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# RESEARCH ARTICLE

## PHARMACOGNOSTIC EVALUATION AND FORMULATION OF A COCONUT OIL BASED HERBAL WOUND HEALING BALM CONTAINING *NIGELLA SATIVA* AND *TECTONA GRANDIS*

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## ABSTRACT

Medicinal plants have been widely utilized since ancient times for the treatment of wounds and various skin disorders due to their rich phytochemical composition and multiple therapeutic properties, including antimicrobial, anti-inflammatory, antioxidant, and tissue-regenerating activities. The present study focuses on the pharmacognostic evaluation and formulation of a herbal wound-healing balm using Tectona grandis and Nigella sativa, aiming to develop a safe, effective, and natural topical formulation. Tectona grandis leaves were collected, authenticated, shade-dried, powdered, and subjected to Soxhlet extraction using ethanol, whereas *Nigella sativa* seeds were processed to obtain volatile oil using a Clevenger apparatus. The obtained extracts were further subjected to preliminary phytochemical screening, which confirmed the presence of important bioactive constituents such as alkaloids, flavonoids, tannins, glycosides, and saponins that are known to contribute to wound healing and antimicrobial activity. The herbal balm was then formulated using coconut oil as a base due to its excellent emollient and penetration-enhancing properties, along with beeswax to provide suitable consistency, and small quantities of clove oil and rose oil for additional therapeutic and organoleptic benefits. The prepared formulation was evaluated for various physicochemical parameters such as appearance, consistency, homogeneity, and Spreadability, and was found to be stable and suitable for topical application. Furthermore, the antimicrobial activity of the formulated balm was assessed against Pseudomonas aeruginosa, and the results indicated significant inhibitory activity, suggesting its effectiveness in preventing wound infections. Overall, the study demonstrates that the combination of *Tectona grandis* and *Nigella sativa* in a suitable topical base result in a promising herbal formulation with enhanced wound-healing potential, supporting its application as a natural alternative to conventional wound care products.



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# INTRODUCTION

A wound is defined as a disruption in the normal anatomical structure and function of the skin or underlying tissues caused by physical, chemical, or biological injury. Wound healing is a natural and complex biological process through which the body restores tissue integrity and function after injury. It involves a series of highly coordinated cellular, molecular, and biochemical events that ensure proper tissue repair and regeneration. The wound healing process occurs in four overlapping phases: hemostasis, inflammation, proliferation, and remodeling. Hemostasis is the immediate response following injury, involving vasoconstriction and blood clot formation to prevent excessive bleeding. This is followed by the inflammatory phase, characterized by vasodilation and migration of immune cells to remove debris and prevent infection. The proliferative phase involves fibroblast proliferation, collagen synthesis, angiogenesis, and re-epithelialization, leading to new tissue formation. Finally, the remodeling phase results in collagen reorganization, increased tensile strength, and scar formation. Proper wound care is essential to promote rapid healing, prevent microbial infection, and reduce complications such as chronic wounds, especially in conditions like diabetes, poor nutrition, or impaired immunity.

Although synthetic drugs such as antibiotics and anti-inflammatory agents are widely used in wound management, they are often associated with limitations including side effects, development of resistance, high cost, and delayed tissue regeneration. These drawbacks have led to increased interest in herbal formulations as safer and more effective alternatives. Herbal medicines offer several advantages such as biocompatibility, minimal side effects, cost-effectiveness, and the presence of multiple bioactive compounds that act synergistically to enhance wound healing. Medicinal plants have been traditionally used in various systems of medicine like Ayurveda, Unani, and Siddha for the treatment of wounds and skin disorders. Their pharmacological activities, including antimicrobial, anti-inflammatory, antioxidant, and tissue-regenerating properties, make them highly suitable for wound management. Pharmacognostic evaluation plays a crucial role in ensuring the quality, purity, and standardization of plant materials used in such formulations. Among various medicinal plants, *Tectona grandis* and *Nigella sativa* have gained significant attention due to their potent therapeutic properties. *Tectona grandis* is rich in phytoconstituents such as flavonoids, tannins, phenolic compounds, and naphthoquinones, which exhibit strong antimicrobial, anti-inflammatory, antioxidant, and wound-healing activities. These compounds help in reducing inflammation, preventing microbial infection, enhancing collagen synthesis, and promoting wound contraction and epithelialization. Similarly, *Nigella sativa*, commonly known as black seed, contains important bioactive constituents such as thymoquinone, nigellone, essential oils, alkaloids, and fatty acids. Thymoquinone is primarily responsible for its pharmacological effects, including anti-inflammatory, antioxidant, antimicrobial, and immunomodulatory activities. It promotes wound healing by reducing oxidative stress, enhancing fibroblast proliferation, stimulating collagen deposition, and accelerating tissue regeneration.

The rationale behind combining *Tectona grandis* and *Nigella sativa* lies in their complementary and synergistic actions. While *Tectona grandis* contributes significantly to wound contraction, collagen synthesis, and antimicrobial protection, *Nigella sativa* enhances anti-inflammatory response, reduces oxidative damage, and promotes faster tissue repair. The combination of these two plants is expected to provide enhanced therapeutic efficacy compared to individual use. A balm is a semisolid topical preparation, usually oil-based and containing waxes, that is applied externally to protect, soothe, and heal the skin. Coconut oil is commonly used as a base in herbal balms due to its excellent emollient properties, antimicrobial activity, and ability to enhance drug penetration into the skin.

Despite extensive studies highlighting the pharmacological properties of *Tectona grandis* and *Nigella sativa*, including their antimicrobial, anti-inflammatory, antioxidant, and wound-healing activities, most of the available literature focuses primarily on individual plant extracts, isolated compounds such as thymoquinone, or their general therapeutic applications. Limited research has been conducted on the combined formulation of these two medicinal plants in a suitable topical dosage form, particularly as a balm, along with proper pharmacognostic evaluation and formulation standardization. Furthermore, there is a lack of studies integrating phytochemical screening, formulation development, and antimicrobial evaluation into a single systematic investigation. Therefore, the present study aims to bridge this research gap by developing a combined herbal formulation that can potentially enhance wound healing through synergistic action. The aim of this study is to formulate and evaluate a herbal wound-healing balm using extracts of *Tectona grandis* and *Nigella sativa*. The objectives include preparation of plant extracts using suitable extraction methods, formulation of a stable herbal balm using appropriate excipients, evaluation of the formulation for its physicochemical properties, and assessment of its antimicrobial activity against selected microorganisms. This integrated approach is expected to contribute to the development of an effective, safe, and scientifically validated herbal wound care product.

# MATERIALS AND METHODS

## Materials

**Plant Materials:** Fresh leaves of *Tectona grandis* and seeds of *Nigella sativa* were used for the study.

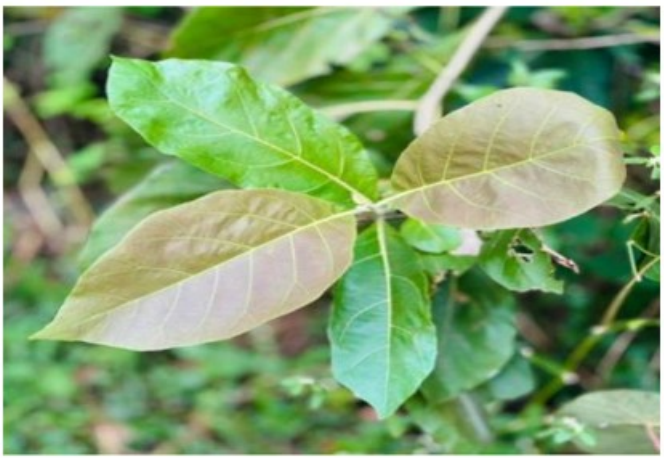

**Figure 1. Tectona grandis**

**Figure 2. Nigella sativa**

**Chemicals and Reagents:** Ethanol, distilled water, Mayer's reagent, Dragendorff's reagent, Benedict's reagent, Molisch's reagent, ferric chloride, concentrated hydrochloric acid, sulfuric acid, chloroform, ammonia solution, and other reagents used for phytochemical screening were of analytical grade.

**Equipment Used:** Soxhlet apparatus, Clevenger apparatus, round bottom flask, condenser, water bath, weighing balance, separating funnel, china dish, and glassware were used for extraction and formulation processes.

**Sample Collection and Authentication**

**Source of Plant:** *Tectona grandis* leaves were collected from Holy Grace Academy of Pharmacy, and *Nigella sativa* seeds were collected from Kodungallur.

**Identification Method:** The collected plant material (*Tectona grandis*) was authenticated at the College of Forestry, Thrissur, by Mr. Aneesh K.S, Assistant Professor, Department of Forest Resource Management.

**Preparation and Extraction of Materials**

**Extraction of *Tectona grandis***

The collected leaves of *Tectona grandis* were shade dried to remove moisture and then finely powdered. About 30 g of the powdered material was packed into a thimble and placed in a Soxhlet apparatus. The extraction was carried out using 250 ml of ethanol as solvent for 10 cycles, maintaining the temperature below 40°C to preserve heat-sensitive constituents. After completion of extraction, the ethanolic extract was concentrated by evaporating the solvent using an electrical water bath. The dried extract obtained was collected, weighed, and stored in an airtight container for further use.

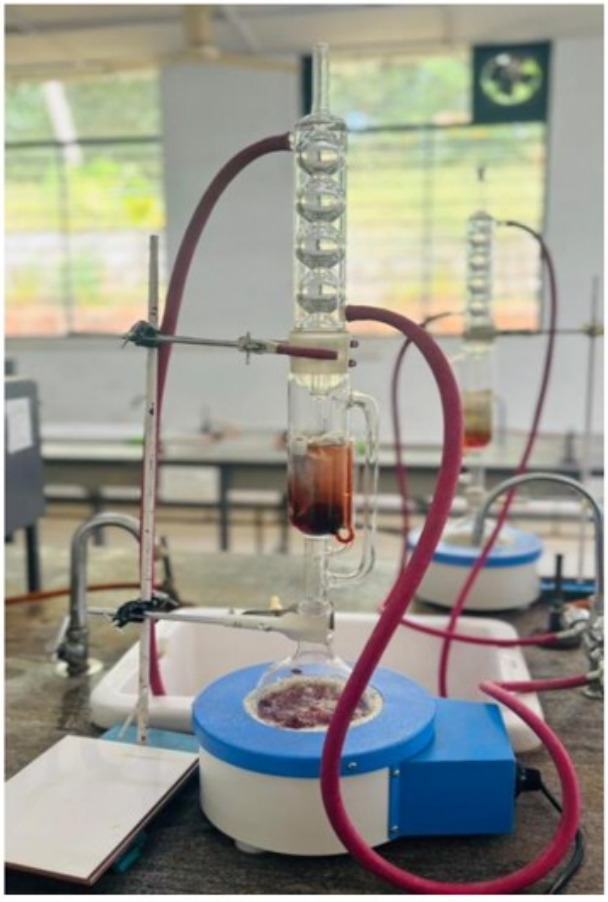

**Figure 3. Extraction of Tectona grandis**

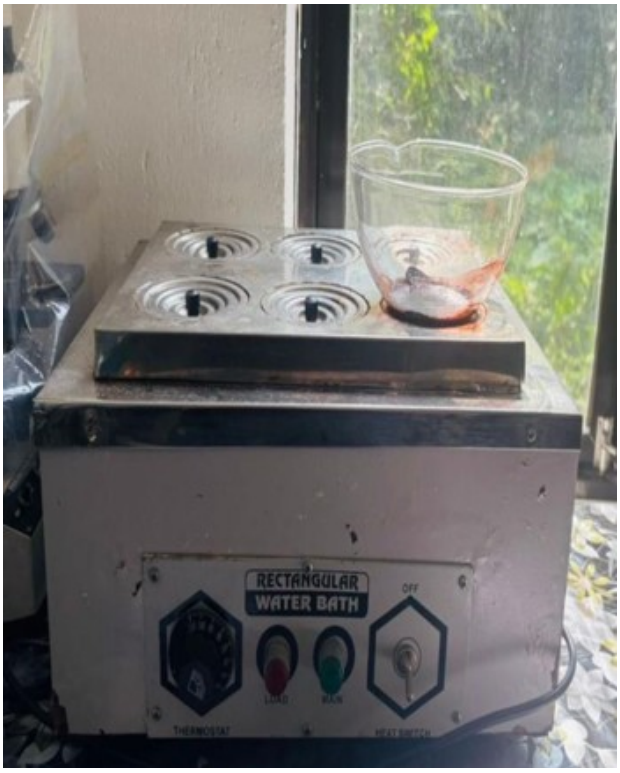


**Figure 4. Drying of Tectona grandis**

**Extraction of *Nigella sativa***

The seeds of *Nigella sativa* were coarsely powdered and transferred into a round bottom flask containing 500 ml of distilled water. The flask was connected to a Clevenger apparatus attached to a condenser, ensuring all joints were properly sealed. The mixture was heated gently to allow boiling, during which vapors of water and volatile oil were produced. These vapors were condensed and collected in the arm of the Clevenger apparatus.

After completion of the process, the apparatus was allowed to cool, and the volatile oil was separated using a separating funnel. The extracted oil was then stored in an amber-colored bottle to protect it from light and degradation.

**Phytochemical Analysis**

Preliminary phytochemical screening of the extracts was carried out to detect the presence of various bioactive constituents such as alkaloids, carbohydrates, saponins, glycosides, tannins, and flavonoids using standard qualitative tests including Mayer's test, Dragendorff's test, Benedict's test, Molisch's test, foam test, Borntrager's test, Keller–Killiani test, gelatin test, ferric chloride test, and Shinoda test.

**Formulation of Balm**

**Table 1. Formulation of Wound Healing Balm**

| S. No | Ingredients | Quantity |
|---|---|---|
| 1 | *Tectona grandis* extract | 3 g |
| 2 | *Nigella sativa* oil | 8 ml |
| 3 | Coconut oil | 16 g |
| 4 | Beeswax | 6 g |
| 5 | Clove oil | 0.5 ml |
| 6 | Rose oil | 0.2 ml |

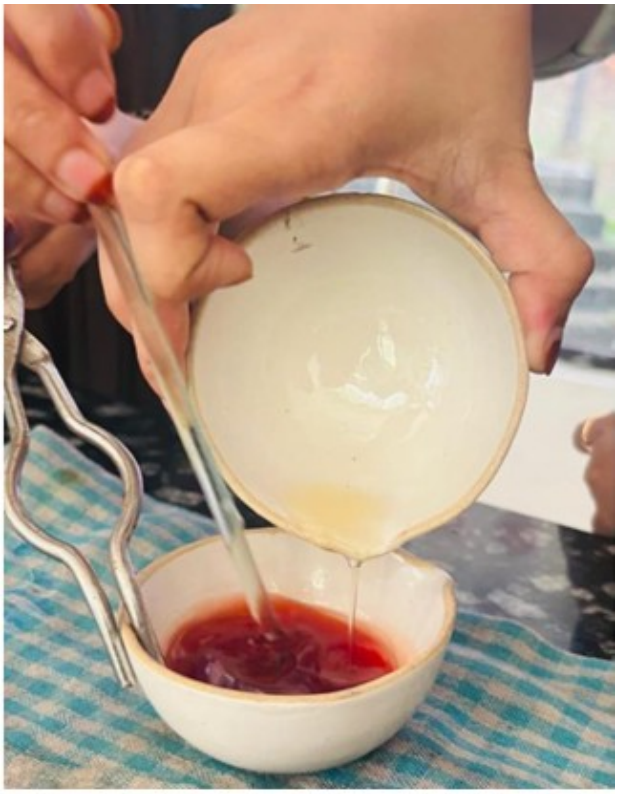

**Figure 5. Preparation of wound healing balm**

### Procedure

- *Nigella sativa* oil and coconut oil were taken and gently heated.
- Accurately measured quantities of clove oil and rose oil were added to the oil mixture.
- Beeswax was weighed and melted separately in a china dish.
- The melted beeswax was added to the heated oil mixture when both reached approximately 70°C, followed by continuous stirring.
- The required quantity of *Tectona grandis* extract was added slowly to the molten mixture with continuous stirring to ensure uniform distribution.
- Heating was stopped, and the mixture was stirred continuously until a homogeneous blend was obtained.
- The molten balm was poured into clean containers and allowed to cool and solidify at room temperature.

### Evaluation of Herbal Balm for Wound Healing

Detection of antimicrobial action of herbal balm for wound healing : The balm prepared was subjected to antimicrobial screening. It was carried out by Care Keralam, a joint venture of Ayurvedic Entrepreneurs and KINFRA (Govt.of Kerala), supported by Department of AYUSH, Govt. of India.

### Procedure (Agar Diffusion Method – Zone of Inhibition)

- Mueller–Hinton Agar (MHA) was prepared, sterilized by autoclaving, and poured aseptically into sterile Petri plates. The medium was allowed to solidify.
- A pure culture of *Pseudomonas aeruginosa* (NCIM 2200) was inoculated into sterile nutrient broth and incubated at 37 °C for 18–24 hours.
- The turbidity of the bacterial culture was adjusted to match the 0.5 McFarland standard.
- The standardized bacterial suspension was uniformly swabbed over the surface of the Mueller–Hinton agar plate to form a bacterial lawn.
- Wells were made in the agar using a sterile cork borer (agar well diffusion method), or sterile discs were placed on the agar surface (disc diffusion method).
- The test sample (wound healing balm extract) was added into the wells/discs.
- Streptomycin was applied separately as a standard drug (positive control).
- The plates were incubated in an inverted position at 37 °C for 24 hours.
- After incubation, the plates were examined for clear zones around the wells/discs indicating the zone of inhibition.

# RESULT AND DISCUSSION

### Evaluation of wound healing balm

**Table 2. Evaluation parameters of wound healing balm**

| Parameters | Results |
|---|---|
| Colour | Reddish brown |
| Odour | Characteristic odour |
| Texture | Uniform |
| Appearance | Smooth, greasy or slightly waxy |

### Preliminary phytochemical screening

**Table 3. Result of Nutritional Screening Test**

| Phytochemical (phytoconstituent) | Biochemical test | Inference |
|---|---|---|
| Alkaloid | Dragendroff's test | + |
| Glycoside | Keller-Killiani | + |
| Flavanoid | Shinoda test | + |
| Tannins | Ferric chloride test | + |
| Saponins | Foam test | + |
| Carbohydrates | Molisch's test | - |
| Proteins | Biuret test | - |
| Amino acid | Ninhydrin test | - |

**Table 4. Antimicrobial test result**

| Test organism | Test-(zone of inhibition in mm) | Standard Drug | Test method |
|---|---|---|---|
| **Pseudomonas aeruginosa NCIM 2200** | 29 mm | Streptomycin (34 mm) | CKL/MB/MOA-044 |

### Antimicrobial studies

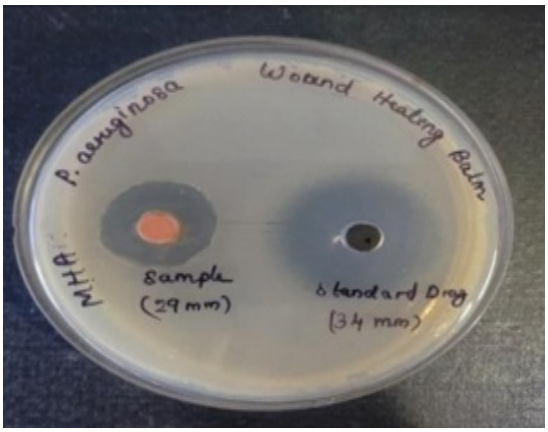


**Figure 6. Antimicrobial test**

# CONCLUSION

This project focused on the preparation and evaluation of a herbal wound healing balm formulated using medicinal plants *Tectona grandis* and *Nigella sativa*. Wound healing is a complex biological process involving restoration of damaged tissue through coordinated cellular and biochemical mechanisms. The aim of the study was to develop a natural topical formulation with potential antimicrobial and wound healing properties. In the present study, plant materials were collected, identified, and authenticated prior to processing. The plant material was dried, powdered, and subjected to extraction using ethanol in a Soxhlet apparatus for *Tectona grandis*, followed by concentration of the extract by evaporation to dryness. *Nigella sativa* was also processed for obtaining active constituents. The obtained extracts were incorporated into a suitable coconut oil-based balm formulation using appropriate base materials and preservatives to enhance stability and shelf life. Preliminary phytochemical screening of the plant extracts confirmed the presence of bioactive constituents such as alkaloids, flavonoids, glycosides, saponins, and tannins, which are known to contribute to antimicrobial, antioxidant, and wound healing activities. The formulated balm was evaluated for physical properties, including color, odour, texture, and appearance, and was found to be acceptable with a uniform, smooth, greasy, and slightly waxy consistency. Phytochemical analysis of the formulation further supported the presence of key bioactive compounds responsible for therapeutic action.

Antimicrobial activity was assessed against *Pseudomonas aeruginosa* using the agar diffusion method. The herbal balm showed a zone of inhibition of 29 mm, compared to 34 mm for the standard drug Streptomycin, indicating significant antibacterial activity. This demonstrates that the formulation possesses effective antimicrobial potential against clinically relevant pathogens. In conclusion, the study successfully formulated and evaluated a coconut oil-based herbal wound healing balm using *Tectona grandis* and *Nigella sativa*. The formulation exhibited notable antimicrobial activity and contains phytoconstituents that support wound healing potential. The findings suggest that the developed herbal balm may serve as a promising natural alternative for wound management due to its effectiveness, biocompatibility, and reduced risk of adverse effects.

However, further investigations such as in vivo studies, clinical trials, stability testing, and large-scale formulation development are recommended to fully establish its therapeutic efficacy and commercial applicability.

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