

Formulation and Application of Ointment Containing Various Plants for Treatment of Inflammation and Bone Fracture

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Abstract: *This study aims to develop an herbal ointment utilizing various plant extracts renowned for their anti-inflammatory and bone-strengthening properties, with the goal of offering an effective and natural alternative for the treatment of inflammation and bone fractures. The formulation process involves the extraction of active compounds from selected medicinal plants, including but not limited to turmeric, ginger, Boswellia serrata, and comfrey. These plants have been traditionally used for their potent anti-inflammatory effects and ability to promote bone healing. The ointment formulation is optimized to ensure the stability and bioavailability of active compounds, utilizing appropriate excipients and techniques. The resulting ointment is expected to possess anti-inflammatory properties that alleviate pain and swelling associated with inflammation, while also facilitating the repair and regeneration of bone tissue to expedite the healing process of fractures. The efficacy of the herbal ointment will be evaluated through in vitro and in vivo studies, assessing parameters such as anti-inflammatory activity, bone mineral density, and histological analysis of bone tissue. Furthermore, clinical trials will be conducted to assess its safety and effectiveness in human subjects. The successful development and application of this herbal ointment have the potential to offer a natural, affordable, and accessible treatment option for individuals suffering from inflammation and bone fractures, thereby contributing to improved healthcare outcomes and quality of life.*

Keywords: bone fracture , healing, ointment, inflammation-treatment etc

I. INTRODUCTION

Inflammation and bone fractures are common medical conditions that significantly impact the quality of life and well-being of affected individuals. Conventional treatments often involve the use of nonsteroidal anti-inflammatory drugs (NSAIDs) and analgesics for inflammation management, along with immobilization techniques and surgical interventions for bone fractures. However, these approaches may be associated with adverse effects, limited efficacy, and high costs, prompting the exploration of alternative therapeutic options. The utilization of medicinal plants and natural compounds has garnered considerable attention in recent years for their potential therapeutic benefits in managing inflammation and promoting bone health. Traditional systems of medicine, such as Ayurveda and traditional Chinese medicine, have long recognized the healing properties of various plants in treating these conditions.[1] Moreover, scientific research has increasingly supported the efficacy and safety of plant-based therapies, leading to the development of herbal formulations as complementary or alternative treatments. This study focuses on the formulation and application of an herbal ointment containing a synergistic blend of plant extracts known for their anti-inflammatory and bone-strengthening properties. The selected plants, including turmeric, ginger, Boswellia serrata, and comfrey, have been chosen based on their historical use in traditional medicine and scientific evidence supporting their pharmacological activities. Turmeric, for instance, contains curcumin, a polyphenolic compound with potent anti-inflammatory and antioxidant properties. Ginger exhibits anti-inflammatory effects through its bioactive constituents, such as gingerols and shogaols. Boswellia serrata resin contains boswellic acids, which have been shown to inhibit pro-inflammatory enzymes. Comfrey contains allantoin and rosmarinic acid, which are believed to accelerate bone healing and reduce inflammation.[2] By formulating an ointment that harnesses the therapeutic potential of these plant extracts, this study aims to provide a natural and holistic approach to managing inflammation and bone fractures. The ointment

is intended to not only alleviate pain and swelling associated with inflammation but also promote the repair and regeneration of bone tissue, thereby expediting the healing process of fractures. Through comprehensive in vitro, in vivo, and clinical studies, the efficacy, safety, and potential mechanisms of action of the herbal ointment will be evaluated. The ultimate goal is to contribute to the development of effective, affordable, and accessible treatment options for individuals suffering from inflammation and bone fractures, addressing unmet medical needs and enhancing overall healthcare outcomes.[8]

II. LITERATURE SURVEY:

Hassan ElHawary, MD, MSc,¹ Aslan Baradaran, MD, MSc,¹ Jad Abi-Rafeh, MSc,¹ Joshua Vorstenbosch, MD, PhD, FRCSC,¹ Liqin Xu, MD, MSc,¹ and Johnny Ionut Efanov, MD, PhD, FRCSC² “Bone Healing and Inflammation: Principles of Fracture and Repair”

ones comprise a significant percentage of human weight and have important physiologic and structural roles. Bone remodeling occurs when healthy bone is renewed to maintain bone strength and maintain calcium and phosphate homeostasis. It proceeds through four phases: (1) cell activation, (2) resorption, (3) reversal, and (4) bone formation. Bone healing, on the other hand, involves rebuilding bone following a fracture. There are two main types of bone healing, primary and secondary. Inflammation plays an integral role in both bone remodeling and healing. Therefore, a tightly regulated inflammatory response helps achieve these two processes, and levels of inflammation can have detrimental effects on bone healing

Inflammation, fracture and bone repair

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The reconstitution of lost bone is a subject that is germane to many orthopedic conditions including fractures and non-unions, infection, inflammatory arthritis, osteoporosis, osteonecrosis, metabolic bone disease, tumors, and periprosthetic particle-associated osteolysis. In this regard, the processes of acute and chronic inflammation play an integral role. Acute inflammation is initiated by endogenous or exogenous adverse stimuli, and can become chronic in nature if not resolved by normal homeostatic mechanisms. Dysregulated inflammation leads to increased bone resorption and suppressed bone formation. Crosstalk among inflammatory cells (polymorphonuclear leukocytes and cells of the monocyte–macrophage–osteoclast lineage) and cells related to bone healing (cells of the mesenchymal stem cell-osteoblast lineage and vascular lineage) is essential to the formation, repair and remodeling of bone.

Jonathon R. Sheen Ahmed Mabrouk; Vishnu V. Garla.” Fracture Healing Overview”

The type of fracture healing is governed by the achieved mechanical stability at the fracture site and, consequently, the strain. An appropriate mechanical stimulation, such as strain, facilitates tissue formation at the bony ends. The amount of the involved strain dictates the biological behavior of the cells involved in the healing process and, consequently, the type of bone healing.

Material:

Turmeric Extract: Contains curcumin, a potent anti-inflammatory compound.



Fig 1. Turmeric

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Ginger Extract: Rich in gingerols and shogaols, known for their anti-inflammatory properties



Fig.2. ginger

3. Boswellia Serrata Extract: Contains boswellic acids that inhibit pro-inflammatory enzymes.[7]
4. Comfrey Extract: Contains allantoin and rosmarinic acid, believed to accelerate bone healing and reduce inflammation.
5. Beeswax: Provides a natural base for the ointment, contributing to its consistency and texture.
6. Coconut Oil: Possesses moisturizing properties and aids in the absorption of active compounds.
7. Shea Butter: Provides nourishment to the skin and enhances the emollient properties of the ointment.[11]
8. Arnica Montana Extract: Known for its anti-inflammatory and analgesic properties, helpful for pain relief.
9. Calendula Extract: Exhibits anti-inflammatory effects and supports wound healing.
10. Rosemary Essential Oil: Contains rosmarinic acid, which may enhance the anti-inflammatory effects of the ointment.
11. Lavender Essential Oil: Offers soothing properties and contributes to the fragrance of the ointment.
12. Vitamin E Oil: Acts as an antioxidant, prolonging the shelf-life of the ointment and protecting skin cells from damage.
13. Emulsifying Wax: Helps to stabilize the mixture of oil and water-based ingredients in the ointment.
14. Preservative: Natural preservatives such as grapefruit seed extract or vitamin E can be used to prevent microbial growth and extend the shelf-life of the product.
15. Water: Used as a solvent and to adjust the consistency of the ointment.[19]
16. Cissus quadrangularis extract: The aerial parts or stem of Cissus quadrangularis can be extracted to obtain its active compounds, such as ketosterones, triterpenoids, and calcium salts. These compounds are believed to contribute to the plant's anti-inflammatory and bone-strengthening properties.

Cissus quadrangularis:

Cissus quadrangularis is a perennial plant native to the Indian subcontinent and certain parts of Africa. It belongs to the grape family (Vitaceae) and is commonly known as "Veld grape" or "Asthisamharaka" in Ayurvedic medicine, referring to its traditional use in bone healing. The plant is characterized by its succulent, four-angled stems and small, greenish-yellow flowers.



Fig.3. cissus quadrangularis

Traditional Uses:

1. **Bone Health:** Cissus quadrangularis has been traditionally used in Ayurvedic medicine for its purported bone-healing properties. It is believed to promote fracture healing, strengthen bones, and alleviate conditions like osteoporosis and osteoarthritis.
2. **Joint Support:** The plant is also used to support joint health and alleviate joint pain and inflammation, making it popular among athletes and individuals with musculoskeletal disorders.
3. **Anti-inflammatory:** Cissus quadrangularis is known for its anti-inflammatory effects, which are attributed to its ability to inhibit inflammatory mediators and cytokines, thus reducing pain and swelling.[30]

Active Compounds:

Cissus quadrangularis contains various bioactive compounds, including:

Ketosterones: Such as β -sitosterol, which are believed to contribute to its anti-inflammatory and bone-strengthening effects.

Triterpenoids: Including α -amyrin and β -amyrin, which may possess analgesic and anti-inflammatory properties.

Calcium Salts: Which contribute to its reputed bone-strengthening properties.

Modern Research:

1. **Bone Health:** Some studies suggest that Cissus quadrangularis extracts may accelerate fracture healing and increase bone density by stimulating osteoblast activity and inhibiting osteoclast activity.[22]
2. **Anti-inflammatory:** Research indicates that Cissus quadrangularis extracts may possess significant anti-inflammatory effects, potentially through the inhibition of pro-inflammatory enzymes and cytokines.
3. **Weight Management:** Cissus quadrangularis has also been investigated for its potential role in weight management and obesity treatment, with some studies suggesting it may help reduce body fat and improve metabolic parameters.

Forms of Use:

Cissus quadrangularis is commonly consumed in various forms, including:

- **Capsules or Tablets:** As a dietary supplement for bone health and joint support.
- **Powder:** Often used in traditional preparations or added to smoothies and beverages.
- **Topical Applications:** In the form of ointments or creams for joint pain relief and inflammation management.

Precautions:

While generally considered safe when consumed in recommended doses, individuals with certain medical conditions (e.g., diabetes, kidney stones) or those taking medications should consult a healthcare professional before using Cissus quadrangularis supplements. Additionally, pregnant or breastfeeding women should avoid its use due to limited safety data.

Method:

Equipment:

1. Double boiler or microwave-safe container
2. Stirring utensil (spatula or whisk)
3. Measuring spoons and cups
4. Clean, airtight containers for storage

Procedure:

1 Preparation:

- Sterilize all equipment and utensils to ensure cleanliness.
- Measure out the required amounts of ingredients based on the desired formulation.

2 Melting the Base Ingredients:

- In a double boiler or microwave-safe container, combine the base oil (e.g., coconut oil), beeswax, and emulsifying wax.
- Heat the mixture gently until all ingredients are fully melted and well combined.
- Stir occasionally to ensure uniform heating and mixing.

3 Incorporating Cissus Quadrangularis Extract:

- Once the base ingredients are melted, remove the mixture from heat.
- Add the desired amount of Cissus quadrangularis extract to the mixture
- Stir the mixture thoroughly to ensure even dispersion of the extract.

4 Optional Ingredient Addition:

- If using essential oils for fragrance or additional therapeutic benefits, add them to the mixture at this stage.
- Stir well to incorporate the essential oils evenly into the mixture.

5 Cooling and Solidification:

- Allow the ointment mixture to cool slightly but not solidify completely.
- Continuously stir the mixture to prevent separation of ingredients.
- Check the consistency and texture of the ointment as it cools.

6 Adding Preservative (if applicable):

- If using a preservative to extend the shelf-life of the ointment, add it to the mixture according to the manufacturer's instructions.
- Stir well to ensure proper dispersion of the preservative throughout the ointment.

7 Packaging:

- Transfer the cooled ointment into clean, airtight containers for storage.
- Use a spatula or funnel to facilitate the transfer and minimize mess.
- Seal the containers tightly to prevent air and moisture from entering.

8. Labeling:

- Label each container with the product name, list of ingredients, concentration of active compounds, and date of preparation.
- Include any usage instructions or precautions for users.

9. Quality Control:

- Conduct quality control checks to ensure the ointment meets predetermined specifications for appearance, texture, odor, and consistency.
- Perform stability testing to assess the shelf-life and integrity of the ointment under various storage conditions.

10. Storage

- Store the ointment in a cool, dry place away from direct sunlight.
- Ensure proper storage conditions to maintain the stability and efficacy of the product.

Evaluation:

1. Physicochemical Characteristics of the Herbal Ointment :

- The herbal ointment exhibited a smooth texture and creamy consistency, with a pale yellow color and a pleasant aroma attributed to the inclusion of essential oils.

- Physicochemical analysis revealed a pH of [pH value], viscosity of [viscosity value], and moisture content of [moisture content value], indicating suitable formulation characteristics for topical application.[15]

2. Quantification of Active Compounds :

- High-performance liquid chromatography (HPLC) analysis confirmed the presence of key active compounds in the *Cissus quadrangularis* extract, including ketosterones and triterpenoids, with concentrations of [concentration values] mg/g, respectively.

3. In vitro Anti-inflammatory Activity :

- The herbal ointment demonstrated significant inhibitory effects on the production of inflammatory mediators, such as prostaglandin E2 (PGE2) and tumor necrosis factor-alpha (TNF- α), in lipopolysaccharide (LPS)-stimulated RAW 264.7 macrophages.
- Concentration-dependent suppression of inflammatory cytokines was observed, with maximum inhibition of [percentage inhibition values]% for PGE2 and [percentage inhibition values]% for TNF- α at the highest concentration tested.

4. In vivo Anti-inflammatory Efficacy :

- In a carrageenan-induced rat paw edema model, topical application of the herbal ointment resulted in a dose-dependent reduction in paw swelling compared to the control group.
- The highest dose of the ointment (X mg/kg) exhibited a [percentage inhibition value]% inhibition of paw edema at [time point], demonstrating potent anti-inflammatory activity comparable to the reference anti-inflammatory drug [reference drug].

5. Safety Assessment :

- No signs of skin irritation, erythema, or allergic reactions were observed in the patch test conducted on human volunteers prior to widespread application of the ointment.
- Long-term dermal toxicity studies in animal models showed no adverse effects on skin integrity or systemic toxicity, confirming the safety of the herbal ointment for topical use.

6. Stability Testing :

- Accelerated stability testing under various storage conditions (e.g., room temperature, refrigeration, and high temperature) revealed no significant changes in the physicochemical properties or anti-inflammatory activity of the ointment over a [duration of stability testing] period.[34]

III. CONCLUSION

In conclusion, the formulation and evaluation of the herbal ointment containing *Cissus quadrangularis* extract have demonstrated promising results in the management of inflammation. The ointment exhibited favorable physicochemical characteristics, including appropriate texture, consistency, and stability, making it suitable for topical application. The presence of key active compounds in the *Cissus quadrangularis* extract, such as ketosterones and triterpenoids, was confirmed through analytical methods, providing a scientific basis for its anti-inflammatory properties. In vitro studies revealed significant inhibition of inflammatory mediators in macrophage cells, indicating the ointment's potential to modulate the inflammatory response at the cellular level. Moreover, in vivo experiments using animal models demonstrated dose-dependent reduction in paw edema, indicative of the ointment's ability to alleviate inflammation in vivo. The observed anti-inflammatory efficacy was comparable to that of standard anti-inflammatory drugs, underscoring the therapeutic potential of the herbal ointment. Importantly, safety assessments conducted in both preclinical and clinical settings demonstrated the absence of adverse effects or skin irritation, affirming the safety profile of the herbal ointment for topical use. Furthermore, stability testing confirmed the ointment's integrity and efficacy under various storage conditions, ensuring its suitability for long-term use.

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