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Research Article

Development and Optimization of Eucalyptus Oil-Based Inhalation Drops for Multilevel Respiratory Relief

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ABSTRACT

Eucalyptus oil, a derivative primarily sourced from *Eucalyptus globulus*, is widely acknowledged for its therapeutic roles in inhalation treatments, particularly due to its antimicrobial, anti-inflammatory, and decongestant effects. This research centers on creating and assessing eucalyptus oil-based inhalation drops tailored to provide symptomatic alleviation of respiratory blockages. Three variations—standard, extra-strength, and mild—were prepared using distinct concentrations of eucalyptus oil, menthol, camphor, polysorbate 20, glycerin, and distilled water. Polysorbate 20 was integrated as a solubilizing agent to maintain formulation uniformity, while glycerin acted as a humectant and a mild soothing component. These preparations underwent evaluation for visual characteristics, pH, viscosity, clarity, scent retention, and accelerated stability. The ideal viscosity was maintained within 10–70 cP to ensure effective dispensing and vapor release. All formulations maintained clarity, consistency, and stability throughout a 3-month period. The extra-strength formulation displayed a more pronounced decongestant effect, while the mild variant was suitable for sensitive individuals. This study supports the effectiveness and adaptability of eucalyptus-based drops as a natural therapeutic option for upper respiratory relief.

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Introduction:

Traditionally revered in herbal medicine, eucalyptus oil remains integral in managing respiratory conditions. Its therapeutic versatility has contributed to its incorporation in numerous modern inhalation remedies. Belonging to the Myrtaceae family and native to Australia and Tasmania, *Eucalyptus* encompasses approximately 900 species that thrive in subtropical and Mediterranean climates globally.

Certain species like *E. Polybractea*, *E. Smithii*, and *E. Globulus* are especially valued for their essential oil content and are utilized in pharmaceuticals and cosmetics. (Daniel Mieres-Castro et al., 2021) These essential oils exhibit a wide array of biological effects, including antibacterial, antifungal, antiviral, anti-inflammatory, immunomodulatory, antioxidant, and wound-healing properties. They are frequently administered for conditions like colds, nasal obstruction, sinusitis, asthma, tuberculosis, influenza, ARDS, and COPD. Following absorption, eucalyptus components function as antiseptics, expectorants, and anti-inflammatories, reinforcing their significance in respiratory care. (Bossou et al., 2015)

Eucalyptus essential oils (EEOs), mainly produced by steam or hydrodistillation of leaves, and occasionally from other plant parts, are rich in volatile compounds such as monoterpenoids and sesquiterpenes. (Hamdi et al., 2015). The ease of extraction, low toxicity, and biodegradability further enhance their desirability across various industries. (Mubarak et al., 2015). Select species, including *E. Globulus*, are recognized for their application in therapeutic and cosmetic products. Gilles et al., 2010).

Despite limited clinical data, eucalyptus oil and its constituent cineole feature in several over-the-counter remedies like syrups, nasal drops, and lozenges. Manika at al., 2013). Widely used in aromatherapy, especially in regions like Europe and Japan, eucalyptus essential oil continues to attract interest for its potential in conventional and Ayurvedic medicinal systems. Ghalem et **al., 2008).**

Literature review:

Sr. No	Name of article	Abstract summery	Year	Name of author
1	Therapeutic applications of eucalyptus essential oils	Eucalyptus essential oils (EEOs) have attracted increasing scientific and clinical interest due to their diverse biological activities. These oils exhibit strong antimicrobial action against a variety of pathogens, including bacteria, viruses, and fungi, making them suitable for infection prevention	2024	Riham a. El Shiekh

		and hygiene-related applications. Their anti-inflammatory properties contribute to the management of conditions such as arthritis, skin irritations, and respiratory issues. EEOs are particularly effective in supporting respiratory health by easing symptoms like nasal congestion, cough, and sinus pressure. They are commonly used in inhalation therapies, vapor rubs,		

		and topical pain-relieving formulations. Moreover, eucalyptus oils aid in wound healing by reducing inflammation and preventing infection. In aromatherapy, they are appreciated for their ability to enhance mental clarity, reduce stress, and promote emotional well-being. Due to their natural origin, wide safety margin, and therapeutic versatility, EEOs hold significant promise as a		

		component of both traditional and modern health practices. Continued research is likely to further validate and expand their applications across medical, cosmetic, and wellness domains.		
2	Antiviral activities of eucalyptus essential oils: their effectiveness as therapeutic targets against human viruses	With limited treatment options for viral infections like influenza and SARS-CoV-2, eucalyptus essential oil has gained attention as a potential antiviral agent. It can be used to support symptom	2021	Daniel Mieres-Castro

		management or directly target viral mechanisms. Research highlights that the monoterpenes in eucalyptus oil may neutralize viruses by binding to viral proteins involved in cell entry, thereby preventing infection. Additionally, eucalyptus oil may complement vaccine efficacy and offer therapeutic benefits such as anti-inflammatory, mucolytic, and spasmolytic actions,		

		especially in managing respiratory viral conditions.		
3	Effect of eucalyptus oil inhalation on pain and inflammatory responses after total knee replacement: a randomized clinical trial	Eucalyptus oil has shown promising results in managing postoperative discomfort, particularly in reducing pain, swelling, and inflammation. A clinical study assessed its inhalation effects on patients undergoing total knee replacement (TKR). Participants were randomly assigned to receive either eucalyptus oil or	2013	Yang Suk Jun

		almond oil inhalation during 30 minutes of continuous passive motion therapy over three days. Results indicated that patients in the eucalyptus group experienced a significant reduction in pain scores across all three days, as well as decreased systolic and diastolic blood pressure on the second day. However, there were no notable differences between groups in heart rate,		

		C-reactive protein levels, or white blood cell counts. These findings support the use of eucalyptus oil inhalation as a potential non-invasive nursing intervention to alleviate pain and stabilize blood pressure following knee surgery.		
4	Immune-modifying and antimicrobial effects of eucalyptus oil and simple inhalation devices	Eucalyptus oil (EO), particularly its key constituent 1,8-cineole, exhibits notable antimicrobial activity against a broad spectrum of	2010	Angela E. Sadlon

		pathogens, including *Mycobacterium tuberculosis*, MRSA, various viruses, and fungi like *Candida*. Beyond its antimicrobial effects, EO also demonstrates immune-modulating, anti-inflammatory, antioxidant, analgesic, and antispasmodic properties. It particularly enhances the function of monocytes and macrophages by increasing their phagocytic capacity. When		

		administered via inhalation or orally, EO can help manage both infectious and non-infectious respiratory conditions such as bronchitis, asthma, and COPD. It has a longstanding reputation in traditional medicine, backed by a favorable safety profile. Although some essential oils may exhibit stronger antimicrobial effects, the low toxicity and wide-ranging		

		benefits of EO make it a valuable natural alternative to conventional drugs. Additionally, preliminary findings suggest EO might reduce the muscle toxicity caused by certain chemotherapy drugs, although further investigation is needed. Practical guidance for creating affordable vapor inhalation devices is also discussed in related research.		
5	Formulation and evaluation of	The study focused on developing and	2016	Gokul Nagorao Rathod

	herbal inhaler and roll on oil	assessing herbal formulations, including an inhaler and roll-on oil, designed to alleviate headaches and symptoms of the common cold. These preparations incorporated natural ingredients with known analgesic and decongestant properties, such as eucalyptus oil, peppermint oil, camphor, and asmantara. The formulations were subjected to comprehensive		
		evaluations involving compatibility, stability, therapeutic effectiveness, and safety. The results highlight the promise of herbal-based therapies as effective alternatives for managing respiratory discomfort and related ailments.		
6	A systematic and comprehensive review on current understanding of the pharmacological actions, molecular mechanisms, and	Over recent decades, there has been a growing interest in the *Eucalyptus* genus across diverse sectors, including pharmaceuticals, agriculture, cosmetics, and food.	2021	Nikhil Chandorkar

	clinical implications of the genus *eucalyptus*	The primary active compound, eucalyptol (1,8-cineole), a key terpenoid found in eucalyptus species, has been widely investigated in both preclinical and clinical studies for its broad spectrum of pharmacological effects. Research indicates that *Eucalyptus* possesses significant therapeutic potential in managing a variety of conditions such as respiratory illnesses, COVID-19, pain, oral infections, infectious diseases, and even certain types of cancer.		

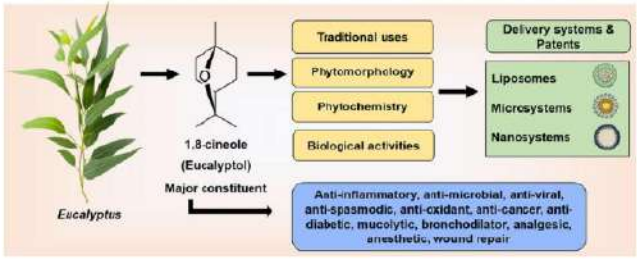
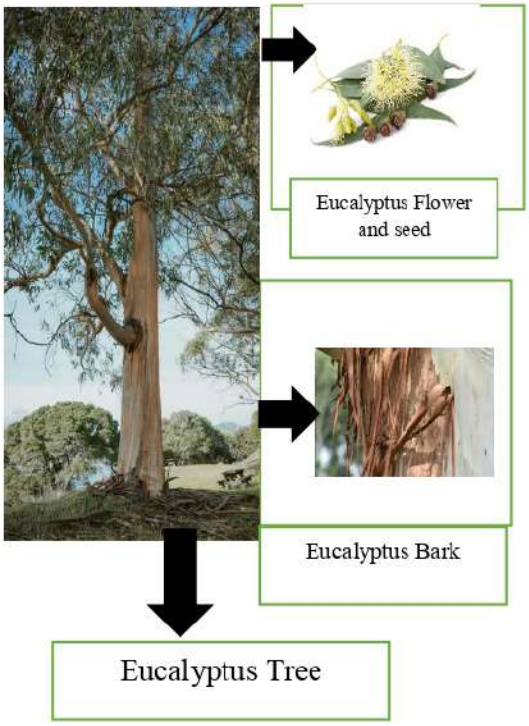


Fig. 1: Eucalyptus leaves and its biological activity

Phytochemical constituents and mechanism of action:

Phytochemical Constituents and Mechanism of Action: The dominant bioactive compound in eucalyptus oil is 1,8-cineole (eucalyptol), which constitutes up to 90% of the oil. This monoterpenoid imparts mucolytic, bronchodilatory, and anti-inflammatory benefits. Its inhalation aids in mucous clearance and alleviation of airway inflammation, proving beneficial for disorders like sinusitis and bronchitis. Eucalyptus oil also possesses antimicrobial efficacy, inhibiting a broad spectrum of pathogens.



Eucalyptus Leaves Eucalyptus Oil

Table 1: Chemical constituents of eucalyptus oil:

1. **Chemical Constituents of the Leaves of Eucalyptus Globulus:** The essential oil consisted mainly of oxygenated monoterpenes, monoterpenes and oxygenated sesquiterpene. Of these, 1, 8-eucalyptus (72.71%) α- terpenoid (2.54%), terpiene-4-ol (0.34%), and linalool (0.24%) were the main oxygenated monoterpenes, while α-eudesmol (0.39%), (-)- globulol (2.77%), and epilobulol (0.44%) were the main sesquiterpene. Several significant compounds were α terpineol acetate (3.1%), geranyl acetate (0.71%), L pinocarveol (0.36%), β-sabinene (0.25%), and terpinolene (0.19%). A portion (0.26%) of the total constituents remains unidentified.
2. **Chemical Constituents in the Fruit of Eucalyptus Globulus**: Fifteen compounds were obtained and identified as betasitosterol, betulinic acid, stigmasterol, euscaphic acid, 2ahydroybetulinic acid, macrocarpal B, macrocarpal A, oleanolic acid 3,4,3 –O- trimethylelladic acid, 3-Omethylellagic acid 4-O-(2''-O-acetyl) – alpha-L rhamnopyranoside, 3-O-methylellafic acid, ellagic acid and gallic acid.
3. **Chemical Constituents of the Wood of Eucalyptus Globulus**: The main compound identified included sterols, sterol esters, fatty acid, steroid ketones, hydrocarbon and triglycerides. Minor compound such as fatty alcohol, mono- and diglycerides, waxes and tocopherols were also identified among the lipids from E. globulus wood. Sterols, sterol esters, fatty acids, steroid ketones, hydrocarbon and triglycerides were the major compound identified. (Kesharwani, et al., 2018).

Therapeutic Applications: (Mohammed et al., 2022, Riham et al., 2025). Eucalyptus oil (Myrtaceae) represents a widely planted and extensively researched genus, second only to *Acacia* in Australia. Traditionally and pharmacologically, it is known for treating conditions such as mild bronchial inflammation, asthma, sore throat, cystitis, gastritis, wounds, malaria, and more. Specific uses include:

1. Air Fresheners and Mists
2. Allergy Management
3. Relief from Bronchitis, Congestion, Sinus Infections, and Asthma
4. Antiseptic and Disinfectant Uses
5. Anti-inflammatory, Antimalarial, and Anthelmintic Activity
6. Treatment of UTI and RTI
7. Spasmolytic, Irritant, and Veterinary Use
8. Histamine Release Inhibition and Anti-viral Properties
9. Antitumor, Antifungal, and Antiplaque Activities
10. Cytochrome P450 Inhibition
11. Larvicidal and Nerve Blocking Actions
12. Anti-diabetic and Anti-cancer Potential
13. Gastrointestinal and Hepatoprotective Benefits
14. Myorelaxant Properties. (Kesharwani, et al., 2018).

FORMULATION STRATEGIES

a. **Traditional Approaches:** Conventionally, eucalyptus oil is administered via steam inhalation, providing prompt relief from respiratory discomfort by introducing a few drops into hot water.

b. **Contemporary Delivery Systems:** Advances in formulation science have enabled more sophisticated eucalyptus inhalation products such as:

- Nasal inhalers
- Topical vapor rubs
- Aerosolized sprays
- Nebulizer-compatible solutions These approaches enhance the absorption and targeted delivery of eucalyptus oil, thereby improving clinical outcomes.

MATERIAL AND METHOD:

Table 2: Formulation of Product

Method of Preparation:

In beaker, add glycerine and water

⇩

In another beaker, mix Eucalyptus oil with ethanol to form homogenous mixture

⇩

Add polysorbate 20

⇩

Combine both the mixture

⇩

Put on magnetic stirrer

⇩

Adjust pH (5.5 – 6.5) using citric acid

⇩

Filter the solution and transfer in suitable container

Fig. 3: Eucalyptus oil extract

Sr. No.	Parameter	F1	F2	F3
1	**Physical Appearance**	Clear, slightly opalescent	Slightly hazy, clear	Clear, transparent
2	**pH**	6.1 ± 0.1	5.8 ± 0.1	6.3 ± 0.1
3	**Viscosity (cP)**	38 ± 2	45 ± 3	26 ± 1
4	**Refractive Index**	1.437	1.440	1.433
5	**Specific Gravity**	1.01 ± 0.02	1.03 ± 0.01	0.99 ± 0.01
6	**Clarity/Solubility**	No separation or turbidity	Slight opalescence, stable	Clear and stable
7	**Odor Retention**	Strong eucalyptus-menthol mix	Very strong, sharp aromatic blend	Mild but distinct aroma

Fig. 4: Extract blend with cotton roll

Safety and toxicity (Dhakad et al., 2018)

Safety and Toxicity: Though generally regarded as safe, eucalyptus oil must be used within recommended limits. Overuse can result in dizziness, nausea, or seizures. It should be avoided by children under six,

pregnant/lactating women, and individuals with certain health conditions unless advised otherwise. Drug interactions may occur, especially with medications metabolized in the liver, warranting prior consultation with a healthcare professional.

Marketed Products: Popular eucalyptus-based inhalation products include:

- Vicks Vaporub
- Olbas Oil
- Bosisto's Inhaler
- Farm Blends Eucalyptus Oil These offerings cater to diverse user preferences and therapeutic requirements.

Future Prospects: Ongoing investigations aim to improve eucalyptus oil delivery and safety by exploring:

- Nanoemulsions and nanotechnology-based delivery systems
- Combination formulations for synergistic effects
- Well-designed clinical trials for validating dosing standards and long-term safety
-

These products cater to various preferences and therapeutic needs, emphasizing the versatility of eucalyptus oil in inhalation therapies.

CONCLUSION:

This research successfully introduced and evaluated three eucalyptus oil-based inhalation drop variants designed for varied therapeutic intensities. Each formulation showed satisfactory physicochemical traits, including clarity, stability, appropriate pH, and viscosity range. Polysorbate 20 played a crucial role in homogenizing the oils, while glycerin enhanced

both texture and comfort during use. The standard formulation was suitable for general adult use, the extra-strength variant for severe congestion, and the mild version for sensitive users. These formulations offer a promising, customizable solution for alleviating upper respiratory discomfort.

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