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# REVIEW ON MELALEUCA ALTERNIFOLIA

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## ABSTRACT

Tea tree oil, derived from the leaves of the Melaleuca alternifolia plant, is a highly regarded essential oil known for its wide-ranging therapeutic properties. Native to Australia, the use of tea tree oil dates back centuries, where Indigenous Australians utilized it for its antimicrobial and healing properties, applying crushed leaves to wounds and skin infections.

7The oil is extracted through steam distillation, capturing the potent compounds that give it its distinctive aroma and beneficial characteristics. Tea tree oil contains over 100 different compounds, with terpinen-4-ol being the primary active component responsible for its antimicrobial effects. It is commonly used in various applications, including skincare, hair care, and alternative medicine. This research discusses the effectiveness of tea tree oil against several bacterial and fungal infections.(1)

In recent years, tea tree oil has gained significant popularity in the wellness and beauty industries, with claims ranging from treating acne and fungal infections to acting as a natural disinfectant. Numerous studies have explored its efficacy, demonstrating its potential as an antimicrobial agent against a range of bacteria, viruses, and fungi. However, while tea tree oil is celebrated for its benefits, it should be used with caution, as it can cause skin irritation in some individuals, particularly in concentrated forms. This study investigates the antimicrobial properties of tea tree oil against various pathogens.(7)

## I. INTRODUCTION

**Brief History of Tea Tree Oil**

Indigenous Use: The origins of tea tree oil can be traced back to the Indigenous people of Australia, who have utilized the leaves of the Melaleuca alternifolia plant for centuries. They crushed the leaves and applied them topically to wounds, burns, and skin infections, benefiting from the oil's natural antiseptic and healing properties.

European Discovery: In the late 18th century, British explorer Captain James Cook encountered tea tree during his travels in Australia. He and his crew noted the Indigenous Australians using the leaves for medicinal purposes and discovered its pleasant aroma. Cook's crew began brewing tea from the leaves, hence the name "tea tree."

Scientific Exploration: The commercial production of tea tree oil began in the early 20th century, especially after Arthur Penfold, an Australian chemist, published research in the 1920s. His work highlighted the oil's antimicrobial properties, increasing interest in its potential medicinal applications.

World War II: During World War II, tea tree oil gained recognition as it was included in first aid kits for Australian soldiers due to its effectiveness as a topical antiseptic. This further established its reputation for healing and infection control.

Modern Popularity: The latter half of the 20th century and the early 21st century saw a surge in the popularity of tea tree oil, coinciding with the natural health movement. It became a common ingredient in various personal care products, such as skincare, hair care, and natural remedies. Research confirmed its effectiveness against a variety of microorganisms, leading to endorsements by health practitioners.

Current Applications: Today, tea tree oil is widely recognized for its versatility, used in treating acne, dandruff, fungal infections, and as a natural disinfectant. It remains a staple in holistic and alternative medicine practices.(7,9)

**Morphology of Tea Tree Oil**

Tea tree oil is derived from the leaves of the Melaleuca alternifolia plant, which is native to Australia. Here's a brief overview of its morphology:

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**1. Plant Structure**

**Species**: Melaleuca alternifolia

**Type**: Evergreen shrub or small tree, typically 1-7 meters tall.

**Leaves**

Shape: Narrow, lanceolate (pointed at both ends).

**Size**: 1-2.5 cm long, 0.5-1.5 cm wide.

**Arrangement**: Alternately arranged with a whorled pattern at the nodes.

**Color**: Glossy green above, paler underneath.

**Texture**: Leathery, with a strong aromatic scent when crushed.

**2. Essential Oil Characteristics**

**Extraction Method:** Steam distillation of leaves and twigs.

**Appearance**: Colorless to pale yellow liquid.

**Odour**: Characteristic medicinal aroma.

**Density**: Ranges from 0.89 to 0.93 g/cm$^3$.(10,11,12,13)

**Overview of the morphology, biological sources, and classifications of tea tree oil, specifically focusing on its botanical aspects:**

**1. Botanical Name**

**Scientific Name**: Melaleuca alternifolia

**2. Biological Sources**

**Plant Family**: Myrtaceae

**Common Names**

Tea tree, narrow-leaved paperbark

**Origin**: Native to Australia, primarily found in New South Wales and Queensland.

**Parts Used**: The essential oil is extracted from the leaves and twigs of the plant.

**3. Biological Classification**

**Kingdom**: Plantae

**Clade**: Angiosperms

**Clade**: Eudicots

**Clade**: Rosids

**Order**: Myrtales

**Family**: Myrtaceae

**Genus**: Melaleuca

**Species**: M. Alternifolia(10,11,12,13)

**Microscopic Study of Tea Tree Oil**

A microscopic study of tea tree oil primarily focuses on the microscopic structure of the leaves of Melaleuca alternifolia, as well as the characteristics of the oil itself. Here's a brief overview:

**Leaf Anatomy**:

**Stomata**: The leaves contain numerous stomata on the lower epidermis, which facilitate gas exchange. They are typically surrounded by guard cells that regulate their opening and closing.

**Trichomes**: Glandular trichomes are present, which secrete essential oils. These are seen as small, hair-like structures that can be observed under a microscope.

**Mesophyll**: The leaf mesophyll consists of palisade and spongy parenchyma cells, where photosynthesis occurs.

**Oil Glands:**The essential oil glands are found within the leaf structure, appearing as secretory cavities or glands. These glands store and release the volatile oil, which can be identified microscopically.

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**2. Microscopic Characteristics of Tea Tree Oil**

**Crystalline Structure**: When observed under a microscope, tea tree oil may show crystalline structures, particularly when cooled. These crystals are generally associated with components like terpinen-4-ol and can vary in shape.

**Droplet Morphology:** The oil appears as clear droplets, which may be analyzed for size and distribution using microscopic techniques.

**3. Microscopy Techniques Used**

- Light Microscopy
- Scanning Electron Microscopy (SEM)
- Transmission Electron Microscopy (TEM)(10,11,12,13)

**Chemical constituents**

Tea tree oil, derived from the leaves of the Melaleuca alternifolia plant, is renowned for its antimicrobial, antifungal, and anti-inflammatory properties. It contains a variety of chemical constituents, primarily terpenes and terpenoids. Here's a summary of the major components along with relevant references.

**Major Chemical Constituents of Tea Tree Oil**

**1. Terpinen-4-ol**

**Percentage**: 30-48%

**Properties**: Known for its antimicrobial and anti-inflammatory effects.(14)

**2. γ-Terpinene**

**Percentage**: 10-28%

**Properties**: Exhibits antimicrobial activity and enhances the effects of other compounds in the oil.(7)

**3. α-Terpineol**

**Percentage**: 1-8%

**Properties**: Has antiseptic properties and is a common fragrance component.(6)

**4. 1,8-Cineole (Eucalyptol)**

**Percentage**: 0.5-15%

**Properties**: Provides anti-inflammatory effects and enhances penetration of other active components(15)

**5. Terpinen-1-ol**

**Percentage**: 2-6%

**Properties**: Known for its strong antifungal properties.( 16)

**6. P-Cymene**

**Percentage**: 7-10%

**Properties**: Possesses antimicrobial properties and enhances the oil's fragrance.(17)

**7. Myrcene**

**Percentage**: 0.5-2%

**Properties**: Known for its anti-inflammatory and analgesic effects.(18)

**Identification test**

**1. Gas Chromatography (GC)**

Description: This method separates and identifies the volatile compounds in tea tree oil. The retention times and peak areas of specific compounds (like terpinen-4-ol and γ-terpinene) can be used to verify quality and purity.(19)

**2. Thin Layer Chromatography (TLC)**

Description: TLC is used for the qualitative analysis of essential oils. Different compounds can be visualized on a chromatographic plate, providing a fingerprint of the oil.(20)

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**3. Refractive Index Measurement**

Description: The refractive index of tea tree oil should fall within a specific range (approximately 1.470-1.485). This measurement can help confirm the oil's authenticity.(21)

**4. Infrared (IR) Spectroscopy**

Description: IR spectroscopy can be used to identify functional groups in the oil, providing a profile that can confirm its identity.(22)

**Uses**

**1. Pre-Cosmetic Uses**

**Skin Care**: TTO is commonly used in skincare formulations for its antibacterial and anti-inflammatory properties, making it effective for acne treatment and skin irritation relief.

**Hair Care**: Often included in shampoos and conditioners, TTO helps with dandruff and scalp health due to its antifungal properties.(14)

**2. Commercial Uses**

**Household Cleaning Products**: TTO is incorporated into a variety of cleaning products due to its antimicrobial properties, effective against bacteria and fungi.

**Personal Care Products:** Widely used in soaps, deodorants, and lotions for its natural fragrance and skin benefits.(16)

**3. Industrial Uses**

**Textile and Leather Industry:** TTO is used for its antifungal properties in textile treatments and leather preservation.

**Aromatherapy and Fragrance:** Used in diffusers and aromatherapy products for its soothing properties and pleasant aroma.

**4. Medicinal Uses**

**Antimicrobial and Antifungal Treatments**: TTO is recognized for its effectiveness against a variety of pathogens, including bacteria and fungi, and is used topically for wound care.

**Respiratory Conditions**: Inhalation of TTO vapor is used in treating respiratory infections and symptoms, as it may help clear congestion.(7)

**adulterants, substitutes, and aliend drugs related to tea tree oil,**

**Adulterants**

**1. Synthetic Terpenes (e.g., Terpinen-4-ol, α-Terpineol)**

**Description**: Some manufacturers may add synthetic versions of active compounds found in tea tree oil to enhance the oil’s appearance and scent without providing the same therapeutic properties.(14)

**2. Other Essential Oils (e.g., Eucalyptus Oil, Lavender Oil)**

**Description**: Lower-cost essential oils may be mixed with tea tree oil to reduce production costs. This can compromise the oil's efficacy and purity.(19)

**Substitute Drugs**

**1. Lavender Oil**

**Description**: Often marketed as a natural alternative to tea tree oil, lavender oil possesses some similar antimicrobial properties but is not as effective for certain conditions, such as acne.(14)

**2. Peppermint Oil**

**Description**: Used in some formulations as a substitute for its antimicrobial and anti-inflammatory properties, though its profile is different and may not offer the same benefits as TTO.(24)

**Aliend Drugs**

**1. Benzoyl Peroxide**

**Description**: Often used as a topical treatment for acne, it acts as an antimicrobial and is commonly used in formulations aslongside or instead of tea tree oil.(25)

**2. Clindamycin**

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**Description**: An antibiotic used for treating bacterial infections, it can be an alternative for treating acne in cases where tea tree oil is ineffective or not suitable.(26)

**Per hector percentage Yield of tea tree oil**

The percentage yield of tea tree oil (TTO) per hectare can vary significantly based on several factors, including the cultivation practices, the age of the trees, climate conditions, and harvesting methods. However, average yields have been reported in various studies. Here's a summary of the percentage yield of tea tree oil per hectare along with relevant references.

Average Yield of Tea Tree Oil

**1. Typical Yield Range:**

**Percentage Yield**: The average yield of tea tree oil per hectare is generally reported to be between 500 to 3,000 liters. This translates to an approximate yield of 0.5% to 2.5% by weight from the leaves harvested.(27)

**2. Factors Influencing Yield:**

The yield can be influenced by:

**Plant Age**: Younger plants tend to produce lower yields, while mature plants (typically 3-6 years old) yield more oil.

**Cultivation Practices:** Organic vs. conventional farming can affect oil yield and quality.

**Climate Conditions:** Temperature, rainfall, and soil type can impact oil production.(28)

**3. Specific Studies:**

**Study Findings**: In some specific studies, yields have been reported at about 1,000 to 2,000 liters per hectare per year for well-maintained plantations.(29)

**4. Regional Variations:**

Different regions may report varying yields based on local agricultural practices and environmental conditions. For example, Australian farms often report higher yields compared to those in other countries.(30)

**Per Kilogram Valuation of Tea Tree Oil**

The valuation of tea tree oil (TTO) can vary based on factors such as quality, source, market demand, and production methods. Here's a brief overview of the per kilogram valuation of tea tree oil along with relevant references.

**1. Market Price Range:**

The price of tea tree oil typically ranges from $60 to $120 USD per kilogram. This price can fluctuate based on factors like quality, purity, and region of production.

**2. Quality and Composition:**

Higher quality oils, particularly those with a terpinen-4-ol content exceeding 40%, may command prices at the upper end of the spectrum. Conversely, lower-quality oils or adulterated products may sell for significantly less.(19)

**3. Export and Domestic Prices:**

In exporting countries like Australia, where tea tree oil is primarily produced, prices can vary due to international demand and local supply conditions. Domestic prices may be lower due to reduced transport costs.(31)

**4. Market Trends:**

Recent trends show that the demand for natural products, including tea tree oil, has increased, which could impact pricing. Market reports indicate that TTO's valuation is likely to rise as more consumers prefer natural over synthetic products.(32)

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