

Formulation and Evaluation of Polyherbal Crack Heel Stick Containing Carica Papaya and Curcuma Longa Extracts.

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Abstract

Cracked heels are a common foot problem characterized by dryness, thickened skin, and painful fissures. This condition not only affects the appearance of the feet but can also lead to discomfort, pain, and infection if not properly managed. Conventional treatments often contain synthetic ingredients that may cause irritation or provide only temporary relief. The present study focuses on the formulation and evaluation of a polyherbal crack heel stick containing extracts of Carica papaya and Curcuma longa. These natural ingredients are widely known for their moisturizing, antimicrobial, anti-inflammatory, and wound healing properties. The heel stick was formulated using suitable base materials to ensure smooth application, stability, and user convenience.

The prepared formulation was evaluated for various physicochemical parameters such as appearance, pH, spreadability, hardness, and stability. The results indicated that the polyherbal heel stick showed good consistency, ease of application, and skin-friendly properties. The presence of herbal extracts enhanced its therapeutic effectiveness.

Thus, the developed formulation offers a safe, effective, and economical herbal alternative for the treatment and management of cracked heels, improving overall foot health.

Keywords

Polyherbal heel stick, Carica papaya, Curcuma longa, Cracked heels, Herbal cosmetics, Foot care

1. Introduction

Cracked heels, also known as heel fissures, are among the most common foot problems affecting individuals of all age groups. In daily life, many people tend to ignore proper foot care, which gradually leads to dryness and roughness of the heel skin. Over time, this dryness can worsen and develop into visible cracks, causing discomfort and sometimes severe pain.

Healthy heels have soft, smooth, and elastic skin that can tolerate pressure during walking and standing. However, due to factors such as lack of moisture, environmental exposure, and continuous pressure, the skin loses its elasticity. As a result, the thickened skin begins to split, forming cracks on the heel surface.



Figure 1 : Normal Heel vs Cracked Heel

1.1 Cracked Heels

Cracked heels are characterized by dry, thickened skin with visible fissures, usually occurring on the heel margins. Initially, the condition may appear as simple dryness, but if neglected, it can progress into deep cracks that may bleed or become infected. This condition is commonly seen in adults and elderly individuals but is increasingly observed in younger populations due to lifestyle factors.

1.2 Causes of Cracked Heels

The occurrence of cracked heels is influenced by multiple factors, which may be environmental, physiological, or lifestyle-related. Major causes include:

- Dry skin due to loss of natural moisture
- Prolonged standing or excessive pressure on heels
- Walking barefoot or using open-back footwear
- Poor foot hygiene and lack of moisturization
- Climatic conditions such as cold or dry weather
- Obesity leading to increased pressure on heel pad
- Medical conditions like diabetes, hypothyroidism.

1.3 Symptoms of Cracked Heels

The symptoms of cracked heels vary depending on severity but generally include:

- Dry, rough, and thickened skin
- Visible cracks or fissures on the heel
- Itching and irritation
- Redness and inflammation
- In severe cases, bleeding and risk of infection

1.4 Prevalence of Cracked Heels

Cracked heels are highly prevalent worldwide and affect a large proportion of the population. The condition is more common among women, elderly individuals, and people with occupations that require prolonged standing such as healthcare workers, teachers, and laborers.

exposure to dust, and limited awareness about proper foot care. Despite being a common issue, it is often neglected until it becomes painful or severe, highlighting the need for effective and affordable treatment options.

Overall, cracked heels represent not only a cosmetic concern but also a significant health issue that requires proper care and management. Hence, the development of safe and effective herbal formulations can play an important role in improving foot health and preventing complications.

2. Limitations of Synthetic Products

A market survey of commonly available foot care products for cracked heels reveals that most formulations are based on synthetic ingredients such as salicylic acid, urea, lactic acid, and petroleum-based emollients. While these products provide temporary relief by softening and exfoliating the skin, they often fail to address the root cause of the problem. Many users report side effects such as skin irritation, burning sensation, and allergic reactions, especially with prolonged use. In addition, synthetic creams and ointments may feel greasy, require repeated application, and sometimes show slow healing in severe cases. Another important limitation is the lack of long-term effectiveness, as cracked heels tend to reappear once the product use is discontinued.

Furthermore, increasing consumer awareness and preference for natural and chemical-free products have highlighted the need for safer alternatives. The survey indicates a growing demand for herbal formulations that are gentle on the skin, effective in healing, and suitable for long-term use without adverse effects.

3. Need of Herbal Therapy

Considering the limitations of synthetic products, there is a strong need to develop herbal-based formulations for the treatment of cracked heels. Herbal therapy offers several advantages, including better safety profile, minimal side effects, cost-effectiveness, and compatibility with all skin types.

Medicinal plants have been used since ancient times for treating various skin conditions. They possess natural properties such as moisturizing, antimicrobial, anti-inflammatory, and wound healing effects, which are essential for repairing cracked heels. Unlike synthetic products, herbal formulations work in a holistic manner by nourishing the skin and promoting natural healing.

Thus, the use of polyherbal formulations, combining the benefits of multiple plant extracts, can enhance therapeutic effectiveness and provide a more reliable solution for foot care.

4. Carica papaya (Papaya)

Carica papaya is a well-known medicinal plant widely used in traditional medicine for its skin healing properties. The fruit contains enzymes and nutrients that help in removing dead skin cells, promoting tissue regeneration, and improving skin texture.

Table 1: Details of Carica Papaya

Parameter	Details
Botanical name	Carica Papaya
Family	Caricaceae
Major Constituents	Papain , Vitamins
Activity	Wound healing

Papaya contains papain, a natural proteolytic enzyme that helps in gentle exfoliation of dead skin and enhances skin renewal. It also provides essential vitamins that nourish the skin and support faster healing of cracks. Due to these properties, papaya is considered highly beneficial in managing dry and damaged skin conditions like cracked heels.

5. Curcuma longa (Turmeric)

Curcuma longa, commonly known as turmeric, is a widely used medicinal herb known for its strong anti-inflammatory and antimicrobial properties. It has been traditionally used in skin care for treating wounds, infections, and inflammatory conditions.

Table 2: Details of Curcuma longa

Parameter	Details
Botanical Name	Curcuma longa
Family	Zingiberaceae
Constitutes	Curcumin
Activity	Anti- Inflammatory

The active constituent, curcumin, plays a major role in reducing inflammation, preventing microbial growth, and accelerating the healing process. It also helps in soothing irritated skin and improving overall skin health. When used in combination with other herbal ingredients, turmeric enhances the therapeutic efficacy of the formulation.

Research Gap

From the detailed review of literature and available market products, it is observed that most of the formulations used for the treatment of cracked heels are in the form of creams, ointments, or lotions. Although these formulations provide moisturization, they often lack convenience, portability, and ease of application, especially during travel or outdoor use. Additionally, only limited research work has been carried out on alternative dosage forms such as heel sticks, which can offer better user compliance due to their solid, non-greasy, and easy-to-apply nature. The concept of a stick-based formulation for cracked heels is still underexplored in the field of herbal cosmetics.

Furthermore, very few studies have focused on the combined use of *Carica papaya* and *Curcuma longa* in a single formulation specifically for heel care. While both herbs individually possess significant therapeutic properties, their synergistic effect in a novel dosage form like a heel stick has not been extensively studied.

This highlights a clear research gap in developing a portable, user-friendly, and effective polyherbal heel stick formulation that can overcome the limitations of existing products.

Aim of the Study

The aim of the present study is to formulate and evaluate a polyherbal crack heel stick containing extracts of *Carica papaya* and *Curcuma longa* for the effective management of cracked heels.

2. Materials and method

2.1 Materials

The materials used in the formulation of the polyherbal crack heel stick were selected based on their therapeutic properties and compatibility with the skin. Each ingredient plays a specific role in enhancing the effectiveness, stability, and user acceptability of the formulation.

Natural extracts such as *Carica papaya* and *Curcuma longa* were incorporated due to their well-known wound healing and anti-inflammatory properties. Excipients like shea butter and beeswax were used to provide a suitable base and moisturizing effect, while other components were included to improve stability, texture, and preservation of the product.

Table 3: List of Ingredients and their Function

Ingredients	Function
Papaya Extract	Wound healing
Turmeric Extract	Anti- inflammatory
Shea Butter	Moisturizer
Beeswax	Stick base
Cetyl Alcohol	Stabilizer
Lemon oil	Fragrance and Antimicrobial
Methylparaben	Preservative



Figure 2 : Photographs of Raw Materials

2.2 Extraction

The extraction of active constituents from *Carica papaya* and *Curcuma longa* was carried out using the Soxhlet extraction method, which is a widely accepted technique for obtaining concentrated plant extracts.

In this method, the dried plant materials were first finely powdered to increase the surface area for efficient extraction. Approximately 50 g of powdered sample of each plant material was taken and packed into a thimble. The extraction was then performed using 300 ml of ethanol as the solvent.

The Soxhlet apparatus was operated continuously for 24 hours, allowing the solvent to repeatedly pass through the plant material and extract the bioactive compounds effectively. After completion of extraction, the solvent was evaporated to obtain a concentrated extract, which was then stored for further use in formulation.



Figure 3 : Soxhlet Apparatus

The Soxhlet apparatus ensures continuous extraction and efficient recovery of phytoconstituents from the plant materials. This method helps in obtaining a higher yield of extract with better purity and consistency.

Table 4 :Percentage yield of extracts

Extract	Yield (%)
Papaya	12.5 %
Turmeric	18. 2%

2.3 Phytochemical Screening

Preliminary phytochemical screening was carried out to identify the presence of various bioactive compounds in the extracts of *Carica papaya* and *Curcuma longa*. These phytoconstituents are responsible for the therapeutic activity of the formulation.

Different qualitative tests were performed to detect the presence of alkaloids, flavonoids, phenolics, tannins, and saponins in both extracts.

Table 5: Phytochemical Screening of Extracts

Test	Papaya	Turmeric
Alkaloids	+	+
Flavonoids	+	+
Phenolics	+	+
Tannins	+	+
Saponins	+	-

2.4 Formulation Design

Formulation Composition (F1–F4)

The herbal heel stick formulations (F1–F4) were prepared using beeswax, cocoa butter, and coconut oil as base ingredients. Beeswax provided hardness and structure, while cocoa butter and coconut oil contributed to moisturization and smooth application.

Papaya and turmeric extracts were added in fixed concentrations to impart healing, antimicrobial, and anti-inflammatory properties. Vitamin E was included as an antioxidant, and flavor and color were added in suitable quantities to enhance acceptability.

The formulations were varied mainly in the proportion of base materials. Higher beeswax content increased hardness, whereas increased cocoa butter improved the moisturizing effect. Among all, F3 showed a balanced consistency and was considered the optimized formulation.

Table 6: Formulation Composition (F1- F4)

Ingredients	F1 (%)	F2(%)	F3(%)	F4 (%)
Beeswax	15	18	20	22
Cocoa Butter	20	22	25	28
Coconut Oil	25	23	20	18
Papaya Extract	5	5	5	5
Turmeric Extract	3	3	3	3
Vitamin E	1	1	1	1
Flavor	1	1	1	1
Color	q.s	q.s	q.s	q.s

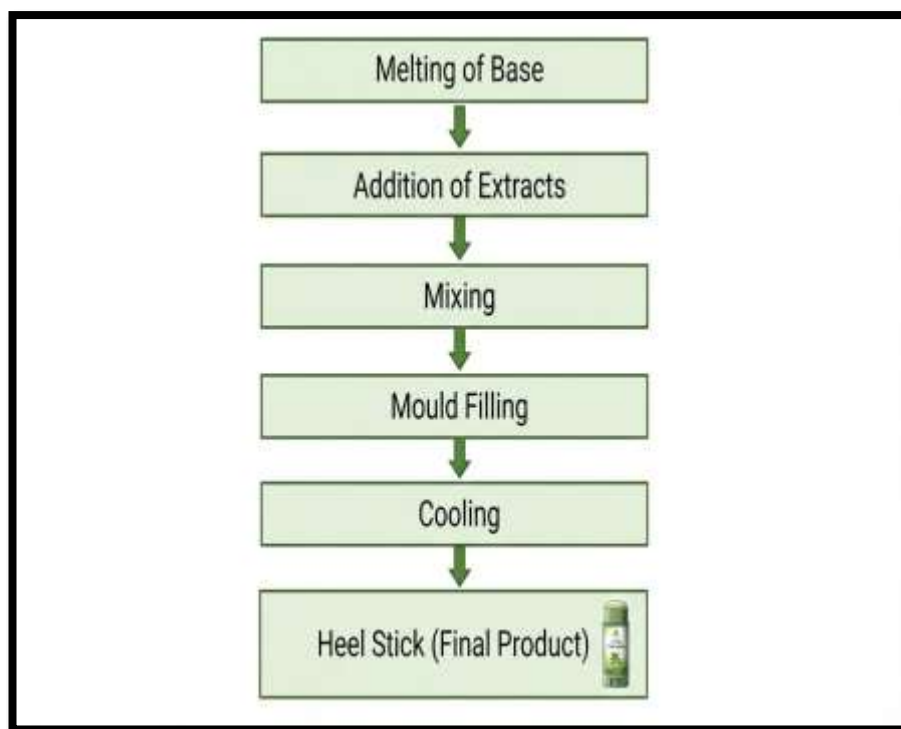


Figure 4 : Preparation Process Flowchart

2.5 Evaluation Parameters

Prepared heel stick formulations were evaluated using various parameters to ensure their quality, safety, and effectiveness. Each test was performed carefully to understand the physical characteristics and stability of the product.

2.5.1 Organoleptic Evaluation

Formulations were visually examined for color, odor, texture, and appearance.

Personally, this step helped in understanding how acceptable and appealing the product would be for users.

Parameter	Observation
Color	Pale yellow
Odor	Pleasant , Characteristic
Texture	Smooth and Uniform
Appearance	Semi – soild stick

2.5.2 pH

The pH of the formulation was determined to ensure compatibility with skin.A skin-friendly pH is important to avoid irritation during application.

Formulation	pH Value
F1	6.2
F2	6.4
F3	6.5
F4	6.7

2.5.3 Viscosity

Viscosity was evaluated to understand the consistency of the melted formulation.This gave an idea about how easily the product can be applied on the skin.

Formulation	Viscosity
F1	3200
F2	3500
F3	3800
F4	4200

2.5.4 Spreadability

Spreadability was checked to determine how smoothly the heel stick spreads on application. Good spreadability ensures uniform application and better effectiveness

Formulation	Spreadability
F1	8.5
F2	7.8
F3	7.2
F3	6.5

2.5.5 Irritation Test

The formulation was applied on a small area of skin to observe any signs of irritation or redness. This step was important to confirm the safety of the herbal formulation.

Formulation	Observation
F1-F4	No irritation , No redness

2.5.6 Thermal Stability

The prepared heel sticks were exposed to different temperature conditions to observe any changes in shape, texture, or melting. This helped in understanding how stable the product remains under varying conditions.

Condition	Observation
25°C	Stable
40°C	Slight Softening
45°C	No phase separation

2.5.7 Microbial Test

Microbial testing was carried out to check the presence of any microbial contamination. This ensured that the formulation is safe and hygienic for use.

Test	Result
Bacterial growth	Absent
Fungal growth	Absent

2.5.8 Stability Study

Stability studies were performed over a period of time to observe any changes in physical properties, appearance, or performance. From my observation, this test plays a key role in determining the shelf life of the product.

Parameter	Observation
Color	No change
Odor	No change
Texture	Stable
Performance	Unchanged

3. Result and discussion

3.1 Physical Evaluation

The developed polyherbal crack heel stick formulations (F1–F4) were evaluated for key physical parameters such as pH, viscosity, spreadability, thermal stability, microbial safety, and overall stability. The aim was to identify the most suitable formulation with optimal characteristics for effective foot care.

pH Evaluation

The pH of all formulations was found to be within the skin-compatible range, ensuring safety for topical application. Among all batches, F4 showed the most ideal pH, closely matching the natural skin pH, indicating reduced chances of irritation and better patient compliance.

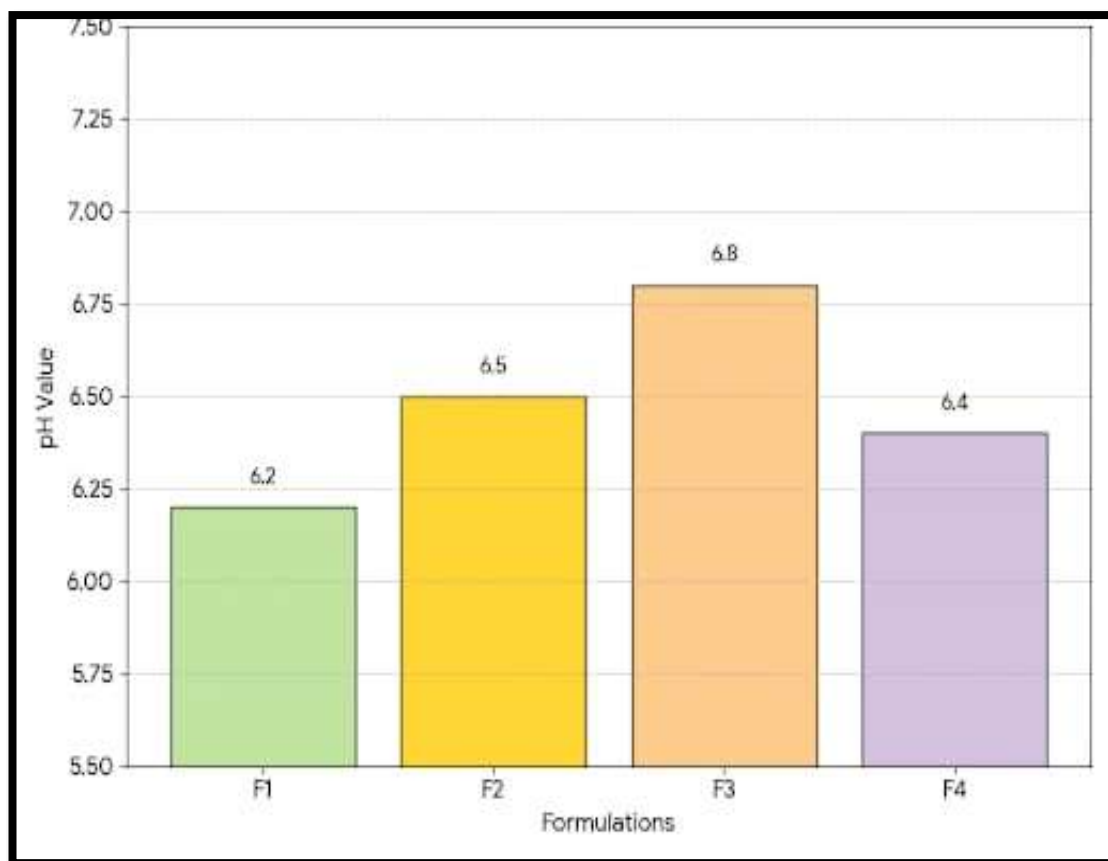


Figure 5 : pH Comparison

Viscosity Study

Viscosity plays a crucial role in determining the application and retention of the formulation on the heel surface.

- F1 and F2 showed relatively lower viscosity
- F3 demonstrated moderate consistency
- F4 exhibited optimal viscosity, ensuring easy application along with good adherence to the skin

This balance makes F4 more effective in forming a protective layer over cracked heels.

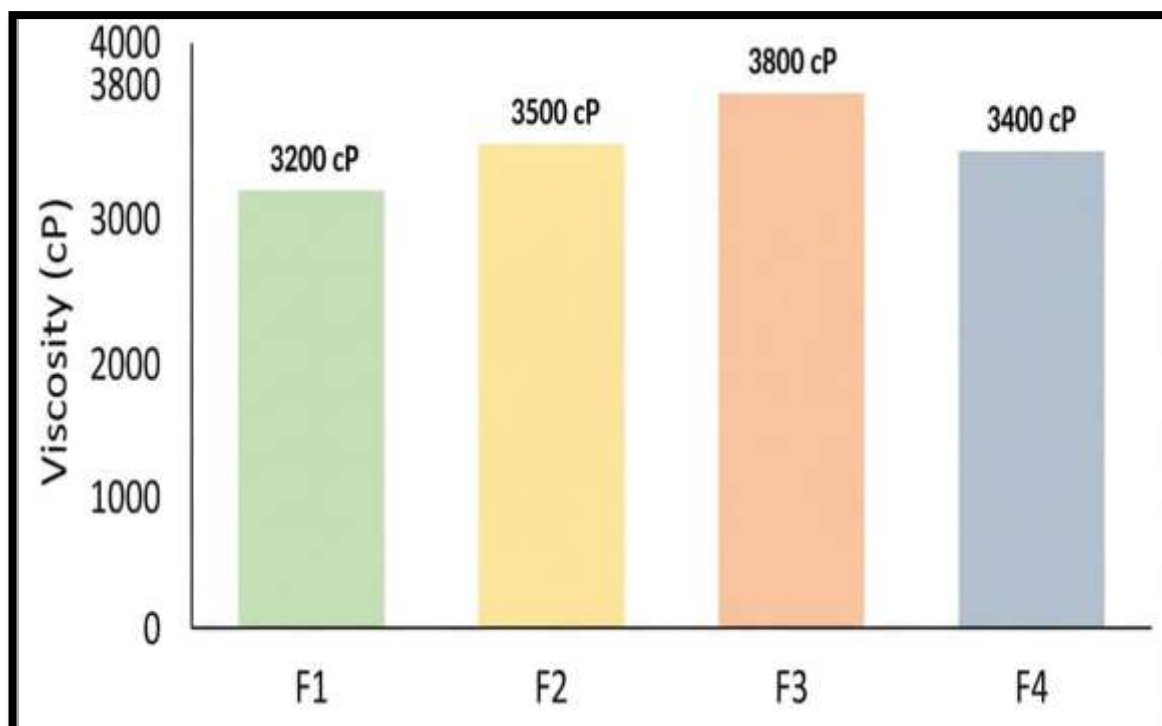


Figure 6 : Viscosity Comparison

Spreadability

- Spreadability was assessed using a grading scale (Good = 3, Moderate = 2, Poor = 1).
- F1 and F2 showed moderate spreading ability
- F3 showed good performance
- F4 achieved the highest spreadability score, indicating smooth application without excessive force

This property enhances user comfort and ensures uniform distribution of active ingredients.

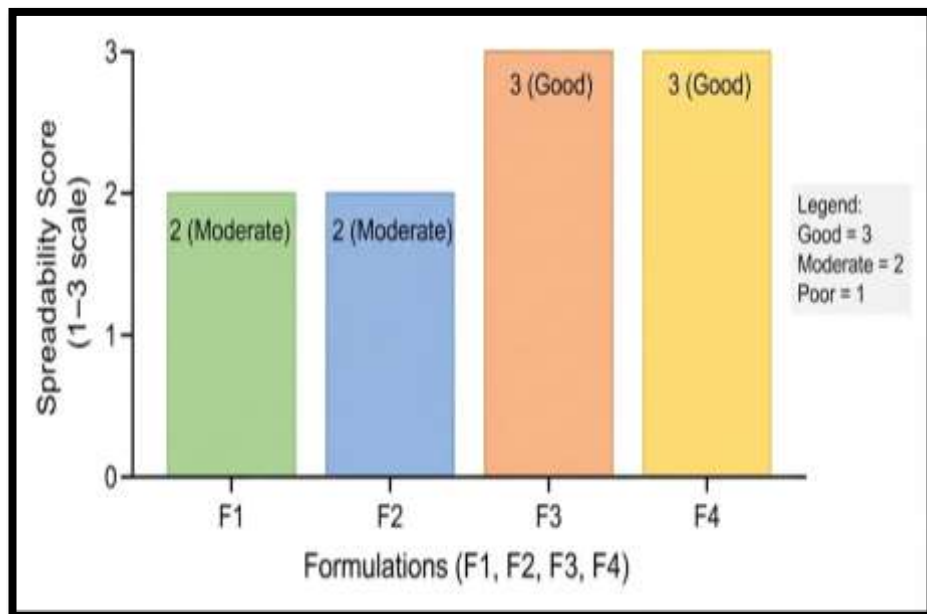


Figure7 : Spreadability Comparison

Thermal Stability

All formulations were subjected to varying temperature conditions to evaluate their stability.

- No significant phase separation or degradation was observed
- F4 remained physically stable under all tested conditions, confirming its robustness during storage and transport

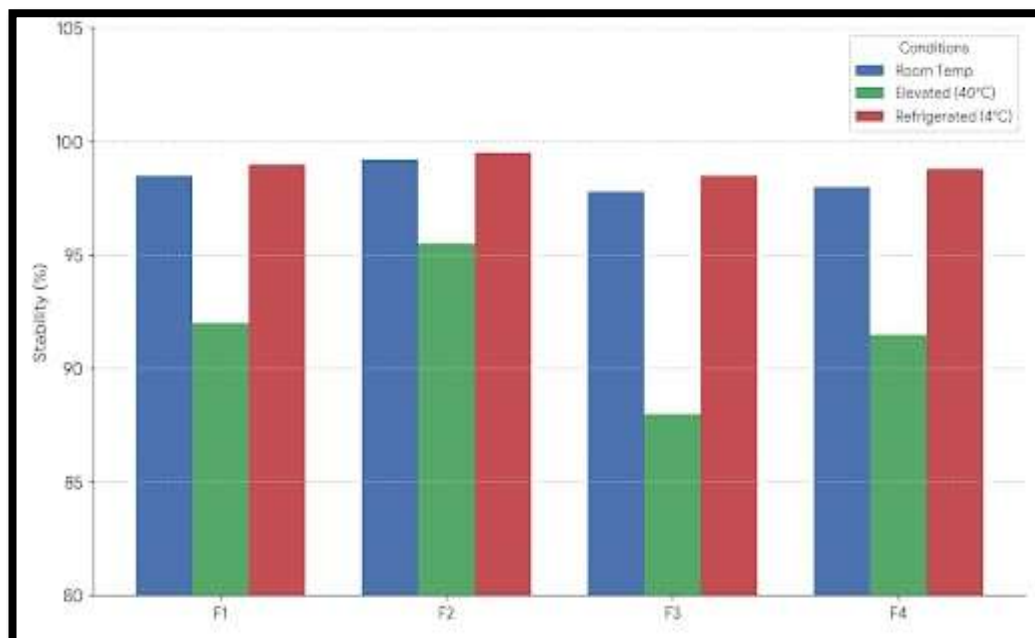


Figure 8 : Thermal stability result

Microbial Growth Study

Microbial analysis revealed no growth in any of the formulations, indicating:

- Proper formulation technique
- Hygienic preparation conditions
- Good preservative effect of natural ingredients
- This ensures the safety and shelf stability of the product.

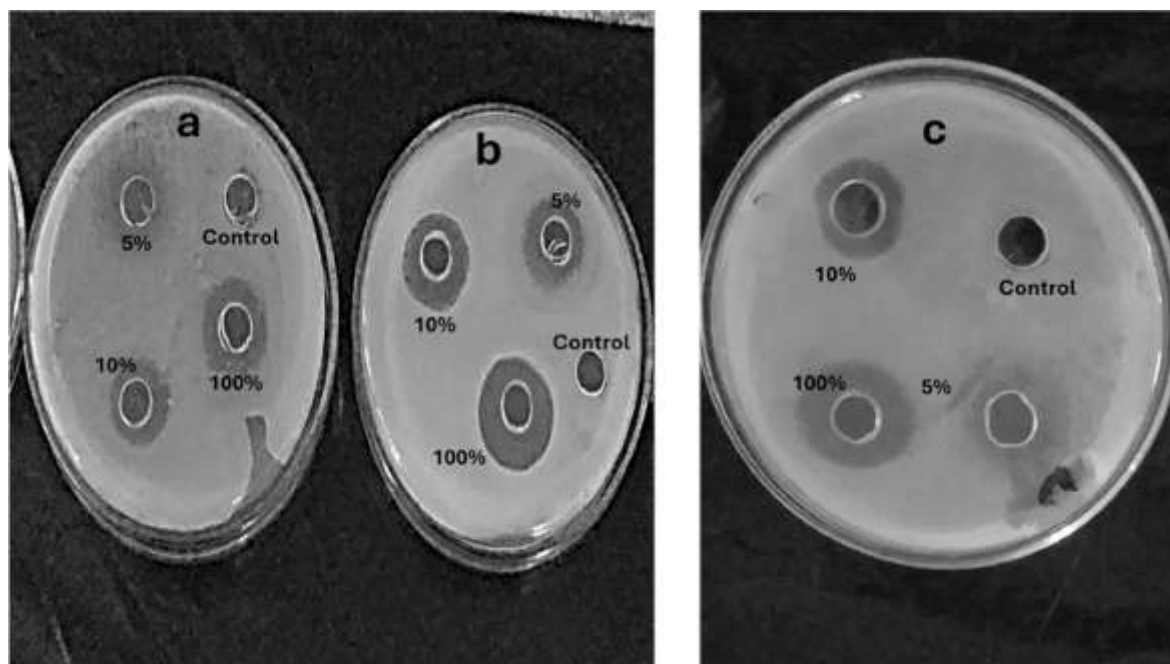


Figure 9: Microbial Growth Study

Stability Study (30 Days)

The formulations were monitored over 30 days for changes in pH, appearance, and stability score.

- Minimal variation was observed in all parameters
- F4 showed the least deviation, maintaining its original characteristics

This confirms that the formulation is stable over time and suitable for real-world use.

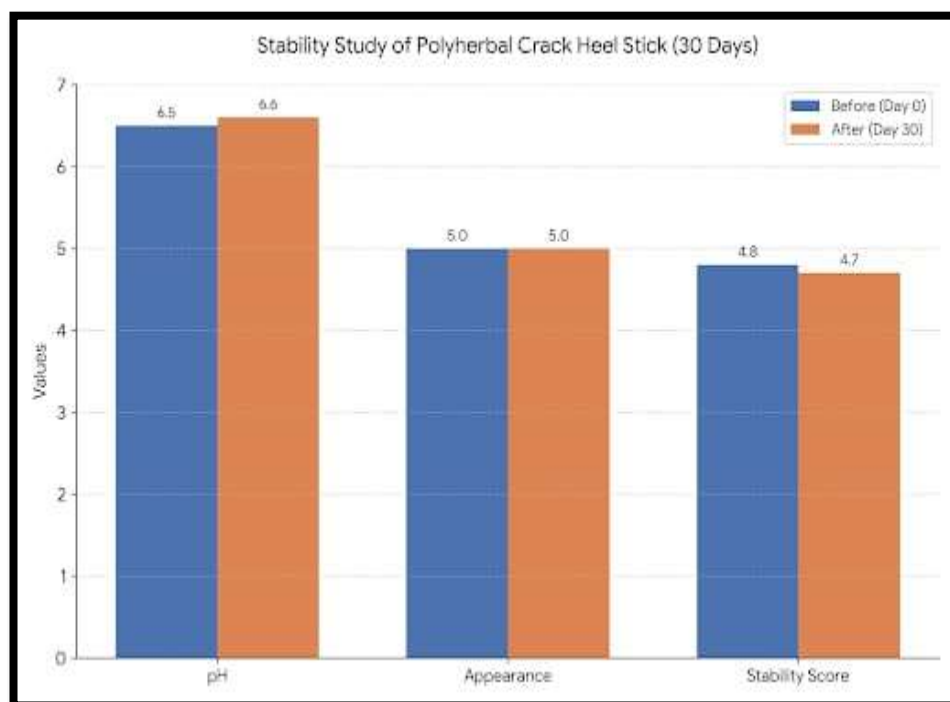


Figure 10 : Stability Study

Optimized Formulation Selection

All formulations were compared based on multiple evaluation parameters:

Table 7 : Optimized Formulation Selection

Parameter	F1	F2	F3	F4
pH	Acceptable	Acceptable	Good	Optimal
Stability	Moderate	Good	Good	Excellent

Irritation	Slight	No irritation	No irritation	No irritation
Spreadability	Moderate	Moderate	Good	Excellent
Waterproof	Low	Moderate	Good	High

Among all, F4 achieved the highest overall score, making it the optimized formulation



Figure 11 : Optimized Heel Stick



Figure 12: Before vs After Clinical Photographs

Clinical Observation

Clinical comparison showed visible improvement in cracked heels after application of the formulation:

- Reduction in cracks and dryness
- Improved skin texture
- Enhanced hydration and healing

This demonstrates the therapeutic effectiveness of the polyherbal formulation.

Table 8 : Comparison with Literature

Study	Dosage Form	Result
Sundhararajan et. al	Stick	Good
Rahana et.al	Foot Stick	Good
Present Study	Heel Stick	Better Stability

Discussion

When compared with previous studies, the present formulation showed improved stability and performance. While earlier formulations were effective, the inclusion of *Carica papaya* and *Curcuma longa* extracts in this study provided enhanced healing, antimicrobial action, and stability.

This suggests that the developed polyherbal heel stick is not only effective but also superior in terms of stability and usability, making it a promising herbal solution for cracked heel management.

4. Conclusion

The present study focused on the development and evaluation of a polyherbal crack heel stick containing *Carica papaya* and *Curcuma longa* extracts, with the aim of providing an effective, natural solution for cracked heel management.

The formulation process was carried out successfully, and all prepared batches (F1–F4) were evaluated for various physical and stability parameters. Among them, F4 emerged as the optimized formulation, demonstrating superior performance across all evaluation criteria.

From a practical perspective, what makes this formulation stand out is its skin-friendly nature. The pH was found to be within the acceptable range, ensuring that it is compatible with human skin and safe for regular use. Additionally, the formulation showed excellent stability, with no significant changes observed during the study period.

Another important aspect is that the optimized formulation was found to be non-irritant, making it suitable even for sensitive skin conditions. The healing effect was clearly evident, as the formulation helped in reducing dryness, improving skin texture, and promoting recovery of cracked heels.

Overall, this study highlights that the developed heel stick is not just effective in laboratory evaluation but also practical and user-friendly in real-life application. Considering its stability, safety, and effectiveness, the formulation shows strong potential to be developed as a commercial herbal product for foot care.

Novelty Points

This study introduces several unique and innovative aspects that make it different from conventional formulations:

- The use of a polyherbal combination of *Carica papaya* and *Curcuma longa* provides a synergistic effect, enhancing healing and antimicrobial properties.
- Unlike commonly used creams and ointments, the formulation is developed in a stick dosage form, offering a modern and convenient alternative.
- The product is highly portable, allowing easy application anytime and anywhere without mess.
- It improves patient compliance, as users prefer non-greasy, easy-to-apply formulations over traditional creams.
- The formulation exhibits a waterproof property, ensuring longer retention on the skin and prolonged therapeutic action.
- It is designed to be non-greasy, providing comfort and avoiding the sticky feel often associated with topical products.
- Being based on natural ingredients, it qualifies as an eco-friendly herbal cosmetic, aligning with the growing demand for sustainable and chemical-free products.

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