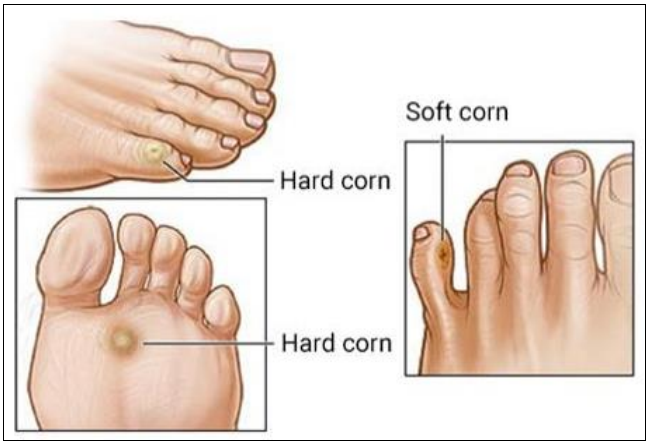

Fig 2

Ailments of a foot of corn

Corns and calluses on the feet can be identified by their specific features and locations. Calluses develop due to constant friction, resulting in thickened dead skin, and can form anywhere on the body. Different types of corns include:

Hard corn: A dense, thickened area of skin, typically found on the outer side of the little toe or the top of the toe.
Soft corn: A tender, reddish patch between the toes with a smooth and thinner centre.
Seed corn: A painful lump of dead skin, often found at the heel or base of the foot.
Plantar callus: A thickened area of skin on the bottom of the foot.

Causes
Corns and calluses develop from repeated friction and pressure, often due to: -

- **Shoes that don't fit well:** Tight footwear, such as high heels, can squeeze certain parts of the feet, while loose shoes may cause the foot to slide and rub against seams or stitching.
- **Not wearing socks:** Going without socks in shoes or sandals increases friction, and socks that don't fit properly can also irritate.
- **Handling tools or instruments:** Regular use of hand tools, musical instruments, or even frequent writing can create pressure on the hands, leading to corns [26].

Symptoms
If you notice any of these symptoms on your toes or other parts of your feet, you might be dealing with foot corns.

- Yellowish, roughened skin with ridges or warts
- Skin that's sensitive to touch
- Pain while wearing shoes.

Prevention of Foot Corn
To prevent foot corns from developing or recurring after treatment, it is important to address the underlying causes.
Here are some strategies to reduce stress and prevent the formation of corns: -

1. **Ensure Proper Fit for Socks and Shoes:** Make sure your socks and shoes fit well. Measure your feet to ensure the correct size and purchase shoes that are snug but not too tight. Buying shoes towards the end of the day, when your feet are slightly swollen, can help you get the right fit.
2. **Trim Your Toenails:** Keep your toenails short to prevent them from pushing against your shoes, which can create pressure and lead to the formation of corns.
3. **Corn Pads:** Corn pads can protect the affected area from excessive pressure or friction. These pads usually have an adhesive backing and are shaped like doughnuts to distribute the pressure around the corn, with the corn placed in the centre of the hole.
4. **Maintain Good Hygiene:** Wash and scrub your feet daily using soapy water and a scrub brush or pumice stone.
5. **Moisturize Regularly:** Keep your feet hydrated by applying foot cream daily to prevent dryness and reduce friction [27].

Treatment of Foot Corn
To treat foot corns, it's important first to address the underlying cause of friction. Typically, when the pressure or friction is eliminated, corn will naturally fade. However, if avoiding further irritation doesn't resolve the problem, doctors suggest the following steps for removal:

- **Soak your foot in warm water:** Submerge the corn in warm water for about 10 minutes to soften the skin.
- **Use a pumice stone to exfoliate:** After soaking, gently scrub the corn with a pumice stone to remove dead skin. This volcanic rock helps exfoliate and can be used in smooth, circular motions or sideways movements.
- **Apply lotion:** Use a moisturizer or cream containing salicylic acid, which helps break down the keratin in the corn and remove dead skin.

Caution: Salicylic acid should be avoided by those with diabetes, heart issues, or sensitive skin [28].

Pathophysiology of Corns
Corns develop due to mechanical trauma to the skin, leading to the thickening of the epidermis. This typically occurs because of friction and pressure between the foot bones and ill-fitting shoes, causing the stratum corneum to proliferate as part of a normal physiological response. The stratum corneum serves as a barrier against mechanical injury, and any damage to this barrier results in homeostasis changes and the release of cytokines into the epidermis, which then increases the synthesis of the stratum corneum. Chronic and unresolved mechanical stress leads to hyperplasia and inflammation.

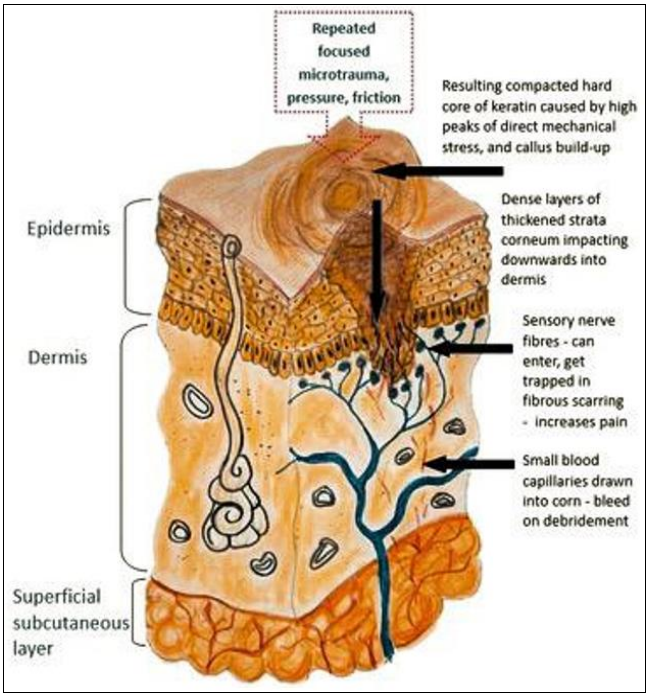

Fig 3

In the case of corns, the mechanical forces are concentrated on a small area of the skin, leading to the thickening of the stratum corneum and the formation of a hard keratin plug that presses painfully into the papillary dermis, known as a radix or nucleus.
The shape of the hands and feet, particularly the bony prominences of the metacarpophalangeal and metatarsophalangeal joints, plays a crucial role in corn development by creating friction on the overlying skin. Continuous motion, such as that seen in musicians, can lead to callosity formation. Toe deformities, such as contractures, and hammer, claw, and mallet-shaped toes, can contribute to the development of corns [29-35].

Plant Profile

Turmeric (Curcuma longa)

Turmeric is a popular medicinal plant valued for its ability to address various health conditions at home. Its rhizomes, the underground parts of the plant, are bright yellow to orange and can be dried and processed into a yellow powder with a slightly bitter, sharp, or sweet flavour. The primary active ingredient in turmeric is curcumin, which is known for its potent antioxidant, antifungal, and anti-inflammatory properties. These qualities make curcumin a key ingredient in various therapeutic formulations [36-39].

Fig 4

Table 1: Taxonomy of turmeric (*Curcuma longa*)

Taxonomic classification	Turmeric
Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Monocots
Clade	Commelinids
Order	Zingiberales
Family	Zingiberaceae
Genus	Curcuma
Species	C. longa

Neem (Azadirachta indica)

Neem is a fast-growing evergreen tree that can reach a height of 15–20 meters. Neem oil, extracted from its seeds, contains bioactive compounds such as Nimbidin and Nimbolinine, which exhibit both antifungal and antibacterial properties [40].

Fig 5

Table 2: Taxonomy of Neem (*Azadirachta indica*)

Taxonomic classification	Turmeric
Kingdom	Plantae
Clade	Tracheophytes
Clade	Angiosperms
Clade	Eudicots
Clade	Rosids
Order	Sapindales
Family	Meliaceae
Genus	Azadirachta
Species	A. indica

Aloe vera (Aloe barbadensis miller)

Aloe vera is a succulent plant known for storing water as a gel within its leaves. This gel is highly hydrating and is commonly used to soothe sunburns, insect bites, minor wounds, and various skin conditions. Additionally, Aloe vera leaves are valued for their moisturizing properties and their ability to promote collagen production, aiding in the healing of cracked heels [41].

Fig 6

Table 3: Taxonomy of Aloe Vera plant (*Aloe barbadensis Miller*)

Taxonomic classification	aloe vera
Kingdom	Plantae
Subkingdom	Tracheobioa
Super division	Spermatophyta
Division	Magnoliophyta
Class	Liliopsida
Subclass	Lilidae
Order	Liliales
Family	Aloaceae
Genus	Aloe L.
Species	Aloe vera (L.)

Tea tree oil

Tea tree oil also referred to as melaleuca oil, is an essential oil extracted by steaming the leaves of the Australian tea tree. Known for its antibacterial properties, it is widely used as a topical remedy. It is commonly applied to address conditions such as acne, athlete's foot, lice, nail fungus, and insect bites. Additionally, tea tree oil helps soften corns, remove dead skin cells through exfoliation, and eliminate bacteria due to its antimicrobial effects [42].

Fig 7

Table 4: Taxonomy of tea tree (*Melaleuca alternifolia*)

Taxonomic classification	Tea tree
Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Myrtales
Family	Myrtaceae
Genus	Melaleuca
Species	Melaleuca alternifolia

Transdermal Drug Delivery

The transdermal drug delivery system involves the topically administered medications in self-contained, discrete dosage forms of patches, which on application to the skin deliver the drug into the systemic circulation at a pre-determined and controlled rate over a prolonged period to increase the therapeutic efficacy and reduce the side effect of the drug.

A transdermal patch is an adhesive patch applied to the skin that delivers a drug at a precise release rate. Once applied, the drug enters the bloodstream and is distributed throughout the body. Most current transdermal systems use patches with semi-permeable membranes. Transdermal drug delivery systems (TDDS), also known as transdermal or skin patches, are designed to deliver drugs to the body, particularly for treating inflammation of the skin and nerves [43-46].

Types

Single-Layer Drug Adhesive System

In this type of patch, the medication is incorporated within the adhesive layer that adheres to the skin. This adhesive layer is responsible for both the release of the drug and certain skin-related functions. A backing and a liner temporarily cover the adhesive layer.

Reservoir System

In this system, the drug is stored in a reservoir separated from the backing layer by a membrane that controls the release rate. The drug release is regulated by the amount passing through the micropores of the membrane. The drug within the reservoir can be in the form of a gel, suspension, or solution, or incorporated into a solid polymer matrix.

Matrix Systems

- **Drug Binding Systems:** This method involves exposing the polymer adhesive by melting it from a solvent or adhesive, such as hot glue.
- **Matrix Dispersion System:** The drug is mixed with either a lipophilic or hydrophilic polymer matrix. The drug and polymer are immobilized on an occlusive substrate within a drug-impermeable backing chamber. An adhesive edge is created by applying adhesive around the perimeter, rather than coating the surface of the drug chamber [47-48].

Advantages

1. The drug bypasses first-pass metabolism in the liver.
2. Gastrointestinal issues are avoided.
3. Enables self-administration.
4. Provides a prolonged and predictable duration of action [49].

Disadvantages

1. Potential for allergic reactions at the application site, such as rashes, local swelling, or itching.
2. Difficulty in absorption for drugs with larger molecular sizes (over 1000 Da).
3. Variation in the skin's barrier function depending on the application site and individual differences [50].

Limitations for selection

The challenges associated with transdermal drug delivery systems (TDDS) include:

- **Limited Drug Compatibility:** Only drugs with specific physicochemical properties, such as appropriate lipophilicity and molecular size, are suitable for transdermal delivery.
- **Ineffectiveness for High Plasma Levels:** TDDS is not suitable for medications that require high systemic concentrations.
- **Potential Skin Reactions:** Drugs that can cause skin irritation or allergic reactions are not appropriate for this method.
- **Barrier for Large Molecules:** Large molecular weight drugs are unable to pass through the skin effectively.
- **Enzymatic Metabolism:** Medications that undergo significant metabolism during skin transport lose their effectiveness.
- **Unsuitability for High Dosage:** TDDS cannot accommodate drugs that require large doses [51].

Products available in the market

Table 5

S. No	Products	Active ingredients	Brand name	Usage /instructions
1.	Medicated Plaster	Salicylic Acid	Corn Cap	Apply directly to Corn, and replace every 48 hours.
2.	Pads, with Protective Cushion	Salicylic Acid	Scholl Corn Removal Pads	Replace daily until corn softens
3.	Medicated Discs& Cushions	Salicylic Acid	Dr. Scholl's Corn Removers	Apply, daily until the corn is removable.
4.	Solution	Salicylic Acid Solution corn is removable+ Lactic	Medical	Apply, twice daily directly to corn
5.	Solution	Salicylic Acid + LacticAcid +Polidocanol	Collomak	Apply1-2 times daily.
6.	Solution	Salicylic Acid Solution + LacticAcid	Duofilm	Apply, once daily for 1-2 weeks
7.	Liquid Solution	Salicylic Acid	Freezone	Use, as directed, to soften corns.
8.	Adhesive Strips	Salicylic Acid	Curad Mediplast	Cut and apply directly; replace every 48 hours
9.	Corn Removal Pad	Salicylic Acid	Corn Ex	Apply, daily until corn is softened.
10.	Foam Pads	No active ingredients (cushion)	Pedi Fix, Soft Foam Pads	Use to reduce pressure, on corns.

Results

The study showed that natural remedies like turmeric, neem, aloe vera, and tea tree oil were effective in treating foot corns. Their active components, such as curcumin and Nimbidin, had properties that reduced inflammation, softened corns, and promoted skin healing. Transdermal patches, including single-layer and reservoir systems, delivered drugs in a controlled manner, avoided side effects like stomach issues, and improved treatment outcomes. These systems were effective for managing thickened skin conditions like corns. Participants experienced less pain and softer skin after treatment, though a few reported mild skin irritations, such as itching. The findings suggest that natural remedies combined with advanced drug delivery methods can be effective for treating foot corns.

Discussion

The results of the study highlight a significant breakthrough in treating foot corn by combining natural remedies with advanced transdermal drug delivery systems. Such as the Effectiveness of Natural Remedies, helps in Inflammation, Skin Healing, Infections, Accessibility and Affordability, Advancement in Drug Delivery for foot corn treatment by addressing limitations, Controlled Drug Release, it's helpful for future advancement for Minimized Side Effects and Improved Compliance and enhanced Quality of Life.

Conclusion

The study highlights the potential benefits of combining natural remedies such as turmeric, neem, aloe vera, and tea tree oil with advanced transdermal drug delivery systems for the treatment of foot corns. These natural ingredients are known for their anti-inflammatory, antifungal, and healing properties, which help alleviate pain, soften corns, and support skin regeneration. When delivered via transdermal patches, these active compounds are released in a controlled manner, enhancing therapeutic efficacy and reducing side effects like gastrointestinal discomfort.

This integration represents a significant advancement in foot corn treatment, offering a non-invasive and convenient method. Additionally, it addresses challenges related to drug absorption and patient compliance, improving the quality of life for individuals with foot corns. Further research and development of transdermal systems could refine these treatments, enhance their effectiveness, and expand their accessibility, particularly for those with chronic foot problems.

Conflict of Interest

Authors do not have any conflict of interest.

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