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Research Article

COMPREHENSIVE STUDY ON PONGAMIA GLABRA VENT. SEED OIL: EXTRACTION, CHARACTERIZATION, AND ANTIFUNGAL ACTIVITY ASSESSMENT

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Abstract

Dandruff remains a prevalent issue globally, impacting individuals across diverse demographics. Its manifestation, characterized by the shedding of scalp skin cells leading to visible flakes, presents in dry and oily forms, each with distinct attributes. While the prevalence peaks during puberty, various factors such as humidity, trauma, and stress exacerbate symptoms. Malassezia yeast overgrowth, thriving in sebum-rich areas, plays a pivotal role, with environmental triggers further complicating the condition. Addressing dandruff necessitates multifaceted approaches, including understanding its pathophysiology and exploring diverse treatment modalities.

This study focuses on Pongamia glabra Vent. seed oil, commonly known as karanj oil, extracted via a comprehensive methodology involving hydrodistillation and cold expression techniques. Characterization of the oil revealed specific properties, including appearance, odor, taste, solubility, and specific gravity, essential for evaluating its quality and suitability for various applications. Additionally, screening for antifungal activity against Malassezia furfur demonstrated promising results, with karanj oil exhibiting significant efficacy, highlighting its potential as a natural alternative for combating fungal infections associated with dandruff.

Keywords: Pongamia Glabra Vent, Volatile Oils, Dandruff Antifungal

1. Introduction

Dandruff, a widespread issue globally, affects both developed and developing nations. It arises from accelerated shedding of scalp skin cells, resulting in visible flakes. Dry and oily dandruff are the primary forms, each with distinct characteristics and causes[1].

Dry dandruff, or Pityriasis simplex, features small, white scales without inflammation. Oily dandruff, or Pityriasis steatoides, is marked by greasy, yellowish scales, often accompanied by inflammation and itching. Both types involve alterations in the scalp's epidermis.

Prevalence peaks during puberty, affecting nearly half the population, with males more prone than females. Various factors like humidity, trauma, and stress worsen symptoms. Ethnicity and hair care practices also influence dandruff severity[2].

Malassezia yeast overgrowth is a key factor, thriving in sebum-rich areas and causing inflammation.

Environmental triggers exacerbate symptoms. Understanding dandruff's composition and quantification aids in diagnosis and treatment evaluation[3].

Antidandruff agents target Malassezia growth, cell turnover, or scaling. They include fungicidal (e.g., ketoconazole, zinc pyrithione), cytostatic (e.g., tar, selenium sulfide), and keratolytic (e.g., salicylic acid, sulfur compounds) substances. However, synthetic agents pose limitations like resistance development and side effects.

Plant-based remedies offer promising alternatives, leveraging botanical antimicrobials. Traditional knowledge highlights plants like Tridax procumbens and Melaleuca alternifolia for their antidandruff properties. Herbal remedies provide a holistic approach to dandruff management, with potential for novel cosmeceuticals[4].

Pongamia glabra Vent is a medium-sized evergreen tree, reaching up to 18 m in height, widely distributed across India. It is known by various names across different languages and belongs to the Papillionaceae family. Botanically, it features imparipinnate leaves with 5 to 9 leaflets, fragrant white to pinkish flowers arranged in pairs, and indehiscent pods containing a single seed[5].

The seeds of Pongamia glabra are the source of a fixed oil, extracted via cold press method, exhibiting specific gravity, refractive index, acid value, saponification value, and unsaponifiable matter within defined ranges. Traditionally, the oil is applied externally to treat skin diseases and internally for digestive issues. It serves various medicinal purposes, including addressing skin ailments, respiratory conditions, and acting as a fish poison[6].

Chemical analysis reveals several compounds in P. glabra, such as karanjin, pongapin, pongaglabrone, pongamol, ovalitenone, and others, along with fatty acids like oleic and linoleic acids. These constituents contribute to its pharmacological activities, including antibacterial, larvicidal, antiviral, antidiabetic, and spermicidal properties. Notably, pongamol from P. glabra seeds demonstrates effective sunscreen properties against harmful UV radiation[7].

2. Methodology

2.1 Extraction of Volatile Oils

The collected drugs underwent two extraction methods to obtain volatile oils and fixed oils. Firstly, hydrodistillation was employed, heating the drugs with water in a Clevenger's apparatus. Volatile compounds vaporized with the steam, condensed, and collected separately, effectively isolating volatile oils. Secondly, a cold expression process was used to extract fixed oils without heat, applying pressure to squeeze out oils from the plant material. This comprehensive approach enabled the extraction of both volatile and fixed oils, facilitating further analysis for potential therapeutic or industrial applications[8,9].

2.2 Determination of Organoleptic and Physical Properties of Extracted Oils

The organoleptic properties of the extracted oils were evaluated to assess their purity, quality, and identification. Here's how each property was assessed:

A. Appearance/Color: The visual appearance and color of the oils were observed for clarity, transparency, and absence of sediment or foreign particles. Clear and transparent oils without discoloration or cloudiness were indicative of high quality.

B. Odor: The scent or aroma of the oils was evaluated for freshness and purity. A strong, pleasant odor suggested high quality, while off-putting or rancid odors indicated potential degradation or contamination.

C. Taste: Although less commonly evaluated, the taste of the oils provided additional information about their quality. Trained professionals assessed taste for freshness and absence of undesirable flavors.

D. Solubility: The solubility of the oils in various solvents was tested to determine their purity and composition. Complete solubility or expected solubility characteristics indicated authenticity, while deviations suggested potential adulteration or contamination.

E. Specific Gravity: The specific gravity of the oils, measured relative to water, was assessed to gauge their density and concentration. Consistent specific gravity values were expected for pure oils, while variations indicated potential impurities or dilution[10,11].

2.3 Method of Antifungal Activity

The antifungal activity of five test oils was evaluated using the disc diffusion method, involving sterilized Whatman No. 1 filter paper discs (6.0 mm diameter) saturated with measured volumes of each oil. These discs were placed on agar medium in Petri dishes, and after appropriate incubation, the presence and diameter of inhibition zones around the discs indicated the extent of antifungal activity[12].

For the formulation of an antidandruff shampoo, three shampoo bases were compared: a coconut oil base (B1), a liquid cream shampoo (B2), and a clear liquid shampoo (B3). Each base offers unique properties, such as moisturizing benefits from coconut oil in B1 or clarity in B3. Comparative testing aimed to identify the base best meeting desired criteria like foam height and stability, ensuring optimal formulation for consumer satisfaction.

The formulation of the coconut oil shampoo base (B1) involved heating coconut and palm oils, then adding alkalis (potassium hydroxide, sodium hydroxide) and sodium lauryl sulfate with constant stirring, followed by the addition of ethyl alcohol after cooling.

For the clear liquid shampoo base (B2), sodium lauryl ether sulfate was added to purified water with continuous stirring, followed by cocodiethanolamine, and finally cocamidopropyl betaine.

The cream shampoo base (B3) formulation began by combining sodium hydroxide, EDTA, and coconut fatty acids in water, heating the mixture, then diluting it and adding stearamide DEA, lauramide DEA, and glycol stearate, heating again for complete mixing.

Stability evaluation involved subjecting each base to storage at 45°C and 5°C for one month, assessing changes in appearance, color, odor, and phase separation, alongside testing foam volume and stability to ensure product quality over time.13,14

3. Results and Discussion

This text describes a process for extracting volatile oils from karanj oil from the seeds of Pongamia glabra Vent.

The extracting volatile oils from the seeds of Pongamia glabra Vent, commonly known as karanj. The table provided shows the percentage yield of oils obtained from this extraction process.

- Plant Used: Pongamia glabra Vent.
- Parts Used: Seeds
- Percentage Yield: 23%

This means that from the seeds of Pongamia glabra Vent, the extraction process yielded approximately 23% of volatile oils based on the weight of the seeds used.

The extraction process likely involved techniques such as hydrodistillation or steam distillation, where the seeds are subjected to heat and steam to release the volatile oils present within them. These oils are then collected, separated from water, and possibly purified for further use in various applications, such as pharmaceuticals, cosmetics, or aromatherapy.

Table 1: Percentage (% age) yield of oils under study

Sr. No.	Plants used for extraction of oils	Parts used	% age (v/w)
1.	*Pongamia glabra* Vent.	Seeds	23 %

Table 2: Organoleptic and physical properties of extracted oils

S. No.	Oils	Appearance/Colour	Odour	Taste	Solubility	Specific Gravity
1.	Karanj oil	Clear viscous, light-yellow liquid	Unpleasant	Bitter	Insoluble in water, soluble in alcohol	0.925

4. Determination of Organoleptic and Physical Properties of Extracted Oils

The table provides organoleptic and physical properties of the extracted karanj oil. Let's break down each property:

A. Appearance/Colour: The karanj oil is described as a clear, viscous, light-yellow liquid. This indicates that the oil has a transparent appearance, with a thick consistency, and a light yellow color. The clarity and colour of the oil are important indicators of its purity and quality.

B. Odour: The oil is characterized by an unpleasant odor. The odor of an oil is influenced by its chemical composition and can vary widely depending on factors such as the extraction method and the presence of impurities. In this case, the unpleasant odor may affect the acceptability of the oil for certain applications, such as in cosmetics or aromatherapy.

C. Taste: The taste of the karanj oil is described as bitter. While tasting oils is not a common practice and should only be done by professionals due to safety concerns, the bitter taste may provide insight into the chemical composition of the oil, particularly the presence of certain compounds such as alkaloids or bitter-tasting substances.

D. Solubility: The oil is reported to be insoluble in water but soluble in alcohol. This solubility profile is typical for many oils, as they are hydrophobic and tend to dissolve better in organic solvents like alcohol rather than in water. The solubility characteristics of the oil have implications for its formulation and application in various industries.

E. Specific Gravity: The specific gravity of the karanj oil is 0.925. Specific gravity refers to the density of a substance relative to the density of water. A specific gravity value less than 1 indicates that the substance is lighter than water. This property is important for various applications, including determining the purity and concentration of the oil.

5. Screening of Oils Under Study for Antifungal Activity Against Malassezia Furfur using Disc Diffusion Method

5.1 Screening of Oils under Study for Antifungal Activity

Table 3: Zone of Inhibition (ZOI) and Minimum inhibitory Concentration (MIC) of oils under study against Malassezia furfur

S .No	Essential oil	ZOI in mm (Mean ± SD)	MIC (µg)
1.	Karanj oil	17.5	32
2.	Ketoconazole	22	16

p value – 0.0001, "–" represents inactive

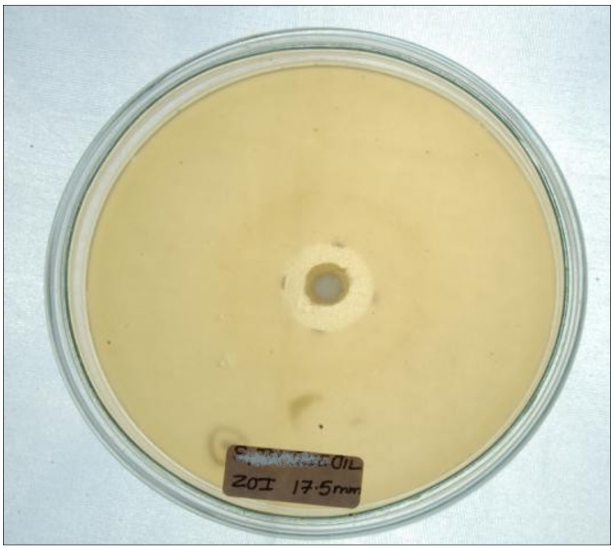

Figure 1: Zone of Inhibition shown by Karanj oil

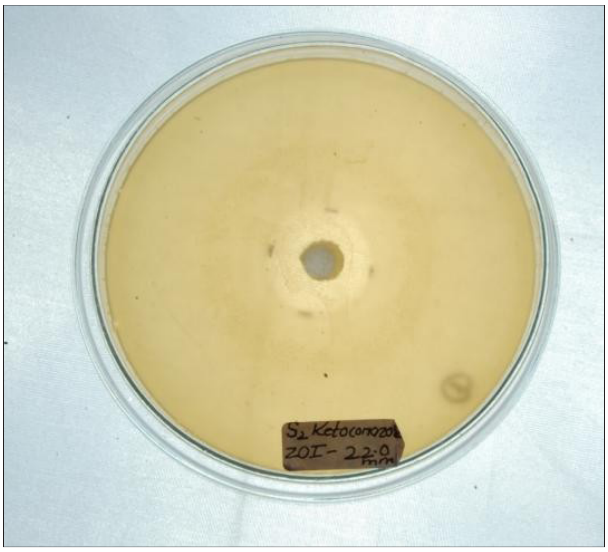

Figure 2: Zone of Inhibition shown by Ketoconazole

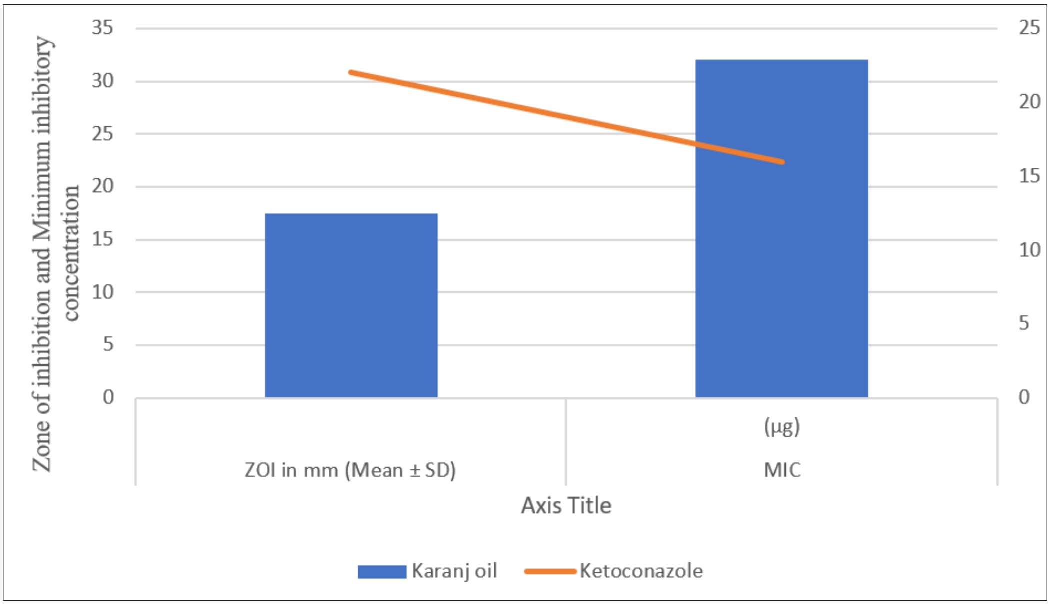

Figure 3: Comparative Zone of inhibition and Minimum inhibitory concentration of different samples

The table presents the results of screening the oils under study, including karanj oil, for their antifungal activity against Malassezia furfur using the disc diffusion method. Let's break down the key components:

A. Essential Oil: This column lists the essential oils tested for their antifungal activity. In this case, karanj oil is one of the oils being evaluated.

B. Zone of Inhibition (ZOI) in mm (Mean ± SD): The zone of inhibition refers to the area around the disc where the growth of the fungus is inhibited by the presence of the oil. It is measured in millimeters. The mean (average) value of the zone of inhibition along with the standard deviation (SD) is provided. A larger zone of inhibition indicates greater antifungal activity of the oil.

C. Minimum Inhibitory Concentration (MIC) (µg): The minimum inhibitory concentration is the lowest concentration of the oil at which visible inhibition of fungal growth occurs. It is measured in micrograms per milliliter (µg/ml). A lower MIC value indicates higher potency, meaning that lower concentrations of the oil are required to inhibit fungal growth.

D. Comparison with Positive Control (Ketoconazole): Ketoconazole is a known antifungal medication used as a positive control in the study. Its ZOI and MIC values are provided for comparison with the oils under study. A smaller ZOI or higher MIC value for the oil compared to ketoconazole suggests lower antifungal activity of the oil relative to the standard medication.

E. P-value: The p-value is a measure of statistical significance and indicates the probability of obtaining the observed results by chance alone. In this context, a p-value of 0.0001 indicates that the observed differences in antifungal activity between karanj oil and ketoconazole are highly significant, suggesting that they are unlikely to have occurred by random variation.

5. Conclusion

This comprehensive study sheds light on the extraction, characterization, and antifungal activity assessment of Pongamia glabra Vent. seed oil, commonly known as karanj oil. Through a systematic methodology, including extraction techniques, evaluation of organoleptic and physical properties, and screening for antifungal activity, valuable insights into the potential applications of this oil have been gained.

The extraction process yielded approximately 23% volatile oils from Pongamia glabra seeds, highlighting the efficiency of the employed methods, hydrodistillation, and cold expression. Characterization of the extracted karanj oil revealed its clear, viscous, light-yellow appearance, along with an unpleasant odor and bitter taste. These properties, combined with its solubility in alcohol and specific gravity of 0.925, provide essential information for assessing its quality and suitability for various applications.

Furthermore, the antifungal activity assessment against Malassezia furfur demonstrated promising results, with karanj oil exhibiting a zone of inhibition of 17.5 mm and a minimum inhibitory concentration (MIC) of 32 µg. While ketoconazole, the positive control, showed slightly higher efficacy with a zone of inhibition of 22 mm and an MIC of 16 µg, the significant antifungal activity of karanj oil underscores its potential as a natural alternative for combating fungal infections, including dandruff caused by Malassezia species.

Overall, this study contributes valuable data to the scientific understanding of Pongamia glabra Vent. seed oil, emphasizing its pharmacological potential, particularly in dermatological applications. Further research and clinical studies are warranted to explore its efficacy and safety profile comprehensively, paving the way for its development as a novel cosmeceutical or therapeutic agent for dandruff management and other skin conditions.

Conflict of Interest: None

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