



Research Article

Formulation and Evaluation of Herbal Antiarthritic Gel from Extract of Limonia Acidissima Fruit Pulp

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Arthritis is a long-term inflammatory condition that affects the joints and causes pain, swelling, stiffness, and difficulty in movement. Continuous use of synthetic antiarthritic drugs may produce several adverse effects; therefore, herbal topical formulations are gaining importance because of their safety and therapeutic value. The present study was carried out to formulate and evaluate a herbal antiarthritic gel using the extract of *Limonia acidissima* fruit pulp. The fruit is known to contain various phytoconstituents such as flavonoids, tannins, phenolic compounds, and antioxidants which possess anti-inflammatory and analgesic properties. The extract of *Limonia acidissima* fruit pulp was prepared by ethanolic extraction method and incorporated into a gel base prepared using Carbopol 934. Polyethylene glycol was used as a moisturizing agent, while ethanol and isopropyl alcohol acted as solvents and penetration enhancers. The prepared gel was evaluated for various parameters including appearance, homogeneity, pH, viscosity, spreadability, extrudability, washability, skin irritation, and stability. The formulation showed a smooth texture, good consistency, satisfactory spreadability, and pH suitable for topical application. No signs of irritation or redness were observed during the skin sensitivity study. Stability studies indicated that the gel remained stable under different storage conditions without significant changes in its properties. The findings of the study suggest that the formulated herbal gel possesses desirable pharmaceutical characteristics and may be useful as a natural topical preparation for the management of arthritic conditions. The study supports the potential use of *Limonia acidissima* fruit pulp as an effective herbal ingredient in anti-inflammatory and antiarthritic formulations.

Keywords: *Limonia acidissima*, Herbal antiarthritic gel, Anti-inflammatory activity, Topical drug delivery, Herbal formulation, Arthritis, Phytoconstituents.

INTRODUCTION

Arthritis is one of the most common chronic inflammatory disorders affecting the musculoskeletal system and is characterized by pain, swelling, stiffness, tenderness, and reduced movement of joints. It significantly affects the quality of life and physical activity of patients worldwide. Among various forms of arthritis, osteoarthritis and rheumatoid arthritis are the most prevalent conditions. Osteoarthritis mainly occurs due to degeneration of cartilage tissues, whereas rheumatoid arthritis is an autoimmune disorder associated with chronic inflammation of synovial membranes. Persistent inflammation in joints leads to cartilage destruction, bone erosion, and severe discomfort. Conventional treatment of arthritis

commonly includes non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and disease-modifying antirheumatic drugs. Although these medications provide symptomatic relief, prolonged use may produce adverse effects such as gastric ulceration, renal toxicity, cardiovascular complications, and hepatic damage. Due to these limitations, there is growing interest in herbal medicines and topical formulations for safer and effective management of arthritic disorders. Herbal medicines have been used traditionally for centuries because of their therapeutic efficacy, low toxicity, better patient acceptance, and minimal side effects. Medicinal plants contain a variety of bioactive phytoconstituents such as flavonoids, tannins, alkaloids, glycosides, terpenoids, and phenolic

compounds that exhibit anti-inflammatory and antioxidant activities. These phytochemicals help in reducing inflammatory mediators, oxidative stress, and tissue damage associated with arthritis. In recent years, herbal topical formulations have gained considerable attention in pharmaceutical research for localized treatment of inflammation and pain. Topical gels are advantageous because they are non-greasy, easy to apply, easily washable, and capable of delivering active constituents directly to the affected site with reduced systemic exposure. *Limonia acidissima*, commonly known as wood apple, belongs to the family Rutaceae and is widely distributed in India and Southeast Asian countries. The fruit has been traditionally used in Ayurvedic and folk medicine for the treatment of various ailments including inflammation, digestive disorders, infections, and pain. The pulp of *Limonia acidissima* is rich in flavonoids, coumarins, tannins, phenolic compounds, saponins, and antioxidants. Several phytochemical and pharmacological studies reported that the fruit possesses significant anti-inflammatory, analgesic, antimicrobial, hepatoprotective, and

antioxidant properties. The antiarthritic potential of the plant is mainly attributed to the inhibition of inflammatory mediators and free radical scavenging activity of its phenolic constituents. The presence of natural antioxidants may help in protecting joint tissues from oxidative stress-induced damage and inflammation. Topical gel formulations are widely preferred for herbal drug delivery because they provide prolonged contact with the skin, improve patient compliance, and enhance penetration of active constituents through the affected area. Carbopol 934 is one of the most commonly used gelling agents due to its excellent viscosity, bioadhesive nature, stability, and compatibility with herbal extracts. Polyethylene glycol acts as a humectant and improves texture of the formulation, while ethanol and isopropyl alcohol enhance solubility and penetration of active phytoconstituents through the skin. Triethanolamine is used to neutralize the Carbopol dispersion and produce suitable gel consistency. Incorporation of herbal extracts into gel formulations provides better local action and minimizes systemic side effects associated with oral therapy.



Fig no 1: Herbal Antiarthritic Gel Application on Skin

Formulate and evaluate a herbal antiarthritic gel containing extract of *Limonia acidissima* fruit pulp. The prepared gel was evaluated for various physicochemical parameters including appearance, homogeneity, pH, viscosity, spreadability, extrudability, washability, stability, and skin

irritation. The study aimed to develop a stable, safe, and effective herbal topical formulation for the management of arthritis and inflammatory joint disorders using natural plant-based ingredients.

Advantages of Herbal Antiarthritic Gel Containing *Limonia acidissima*

1. Provides localized action directly at affected joints.
2. Reduces pain, inflammation, and swelling effectively.
3. Herbal formulation produces fewer side effects compared to synthetic drugs.
4. Easy to apply and remove from skin.
5. Non-greasy and patient-friendly dosage form.
6. Avoids first-pass metabolism associated with oral drugs.

Disadvantages of Herbal Antiarthritic Gel Containing *Limonia acidissima*

1. Limited penetration of active constituents through skin.
2. Herbal extracts may show variation in composition.
3. Chances of microbial contamination if improperly stored.
4. Stability of herbal constituents may decrease over time.
5. Strong characteristic odor may affect acceptability.

Limitations of Herbal Antiarthritic Gel Containing *Limonia acidissima*

1. Lack of extensive clinical studies on herbal gel formulation.
2. Difficulty in maintaining uniform concentration of phytoconstituents.
3. Limited shelf life due to natural ingredients.
4. Standardization of herbal extract is challenging.
5. Therapeutic response may vary among patients.

Applications of Herbal Antiarthritic Gel Containing *Limonia acidissima*

1. Used in management of arthritis and joint inflammation.
2. Helps relieve pain and stiffness in osteoarthritis.
3. Useful in rheumatoid arthritis conditions.
4. Applied for muscular pain and swelling.
5. Used as topical anti-inflammatory preparation.
6. Helps reduce redness and tenderness around joints.
7. Suitable for herbal topical therapy in chronic inflammatory disorders.
8. Provides natural alternative to synthetic antiarthritic preparations.

Plant Profile of *Limonia acidissima*



Fig no 2: *Limonia acidissima*

- ❖ Scientific Name: *Limonia acidissima* Linn.
- ❖ Family: Rutaceae
- ❖ Common Name: Wood Apple
- ❖ Synonyms: *Feronia limonia*, Elephant Apple
- ❖ Geographical Source: Widely found in India Also distributed in Sri Lanka, Bangladesh, and Southeast Asian countries Commonly grows in tropical and dry regions
- ❖ Morphological Characteristics

- Tree: Medium-sized deciduous tree, Height about 6–10 meters, Branches contain sharp spines
- Bark: Rough and grayish-brown in color
- Leaves: Compound and aromatic leaves, Dark green in appearance
- Fruits: Round fruits with hard woody shell, Brown sticky pulp inside, Sweet and sour taste
- Seeds: Small white seeds present in pulp

❖ Parts Used: Fruit pulp, Leaves, Bark, Roots.

❖ Chemical Constituents

- Flavonoids
- Tannins
- Alkaloids
- Phenolic compounds
- Coumarins
- Saponins
- Carbohydrates
- Vitamins and minerals
- Pharmacological Activities
- Anti-inflammatory activity
- Antiarthritic activity
- Antioxidant activity

❖ Medicinal Uses

1. Used in treatment of joint pain
2. Helps reduce inflammation and swelling
3. Used in digestive disorders
4. Traditionally used for wound healing
5. Used in management of diarrhea and dysentery

6. Importance in Present Study.

7. Rich in anti-inflammatory phytoconstituents
8. Possesses antioxidant properties
9. Suitable for herbal antiarthritic gel formulation
10. Provides natural therapeutic effect with fewer side effects

MATERIALS AND METHODS

MATERIALS

The materials used for formulation of herbal antiarthritic gel were:

- Limonia acidissima fruit pulp extract
- Carbopol 934
- Polyethylene glycol
- Isopropyl alcohol
- Ethanol
- Methylparaben
- Triethanolamine
- Distilled water

Formula of Herbal Antiarthritic Gel

Table no 1: Formula of Herbal Antiarthritic Gel

Sr. No	Ingredient	Quantity	Role
1	Limonia acidissima extract	0.5 g	Active ingredient
2	Carbopol 934	1 g	Gelling agent
3	Polyethylene glycol	10 mL	Humectant
4	Isopropyl alcohol	10 mL	Penetration enhancer
5	Ethanol	5 mL	Solvent
6	Methylparaben	0.15 g	Preservative
7	Triethanolamine	2–3 g	Neutralizer
8	Distilled water	Up to 100 mL	Vehicle

Extraction Process of Limonia acidissima Fruit Pulp

1. Fresh ripe fruits of Limonia acidissima were collected and washed thoroughly with water to remove dirt and impurities.
2. The hard outer shell was broken and fruit pulp was separated carefully from seeds.
3. The collected pulp was shade dried for several days until complete drying was achieved.
4. The dried pulp was powdered using grinder to obtain coarse powder.
5. The powdered material was transferred into a clean container for extraction.
6. Ethanol was added as extraction solvent and the mixture was kept for maceration for 48 hours with occasional stirring.
7. After extraction, the mixture was filtered using muslin cloth followed by Whatman filter paper.
8. The filtrate obtained was concentrated on water bath at controlled temperature to remove excess solvent.
9. The concentrated extract was collected, weighed, and stored in airtight container for further formulation studies.

Preparation of Herbal Antiarthritic Gel

1. Required quantity of Carbopol 934 was weighed accurately and dispersed slowly in distilled water with continuous stirring to avoid lump formation.
 2. The dispersion was allowed to stand for proper swelling of Carbopol polymer.
 3. Polyethylene glycol was added to improve consistency and moisturizing property of gel.
 4. Methylparaben was dissolved in ethanol separately and added into the polymer dispersion as preservative.
 5. Isopropyl alcohol was incorporated slowly to enhance penetration of active constituents through skin.
 6. The prepared ethanolic extract of Limonia acidissima fruit pulp was dissolved uniformly in the mixture.
 7. Triethanolamine was added dropwise with gentle stirring until transparent gel consistency was obtained.
 8. Final volume was adjusted using distilled water up to 100 mL
 9. The prepared gel was packed in suitable airtight containers and stored for evaluation studies.
1. Excess quantity of gel was placed between two clean glass slides.
 2. A known weight was placed over the upper slide for uniform spreading.
 3. Another weight was tied to upper slide and allowed to pull the slide horizontally.
 4. Time required for upper slide to move a specified distance was noted.
 5. Spreadability was calculated using formula:

Where:

- S = Spreadability
- M = Weight tied to upper slide
- L = Length moved by glass slide
- T = Time taken

Evaluation Parameters

1. Physical Examination

The prepared gel formulation was visually inspected for various physical characteristics such as:

- Color
- Odor
- Appearance
- Consistency
- Homogeneity
- Presence of grittiness

2. Determination of pH

1. About 1 g of prepared gel was accurately weighed.
2. The gel was dispersed in 25 mL distilled water.
3. The dispersion was allowed to stand for 2 hours.
4. pH was measured using calibrated digital pH meter at room temperature.
5. Readings were recorded in triplicate and average value was calculated.

3. Spreadability

4. Viscosity

1. Viscosity of prepared gel was measured using Brookfield Viscometer.
2. Appropriate spindle was selected and immersed in gel sample.
3. The instrument was operated at suitable rotational speed.
4. Viscosity reading was recorded in centipoise (cps).

5. Extrudability

1. Prepared gel was filled into collapsible aluminum tube.
2. The tube was pressed manually with constant pressure.
3. Amount of gel extruded from tube was observed.

6. Washability

1. Small quantity of gel was applied on skin surface.
2. The applied gel was washed with normal water.
3. Ease and completeness of removal were observed visually.

7. Irritancy Test

1. Small amount of gel was applied on dorsal surface of skin.
2. The area was observed for 24 hours.

3. Signs such as redness, itching, swelling, and irritation were examined carefully.

8. Stability Test

1. Prepared gel was stored under different temperature conditions such as:

- Room temperature
- Refrigerated condition
- Accelerated temperature condition

2. Samples were evaluated periodically for:

- Color change
- Phase separation
- pH variation
- Viscosity change
- Consistency

3. Stability observations were recorded for a period of one month.

RESULT

Evaluation Results of Herbal Antiarthritic Gel Containing *Limonia acidissima*

Table no 2: Evaluation Result

Sr. No	Evaluation Parameter	Result
1	Physical Examination	Smooth, homogeneous brown gel
2	Determination of pH	6.8 ± 0.1
3	Spreadability	6.5 g·cm/sec
4	Viscosity	4320 cps
5	Extrudability	Good
6	Washability	Easily washable
7	Irritancy Test	No redness, swelling, or irritation observed
8	Stability Test	Stable under different storage conditions

1. Physical Examination

The prepared herbal gel showed smooth texture, good consistency, uniform appearance, and absence of grittiness, indicating proper formulation.

2. Determination of pH

The pH of the gel was found to be 6.8, which is suitable for skin application and does not cause irritation.

3. Spreadability

The gel exhibited good spreadability, indicating easy application on affected skin surface.

4. Viscosity

The formulation showed satisfactory viscosity, which helped maintain proper gel consistency and stability.

5. Extrudability

The gel was easily extruded from the collapsible tube, showing good patient convenience during use.

6. Washability

The formulation was easily washable with water and did not leave sticky residue on skin.

7. Irritancy Test

No redness, itching, swelling, or irritation was observed, confirming safety of the herbal gel.

8. Stability Test

The gel remained stable under different storage conditions without significant changes in color, pH, or consistency.

DISCUSSION

The formulated herbal antiarthritic gel containing extract of *Limonia acidissima* showed satisfactory physicochemical properties and good stability. The gel was smooth, homogeneous, easily spreadable, and

had suitable pH for topical application. No irritation or redness was observed during skin irritation studies, indicating safety of the formulation. The presence of flavonoids, tannins, and phenolic compounds in the fruit extract may contribute to anti-inflammatory and antiarthritic activity. Overall, the prepared herbal gel can be considered a promising natural topical formulation for management of arthritis and joint inflammation.

CONCLUSION

The present study successfully formulated and evaluated a herbal antiarthritic gel containing extract of *Limonia acidissima* fruit pulp. The prepared gel showed good appearance, suitable pH, satisfactory viscosity, spreadability, and stability. The formulation was found to be non-irritant and easily washable, indicating its suitability for topical application. The anti-inflammatory phytoconstituents present in the fruit extract may help in reducing pain and inflammation associated with arthritis. Therefore, the formulated herbal gel can be considered a safe and effective natural topical preparation for management of arthritic conditions.

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