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Original Article

Formulation and Evaluation of Herbal Foot Crack Cream from Aegle Marmelos Leaf Extract

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ABSTRACT

The primary objective of this study is to develop and assess an herbal foot crack cream. The herbal foot crack cream was formulated by oil-in-water (O/W) cream base conventional emulsification technique by using ethanolic extract of Aegle marmelos leaf extract. The formulated cream was also evaluated for their physical and chemical properties including pH, spreadability, washability, stability, viscosity, skin irritancy. The pH of herbal foot crack cream was found to be 6.5 which is acceptable in skin irritancy test. This research aims to highlight the therapeutic benefits of Aegle marmelos. Crack heel is a prevalent skin condition character by dryness, thick skin, and painful splits due to environmental factors, lack of hydration, or microbial infections. These findings suggest that Aegle marmelos based cream may serve as a potential herbal formulation for the treatment of wound healing and related skin condition.

Keywords: Aegle marmelos, Antibacterial, foot cracks, skin care, wound healing Leaf Extract

INTRODUCTION

The skin is the body's largest organ, covering approximately 20 square feet. It consists of three layers. The outermost layer, called the epidermis, acts as a waterproof shield and determines our skin tone. Cosmetics are widely used products designed to enhance and maintain the appearance of the face and other body parts such as the skin, eyes, hair, and hands. Herbal cosmetics are a special category that combines cosmetic use with active biological ingredients, nutraceuticals, and pharmaceutical properties. Cosmetics are primarily used for cleansing and beautifying the skin. Their use dates to ancient Egypt around 4000 B.C. On the other hand, pharmaceuticals are drug-based products used to prevent, treat, or cure diseases and influence the body's structure or function. The skin on the feet is especially prone to dryness, roughness, and cracking. Conditions such as athlete's foot, eczema, psoriasis, thyroid issues, and diabetes are common causes of cracked heels. Keeping the skin healthy is vital for overall well-being. Natural treatments are often considered affordable and safe alternatives.[1]

This review highlights various plants used in the treatment of skin diseases, summarizing the significant scientific developments made in this field over the past 17 years. These plants also serve as valuable raw materials for the development of new synthetic compounds. Herbs used in cosmetic formulations possess a range of beneficial properties, including antioxidant, anti-inflammatory, antiseptic, and antibacterial effects.



Fig.1. Crack heel

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Definition:[2] Creams are semi-solid emulsions that appear opaque, unlike ointments which are typically translucent. They are formulated for external use and are meant to be applied to the skin and mucous membranes.

Their consistence depends on whether the

1. Emulsion is water in oil or oil in water
2. Nature of solids in internal phase.

Skin care creams can be classified on different basis

1. According to function. E.g. cleansing, foundation, massage etc
2. According to characteristic properties, e.g. cold creams vanishing creams etc.
3. According to nature or type of emulsion.
4. Skin nourishment is important and required to preserve the normal characters of the skin or as a treatment for dry skin.

The skin on the feet lacks oil glands, which makes it more prone to dryness and cracking. Without proper care and the use of suitable footwear, these cracks can worsen and lead to various skin conditions. When dirt and bacteria enter through cuts and wounds, they can cause infections. Creams and gels are topical preparations designed for application to the skin. They may serve either cosmetic or pharmaceutical purposes, often forming a protective barrier on the skin's surface. Herbal cosmetics are natural products derived from different parts of plants such as flowers, fruits, leaves, and bark. Used since ancient times, they offer numerous benefits. The herbs included in these formulations typically possess antiseptic and germicidal properties.

What Are Cracks?

Cracks refer to breaks or splits in the skin, which are typically the result of extreme dryness. When the skin loses too much moisture, it becomes rough and can develop fissures, especially around the heel area. In severe cases, a deep fissure may form at the bottom of the heel. Therefore, it is essential to pay attention to daily habits and recognize any activities or conditions that may be worsening the problem.

Causes and Risk Factors of Cracked Heels

Cracked heels are primarily caused by excessively dry skin. In most cases, they are a cosmetic concern and do not lead to serious health problems. However, certain conditions and lifestyle factors can increase the likelihood of developing cracked heels.

Common Risk Factors Include:

1. **Obesity** – Extra body weight puts pressure on the heel, causing the skin to expand and crack.
2. **Diabetes** – Can lead to dry skin and poor healing capacity.
3. **Eczema and Psoriasis** – Skin conditions that contribute to dryness and irritation.
4. **Prolonged Standing or Walking on Hard Surfaces** – Increases pressure and friction on the heels.
5. **Thyroid Disorders** – Can slow metabolism, affecting skin health and moisture retention.
6. **Vitamin and Mineral Deficiencies** – Especially deficiencies in vitamin E, zinc, and omega-3 fatty acids.
7. **Genetics** – A hereditary tendency to dry or thick skin can make one more prone to heel cracks.
8. **Estrogen Deficiency** – Particularly in postmenopausal women, which can reduce skin elasticity.
9. **Poor Circulation** – Limits the skin's ability to stay nourished and hydrated.
10. **Constant Use of Footwear** – Especially open-back shoes or hard soles that do not support the heel.

Importance of Investigating Herbal Foot Crack Cream

Absolutely! Exploring herbal foot crack creams is crucial to assess their effectiveness and ensure they are safe for use. Below are some important aspects to consider.

1.1 Cracked Heels Overview

Cracked heels may develop due to several factors, such as insufficient moisture, wearing harsh or ill-

fitting footwear, and the buildup of thickened skin around the heels. Common symptoms include dryness, callused skin, and discomfort or pain in the heel area. Identifying the underlying causes is essential for understanding the condition and reducing the chances of recurrence.

- **Plant profile**

Indian Beals

Aegle marmelos (L.) Correa, commonly referred to as Bael or Bilva, belongs to the Rutaceae family and is widely recognized in traditional Indian medicine for its numerous therapeutic benefits. In Hindu culture, the Bael tree holds religious significance and is considered sacred, often offered in worship to Lord Shiva and Goddess Parvati. Because of this, it is also known as Shiva Duma, meaning "the tree of Shiva." The Bael tree originates from the Eastern Ghats and central regions of India. It is native to the Indian subcontinent and is predominantly found in tropical and subtropical climates.[3]



Fig.2. Leaf of Aegle marmelos

All parts of the Aegle marmelos plant including the roots, bark, leaves, fruit, and seeds possess medicinal value. Among them, the leaves are particularly noted for their anti-inflammatory, antimicrobial, and wound-healing effects.[4]mThe medicinal potential of Aegle marmelos leaves is largely due to their diverse and rich phytochemical composition. Studies have identified a range of bioactive compounds in the leaves, including alkaloids, flavonoids, phenolics, tannins, saponins, coumarins, essential oils, and steroids or terpenoids. These compounds play a key role in the plant's healing properties and serve as the foundation for various modern herbal products, such as foot crack creams, antimicrobial formulations, and antioxidant supplements. Among the notable alkaloids present in Aegle marmelos leaf extract, aegeline and skimmianine are particularly recognized for their antioxidant and anti-inflammatory properties. Flavonoids such as rutin and quercetin offer strong free radical scavenging activity, while phenolic compounds and tannins contribute to the plant's astringent and wound-healing effects. Additionally, coumarins and essential oils boost the extract's therapeutic value by providing antimicrobial and anti-inflammatory benefits, along with a natural fragrance—making them especially suitable for use in topical formulations.[5] The diverse chemical composition of Aegle marmelos leaves highlights their significance in phytopharmaceutical research and justifies their use in a range of medicinal and cosmetic formulations.

Plant Details:

- **Common Names:** Wood Apple, Bengal Quince
- **Kingdom:** Plantae
- **Order:** Sapindales
- **Family:** Rutaceae
- **Genus:** Aegle
- **Species:** Aegle marmelos
- **Botanical Name:** Aegle marmelos
- **Medicinal Uses:** Traditionally used for treating infections and constipation.[6]

Biological Source:

Aegle marmelos, commonly referred to as Bael or Bengal quince, is a plant from the Rutaceae family. Its biological sources include the dried or fresh leaves, fruit, bark, and root.[7]

Geographical Source:

Aegle marmelos (Bael), originally from India, is commonly found across tropical and subtropical areas of Southeast Asia. It is prevalent in countries like Sri Lanka, Myanmar, Bangladesh, Thailand, and regions of Malaysia. The plant is also grown in tropical zones of Africa, the Caribbean, and Australia, especially in

dry and semi-arid climates. It flourishes in dry forests, along riverbanks, and plains, showing a strong adaptability to different soil types particularly those that are alkaline and well-drained.[8]

Chemical Constituents:

The leaves of Aegle marmelos are rich in several bioactive phytochemicals, including alkaloids like aegeline, flavonoids such as rutin and quercetin, as well as terpenoids, phenolic compounds, and coumarins like marmelosin and marmin. They also contain essential oils, including eugenol, all of which contribute to their therapeutic properties.[9]

Health Benefits of Bael (Aegle marmelos):

1. Possesses anti-inflammatory properties.
2. Exhibits anti-fungal effects.
3. Helps in combating acne.
4. Acts as a powerful antioxidant.
5. Supports anti-ulcer activity.
6. Aids in managing diabetes.
7. Demonstrates anti-malarial potential.
8. Shows anti-cancer capabilities.
9. Contains anti-bacterial effects.
10. Offers broad-spectrum anti-microbial action.[10]

Table 1: - Application of different Indian Beal tree parts

Part	Application in medicine
Leaf	Used in the treatment of diarrhoea, asthma, and various skin conditions.
Bark	Beneficial for improving digestive health, addressing respiratory problems, and reducing fever.
Flower	Employed in managing gastrointestinal disorders and treating skin-related issues.
Seed	Possess properties that help combat bacterial and fungal infections.

MATERIAL AND METHOD

A. MATERIAL

Collection of Plant material:

Aegle marmelos leaves that were identified and collected from the Koregaon Bhima, Pune. Maharashtra, India-412216 neighborhood. The beal leaves was cleaned, dried in room temperature, transfer into moderately coarse powder and stored in well closed container before the extraction. While the chemical and reagents apply from Delight college of pharmacy Koregaon Bhima, Pune. Maharashtra, India-412216.

Preparation of Beal Extract:

1. Preparation of Plant Material:

Fresh leaves of Aegle marmelos are collected, washed with distilled water, and shade-dried for 7–10 days. The dried leaves are ground into coarse powder using a grinder or mortar-pestle.

2. Loading the Soxhlet:

Weigh 50 g of the powdered leaves and place them in a thimble made of filter paper. Insert the thimble into the Soxhlet extractor.

3. Solvent Extraction:

Fill the round-bottom flask with 250–300 mL of the chosen solvent (commonly ethanol, methanol, or hydroalcoholic mixture). Attach the Soxhlet setup with a condenser and begin heating the solvent. The solvent will evaporate, condense, and repeatedly wash the plant material in cycles. Allow the extraction to run for 6–8 hours or until the siphon tube's solvent becomes colourless.

4. Concentration of Extract:

Once extraction is complete, collect the extract from the round-bottom flask. Concentrate the extract using a rotary evaporator or on a water bath at 40–50°C to remove excess solvent. Store the semi-solid or dried extract in an airtight container in a cool, dry place.

5. Storage of Extraction:

The extraction is collecting form the round bottle flask. The extraction are filter and store in well tight

closed container. Store in a cool, dry place, away from direct sunlight.

The extraction process:

All process of extraction is conduct in Delight College of Pharmacy, Koregaon Bhima, Pune, Maharashtra, India.



Fig.3. Powder of Aegle marmelos leaf



Fig.4. Process of extraction

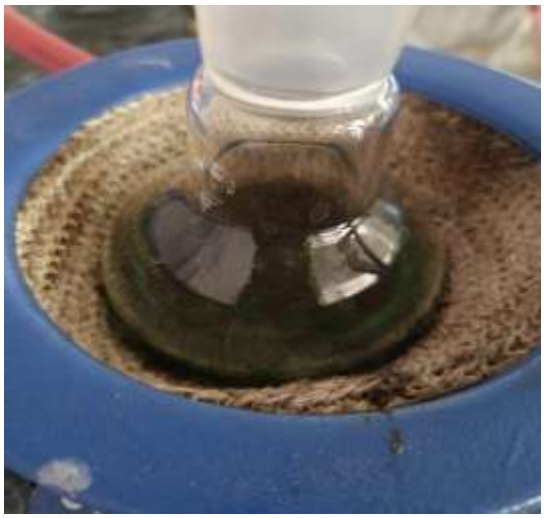


Fig.5. Collection of extract



Fig.6. Filtration of extract



Fig.7. Extracted liquid.

METHOD FOR FORMULATION

Table 1: - Formulation table of herbal foot crack cream

Sr. No.	Ingredient	Quantity (for 50gm Cream)	Function
1	Aegle marmelos leaf extract	3g	Active herbal agent
2	Stearic acid	4g	Emulsifier, consistency builder
3	Lanolin	1g	Emollient, stabilizer
4	Beeswax	2.5g	Thickening and base component
5	Coconut oil	6ml	Natural moisturizer and antimicrobial
6	Glycerin	3g	Humectant
7	Liquid paraffin	4g	Softener and spreadability enhancer
8	Triethanolamine	0.5g	pH adjuster, emulsifying aid
9	Methyl paraben	0.10g	Microbial preservation
10	Distilled water	25.9g	Aqueous phase to complete

B. METHODS

Step-by-Step Preparation Method:

Step 1: Oil Phase Preparation:

1. In a beaker, add:

- Stearic acid (4.0 g)
- Lanolin (1 g)
- Beeswax (2.5 g)
- Coconut oil (6 ml)
- Liquid paraffin (4 g)

2. Heat the mixture in a water bath at 70–75°C until all components are melted and a clear oil phase is obtained.

Step 2: Aqueous Phase Preparation

1. In another beaker, add:

- Distilled water (25.9 g)
- Glycerin (3.0 g)
- Aegle marmelos leaf extract (3.0 g)
- Triethanolamine (0.5 g)
- Methyl paraben (0.10 g)

2. Heat this mixture to 70–75°C, ensuring the preservative dissolves completely and the solution is homogeneous.

Step 3: Emulsification

1. Slowly add the hot aqueous phase into the hot oil phase with continuous stirring (use a glass rod or mechanical stirrer).
2. Continue stirring until a stable emulsion forms.
3. Remove from heat and allow the cream to cool with continuous gentle stirring to prevent air entrapment.

Step 4: Finishing

1. Once the cream cools to below 40°C,
2. Stir gently to mix uniformly.
3. Check the texture. If using a homogenizer, you may use it at this stage for a finer finish.

Step 5: Packaging

1. Transfer the cream into a sterile, airtight container or jar using a spatula.
2. Label with the product name, batch number, and date of preparation.

Storage:

- Store in a cool, dry place, away from direct sunlight.
- Shelf-life: Evaluate stability for 30–60 days under room and elevated temperature conditions.



Fig 8. Herbal Foot Crack Cream

- **Evaluation Parameter for Herbal Foot Crack Cream from Aegle marmelos:**

Physical Evaluation:

1. Appearance

- Method: Visually inspect the cream.

2. Odour

- Method: Smell the cream.

3. pH Measurement

- Method: Dissolve 1 g of cream in 10 mL of distilled water and measure pH using a digital pH meter.

4. Spreadability

- Method: Place 1 g of cream between two glass slides and apply 500 g weight for 1 min. Measure the diameter of the spread.

5. Washability

- Method: Apply cream on skin or glass slide and attempt to wash with water.

6. Stability Testing

- Method: Store cream in various conditions:

- Room temp (25°C)
- Refrigerated (4°C)
- Elevated temp (40°C)
- Observe over 30–60 days

7. Irritancy Test (Patch Test)

- Method: Apply cream to a small area of skin (forearm or behind ear) of 5–10 human volunteers.

8. Viscosity

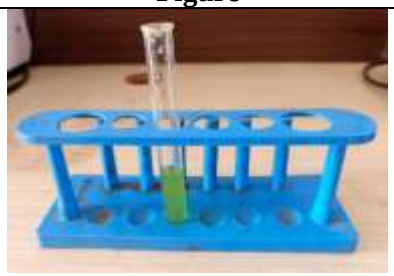
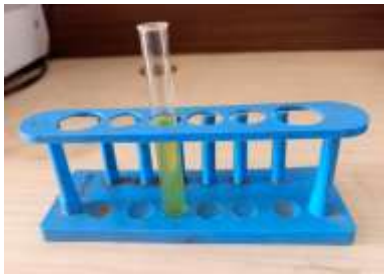
- Method: Use a Brookfield viscometer or manual inspection.

9. Microbial Load (optional for advanced testing)

- Method: Plate sample on nutrient agar and incubate at 37°C for 24–48 hours.

OBSERVATION AND RESULT

Table 2: Table for chemical test of Aegle marmelos leaf extract:

Sr. No.	Observation of test	Figure	Inference
1	**1.For Alkaloid:** Add few drops of Mayer's reagent to the extract. Observation: Creamy white precipitate.		**Passed**
2	**2.For Tannins:** Add 1-2 drops of 5% ferric chloride solution to the extract. Observation: Greenish black colour obtained.		**Passed**
3	**3.For Flavonoids:** Add few magnesium tunnings and conc. HCl to the extract. Observation: Pink colour obtained**.**		**Passed**
4	**4.For Saponins:** Shake the extract vigorously with water. Observation: Solution is stable.		**Passed**
5	**5.For Phenolic compound:** Add 1-2 drops of $FeCl_3$ solution. Observation: Green coloration obtained.		**Passed**

6	**6.For Steroids:** Mix extract with chloroform and add conc. Sulfuric acid. Observation: Reddish brown colour obtained.		**Passed**

6. Evaluation Parameter for Herbal Foot Crack Cream from Aegle marmelos:

Table 3: Table for evaluation test of cream:

Sr. No.	Test of evaluation	Result
1	**Appearance** Method: Visually inspect the cream.	Smooth, homogeneous, and free from lumps or phase separation.
2	**Odour** Method: Smell the cream.	Acceptable odor, no foul or rancid smell.
3	**pH Measurement** Method: Dissolve 1 g of cream in 10 mL of distilled water and measure pH using a digital pH meter.	The pH was found to 6.5.
4	**Spreadability** Method: Place 1 g of cream between two glass slides and apply 500 g weight for 1 min. Measure the diameter of the spread.	6.2 g·cm./sec high spreadability with moderate viscosity (good application).
5	**Washability** Method: Apply cream on skin or glass slide and attempt to wash with water.	Easily washable with water.
6	**Stability Testing** Method: Store cream in various conditions:	Room temp (25°C) Refrigerated (4°C) Elevated temp (40°C) Observe over 30–60 days
7	**Irritancy Test (Patch Test)** Method: Apply cream to a small area of skin (forearm or behind ear) of 5–10 human volunteers.	No irritation or allergic reaction.
8	**Viscosity** Method: Use a Brookfield viscometer or manual inspection.	show moderate to high viscosity for easy application and adherence.
9	**Microbial Load (optional for advanced testing)** Method: Plate sample on nutrient agar and incubate at 37°C for 24–48 hours.	Minimal to no microbial growth.

DISCUSSION

The herbal foot crack cream was successfully formulated using Aegle marmelos leaf extract and various excipients. The cream exhibited a uniform texture, was non-greasy, and had good spreadability. No phase separation or grittiness was observed during storage. The pH of the cream was found to be 6.5, which is within the acceptable range for topical application and is compatible with skin pH. Spreadability was measured as 6.2 g·cm/sec, indicating ease of application and good coverage on skin. The cream showed good extrudability, requiring moderate pressure to be released from the tube, indicating optimal viscosity. The cream was stable for 30 days under ambient conditions with no change in color, odor, or texture. No irritation, redness, or discomfort was observed on volunteer subjects, confirming the cream is safe for topical use. Subjects reported noticeable improvement in heel cracks within 7–10 days of application. This supports the ethnomedicinal claims of Aegle marmelos leaves

having wound-healing and antimicrobial properties. The cream's effectiveness can be attributed to the bioactive compounds in Aegle marmelos, such as tannins, flavonoids, and alkaloids, known for their astringent, anti-inflammatory, and antimicrobial properties.

CONCLUSION:

The present study successfully formulated and evaluated an herbal foot crack cream using Aegle marmelos (Bael) leaf extract. The formulation demonstrated desirable physical characteristics, including smooth texture, appropriate pH, good spreadability, and stability. The presence of phytoconstituents such as tannins, flavonoids, and alkaloids in Aegle marmelos contributed to its antimicrobial, anti-inflammatory, and wound-healing properties. The cream showed promising results in healing cracked heels within a short period without causing skin irritation, confirming its safety and effectiveness for topical use. Therefore, this herbal formulation presents a natural, cost-effective, and skin-friendly alternative to conventional foot care products.

FUTURE SCOPE:

The formulation of Aegle marmelos-based herbal foot cream opens new avenues for developing targeted phytotherapeutic skincare solutions. Future research can focus on nano-formulation approaches to enhance skin penetration and bioavailability of active constituents. Advanced analytical techniques like HPTLC or LC-MS can be used to standardize and quantify bioactive markers for quality control. Exploring different extraction methods may yield higher concentrations of potent compounds, improving therapeutic efficacy. Collaborations with dermatological clinics for long-term efficacy studies, coupled with consumer acceptability trials, will further support the product's viability for large-scale production and market entry as a scientifically validated herbal cosmeceutical.

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