

Eucalyptus Steam Inhalation Therapy: A Comprehensive Review of Mechanisms, Efficacy, and Clinical Applications in Respiratory Relief

Academic Research Paper
Evidence-Based Respiratory Medicine

January 30, 2026

Abstract

Steam inhalation with eucalyptus leaves represents a traditional therapeutic practice with emerging scientific validation for respiratory symptom management. This comprehensive review examines the biochemical mechanisms, clinical efficacy, and safety profile of eucalyptus-based steam inhalation therapy. The primary bioactive compound, 1,8-cineole (eucalyptol), constitutes 70-84% of eucalyptus essential oil and demonstrates anti-inflammatory, bronchodilatory, mucolytic, and antimicrobial properties. Through systematic analysis of recent clinical trials and mechanistic studies, this paper elucidates how steam inhalation therapy combines thermal effects with phytochemical delivery to provide symptomatic relief in conditions including acute respiratory infections, chronic obstructive pulmonary disease (COPD), asthma, and sinusitis. Evidence indicates that eucalyptol modulates key inflammatory pathways through inhibition of nuclear factor kappa-B (NF- κ B), reduction of pro-inflammatory cytokines (TNF- α , IL-1 β , IL-6), and suppression of reactive oxygen species (ROS). Clinical studies demonstrate significant improvements in respiratory function, with reductions in cough frequency up to 68%, decreased respiratory rate in pediatric populations, and enhanced lung function parameters (FEV1) in COPD and asthma patients. This review also addresses safety considerations, contraindications, and optimal application protocols. While steam inhalation with eucalyptus provides evidence-based adjunctive therapy for respiratory conditions, it should complement rather than replace conventional medical treatments.

1 Introduction

Respiratory diseases represent a significant global health burden, affecting millions of individuals worldwide and contributing substantially to morbidity and mortality rates. The World Health Organization estimates that respiratory infections, including acute respiratory infections (ARI), chronic obstructive pulmonary disease (COPD), asthma, and bronchitis, account for a substantial proportion of healthcare utilization and economic costs (11). Traditional therapeutic approaches, particularly steam inhalation therapy, have been utilized across diverse cultures for centuries to manage respiratory symptoms.

Eucalyptus (*Eucalyptus globulus* and related species), belonging to the family Myrtaceae, has occupied a prominent position in traditional medicine systems, including Australian Aboriginal medicine, Ayurveda, and traditional European herbalism. The practice of boiling eucalyptus leaves in water and inhaling the resulting vapor combines two therapeutic modalities: (1) the thermal and humidification effects of steam, and (2) the delivery of volatile phytochemical compounds, primarily eucalyptol (1,8-cineole), to the respiratory tract.

Recent scientific investigations have begun to elucidate the molecular mechanisms underlying the therapeutic effects of eucalyptus steam inhalation, providing empirical support for this traditional practice. This paper presents a comprehensive, evidence-based analysis of eucalyptus steam inhalation therapy, examining its biochemical foundations, clinical applications, efficacy data, and safety profile.

1.1 Historical Context and Traditional Use

The therapeutic use of eucalyptus dates to indigenous Australian practices, where Aboriginal peoples utilized eucalyptus leaves for treating fevers and respiratory ailments. Following European colonization, eucalyptus gained recognition in Western medicine during the 19th century, when it became known as the "Australian fever tree" after crew members of an Australian vessel successfully treated high fevers using eucalyptus tea.

By the late 1800s and early 1900s, Eclectic physicians in the United States employed eucalyptus oil not only for antimicrobial purposes but specifically recommended steam inhalation of eucalyptus vapor for treating asthma, bronchitis, whooping cough, and emphysema. This historical application presaged contemporary scientific understanding of eucalyptus's bronchodilatory and anti-inflammatory properties.

1.2 Botanical and Chemical Characteristics

Eucalyptus globulus (Blue Gum eucalyptus) represents the most extensively studied species for medicinal applications, though several hundred eucalyptus species exist worldwide. The leaves, when subjected to steam distillation or direct boiling, release essential oils containing a complex mixture of terpenoid compounds.

The principal bioactive constituent, 1,8-cineole (eucalyptol), comprises 70-84% of eucalyptus essential oil content, depending on species, geographic origin, and harvest conditions. Additional constituents include α -pinene, β -pinene, limonene, p-cymene, and various sesquiterpenoids. The molecular structure of eucalyptol ($C_{10}H_{18}O$) is characterized as a monoterpenoid oxide, specifically a cyclic ether, which confers its volatility and lipophilic properties enabling penetration of biological membranes.

2 Mechanisms of Action

The therapeutic efficacy of eucalyptus steam inhalation derives from synergistic mechanisms involving both the physical properties of steam and the pharmacological activities of eucalyptol and related compounds.

2.1 Thermal and Humidification Effects of Steam

Steam inhalation provides several direct physical benefits to the respiratory system:

1. **Airway Humidification:** Warm, moist air hydrates mucous membranes lining the nasal passages, throat, and bronchial tree. This moisture helps prevent drying and irritation of respiratory epithelium.
2. **Mucus Modification:** The heat and humidity from steam reduce mucus viscosity through hydration, facilitating mucociliary clearance and expectoration. This effect is particularly beneficial in conditions characterized by mucus hypersecretion.
3. **Vasodilation:** Warmth promotes dilation of blood vessels in the nasal mucosa and upper respiratory tract, increasing blood flow to affected areas. Enhanced circulation delivers greater numbers of immune cells (particularly neutrophils and macrophages) to sites of infection or inflammation.
4. **Bronchodilation:** Heat application promotes relaxation of bronchial smooth muscle, counteracting bronchoconstriction associated with asthma and COPD. This bronchodilatory effect, though temporary, improves airflow and reduces dyspnea.
5. **Mucociliary Clearance Enhancement:** The combination of heat and moisture improves the function of respiratory cilia, promoting more effective clearance of mucus, pathogens, and irritants from the airways.

2.2 Pharmacological Properties of Eucalyptol (1,8-Cineole)

Eucalyptol exerts multiple pharmacological effects relevant to respiratory disease management:

2.2.1 Anti-inflammatory Mechanisms

The anti-inflammatory activity of eucalyptol operates through several molecular pathways:

- **NF- κ B Pathway Inhibition:** Eucalyptol inhibits activation of nuclear factor kappa-B (NF- κ B), a master transcription factor regulating expression of pro-inflammatory genes. At clinically relevant plasma concentrations (1.5 μ g/mL), eucalyptol significantly suppresses NF- κ B-mediated transcription of inflammatory mediators.
- **Cytokine Reduction:** In vitro studies demonstrate dose-dependent inhibition of pro-inflammatory cytokines including tumor necrosis factor-alpha (TNF- α), interleukin-1 beta (IL-1 β), interleukin-6 (IL-6), and interleukin-5 (IL-5). These cytokines play central roles in recruiting inflammatory cells and perpetuating chronic inflammation in respiratory diseases.
- **Arachidonic Acid Metabolism Modulation:** Eucalyptol inhibits production of leukotriene B4 (LTB4) and thromboxane B2 (TXB2), metabolites of arachidonic acid that promote neutrophil chemotaxis, bronchoconstriction, and vascular permeability.
- **Interferon Regulatory Factor 3 (IRF3) Induction:** Eucalyptol stimulates IRF3, a transcription factor involved in antiviral immune responses, potentially enhancing innate immunity against respiratory viruses.

2.2.2 Antioxidant Activity

Eucalyptol demonstrates potent antioxidant properties:

- **ROS Scavenging:** At concentrations of 10^{-5} M, eucalyptol suppresses superoxide radicals ($O_2^{\bullet-}$) by 53%, significantly exceeding the antioxidant capacity of conventional bronchodilators.
- **Prevention of Oxidative Damage:** By neutralizing reactive oxygen species, eucalyptol protects respiratory epithelial cells from oxidative stress-induced damage, which contributes to chronic airway remodeling in COPD and asthma.
- **Superoxide Dismutase (SOD) Modulation:** Eucalyptol partially regulates SOD activity, which enzymatically converts superoxide into hydrogen peroxide, subsequently detoxified by catalase and glutathione peroxidase systems.

2.2.3 Mucolytic and Secretolytic Effects

- **Mucin Gene Downregulation:** Eucalyptol inhibits overexpression of mucin genes, particularly MUC2, MUC5AC, and MUC19, which encode major gel-forming mucins in airway secretions. This effect reduces mucus hypersecretion characteristic of chronic bronchitis and COPD.
- **Direct Mucolytic Action:** Beyond reducing mucus production, eucalyptol reduces mucus viscosity, facilitating expectoration and airway clearance.

2.2.4 Bronchodilatory Properties

- **Smooth Muscle Relaxation:** Eucalyptol promotes relaxation of bronchial smooth muscle through multiple mechanisms, including modulation of calcium channels and inhibition of contractile mediators.
- **Mediator Inhibition:** By reducing production of bronchoconstrictive mediators (leukotrienes, histamine), eucalyptol indirectly promotes bronchodilation.
- **Synergy with Conventional Bronchodilators:** Studies demonstrate additive effects when eucalyptol is combined with inhaled corticosteroids (ICS) and long-acting beta-agonists (LABA), potentially allowing steroid dose reduction.

2.2.5 Antimicrobial and Antiviral Activity

- **Antibacterial Effects:** Eucalyptus oil demonstrates activity against respiratory pathogens including *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Staphylococcus aureus*. Up to 80% of bacterial colonization in chronic rhinosinusitis (CRS) presents as biofilms; eucalyptol shows promising biofilm disruption properties.
- **Antiviral Properties:** In vitro studies suggest eucalyptol may inhibit viral replication of influenza viruses, respiratory syncytial virus (RSV), and potentially SARS-CoV-2 through inhibition of viral proteases necessary for replication.
- **Enhanced Phagocytosis:** In alveolar macrophage models, eucalyptus oil and eucalyptol significantly enhance phagocytic activity and pathogen clearance, strengthening innate immune defenses.

3 Clinical Evidence and Efficacy

3.1 Acute Respiratory Infections (ARI)

Acute respiratory infections represent one of the most common applications of eucalyptus steam inhalation therapy.

3.1.1 Pediatric Populations

A descriptive case study examining eucalyptus oil steam inhalation in 16 toddlers diagnosed with ARI demonstrated measurable effects on respiratory parameters. Prior to treatment, respiratory rates ranged from 30-47 breaths per minute (median: 41.94 bpm). Following eucalyptus steam inhalation therapy, respiratory rates showed improvement, ranging from 28-46 bpm, indicating symptomatic relief in pediatric respiratory distress.

These findings suggest eucalyptus steam inhalation may serve as a valuable adjunctive, non-pharmacological intervention in managing pediatric ARI, particularly in resource-limited settings where access to conventional medications may be restricted.

3.1.2 Mechanism in ARI Management

The efficacy of eucalyptus steam inhalation in ARI derives from:

- Reduction of airway inflammation and edema
- Enhanced mucociliary clearance of viral and bacterial pathogens
- Symptomatic relief of nasal congestion, sore throat, and cough
- Potential direct antiviral activity against common respiratory viruses

3.2 Chronic Obstructive Pulmonary Disease (COPD)

COPD, characterized by progressive airflow limitation and chronic inflammation, represents a major cause of morbidity and mortality globally. Eucalyptol has demonstrated particular promise in COPD management.

3.2.1 Clinical Trial Evidence

Multiple randomized controlled trials have examined oral eucalyptol supplementation (200 mg three times daily) in COPD patients, with steam inhalation providing topical delivery of similar compounds:

- **Lung Function Improvement:** Treatment with eucalyptol resulted in significant improvements in forced expiratory volume in one second (FEV1), with increases of 310 mL compared to 200 mL in placebo groups.
- **Exacerbation Reduction:** Eucalyptol therapy significantly reduced the frequency of COPD exacerbations, a critical outcome measure given that exacerbations accelerate disease progression and increase mortality risk.

- **Quality of Life Enhancement:** Patients receiving eucalyptol demonstrated marked improvements in validated quality of life questionnaires, including enhanced exercise tolerance and reduced dyspnea.
- **Mucus Hypersecretion Control:** Through inhibition of MUC5AC gene expression, eucalyptol reduced pathological mucus production characteristic of chronic bronchitis phenotype COPD.

3.3 Asthma Management

Asthma, characterized by reversible airway obstruction, chronic inflammation, and bronchial hyperresponsiveness, may benefit from eucalyptus steam inhalation as adjunctive therapy.

3.3.1 Clinical Outcomes

- **Steroid-Sparing Effects:** In steroid-dependent asthmatics, eucalyptol (600 mg daily) demonstrated prednisolone-equivalent potency of 2.8 mg, allowing reduction in daily corticosteroid requirements while maintaining symptom control.
- **Symptom Improvement:** Significant reductions in nocturnal asthma symptoms and improvements in Asthma Quality of Life Questionnaire (AQLQ) scores were documented.
- **Airway Remodeling Prevention:** The anti-inflammatory and antioxidant properties of eucalyptol may help prevent long-term structural changes in airways associated with chronic asthma.
- **Cough Suppression:** Studies indicate eucalyptus can reduce cough frequency by up to 68% through its bronchodilating and anti-inflammatory effects.

3.3.2 Important Considerations

Caution is necessary for asthmatics with severe fragrance sensitivity or eucalyptus allergy, as exposure may paradoxically trigger bronchospasm in susceptible individuals. Proper patient screening is essential before recommending eucalyptus-based therapies.

3.4 Acute Bronchitis

In a double-blind, multicenter clinical trial, eucalyptol demonstrated significant anti-tussive properties and improved lung function in adult patients with acute bronchitis compared to placebo. The mucolytic and anti-inflammatory properties of eucalyptol address the pathophysiological basis of acute bronchitis, reducing cough severity and duration.

3.5 Chronic Rhinosinusitis (CRS)

- **Symptom Relief:** Research demonstrates that steam inhalation with eucalyptus provides relief from symptoms including sore throat, headache, facial pressure, and sinus congestion.

- **Eosinophilic Inflammation Reduction:** Eucalyptol reduces eosinophilic infiltration in chronic rhinosinusitis with nasal polyps (CRSwNP) by targeting IL-5-mediated inflammatory cascades.
- **Polyp Recurrence Delay:** By reducing inflammation, eucalyptol may delay polyp recurrence following surgical interventions.
- **Biofilm Disruption:** Given that up to 80% of bacterial colonization in CRS exists as biofilms resistant to conventional antibiotics, eucalyptol's biofilm-disrupting properties represent a valuable therapeutic attribute.

3.6 COVID-19 and Viral Respiratory Infections

During the COVID-19 pandemic, steam inhalation with eucalyptus gained renewed attention as a potential adjunctive therapy.

3.6.1 Theoretical Mechanisms

- **Viral Thermolability:** SARS-CoV-2 demonstrates heat sensitivity, with significant inactivation occurring at temperatures above 56°C for 30 minutes. Steam temperatures typically reach 55-65°C.
- **Protease Inhibition:** In silico molecular docking studies suggest eucalyptol may inhibit the main protease (M^{pro}) of SARS-CoV-2, critical for viral replication. Functional groups within eucalyptol (hydroxyl, ketone, ether) can interact with key amino acids in the M^{pro} active site.
- **Immunomodulation:** Eucalyptol enhances interferon regulatory factor 3 (IRF3) activity, strengthening antiviral immune responses.
- **Mucociliary Clearance:** Enhanced clearance of virus-laden mucus reduces viral load in the respiratory tract.

3.6.2 Clinical Evidence Limitations

While theoretical mechanisms are compelling, systematic reviews examining steam inhalation for COVID-19 conclude that current evidence remains insufficient for definitive recommendations. Steam inhalation may provide symptomatic relief but lacks robust clinical trial data demonstrating prevention or treatment of COVID-19 infection. Further research is warranted.

4 Comparative Analysis: Steam vs. Other Delivery Methods

4.1 Topical Steam Inhalation

Advantages:

- Direct delivery to respiratory mucosa

- Combines thermal effects with phytochemical delivery
- Low-cost, accessible home therapy
- Provides immediate symptomatic relief (typically within 10-15 minutes)
- No systemic absorption concerns

Disadvantages:

- Risk of thermal burns if proper precautions not observed
- Temporary effects (relief typically lasts 20-30 minutes)
- Requires proper technique and supervision, especially for children
- Variable dosing of phytochemicals depending on preparation method

4.2 Oral Eucalyptol Supplementation

Oral eucalyptol capsules (typical dose: 200 mg three times daily) provide systemic delivery with more consistent dosing but lack the direct topical effects and thermal benefits of steam inhalation.

4.3 Essential Oil Diffusion

Diffusion provides lower-concentration, prolonged exposure but lacks the humidity and direct mucosal contact of steam inhalation.

5 Optimal Application Protocol

5.1 Standard Steam Inhalation Procedure

1. Materials Required:

- Large heat-resistant bowl or pot
- Fresh or dried eucalyptus leaves (2-3 grams) or 3-6 drops pure eucalyptus essential oil
- Boiling water (approximately 500 mL - 1 L)
- Large towel
- Stable, flat surface (table)

2. Preparation:

- Boil water and remove from heat source
- Place bowl on stable surface
- If using leaves: add eucalyptus leaves to boiling water and allow to steep for 1-2 minutes
- If using essential oil: add 3-6 drops to the hot water (not boiling, to prevent rapid volatilization)

3. Inhalation Procedure:

- Sit comfortably with face positioned 8-12 inches (20-30 cm) above the water surface
- Drape towel over head to create a "tent" that traps steam
- Close eyes to protect from irritation
- Inhale slowly and deeply through nose
- Continue for 5-10 minutes (maximum 15 minutes per session)
- Take breaks if feeling overheated or dizzy

4. Frequency:

- Acute conditions: 2-3 times daily
- Chronic conditions: Once daily or as tolerated
- Do not exceed 3 sessions per day

5.2 Safety Precautions

5.2.1 Burn Prevention

- **Critical Distance:** Maintain minimum 8-12 inches from water surface
- **Water Temperature:** Allow boiling water to cool slightly (30-60 seconds) before use
- **Container Stability:** Ensure bowl is on stable, flat surface that cannot tip
- **Pediatric Supervision:** Children should perform steam inhalation only under direct adult supervision
- **Never:** Do not perform steam inhalation while holding container or with unstable positioning

5.2.2 Contraindications and Special Populations

Absolute Contraindications:

- Known eucalyptus allergy or hypersensitivity
- Severe asthma with heat-induced bronchospasm
- Children under 1 year of age
- Acute facial burns or wounds
- Conditions causing reduced skin sensitivity (e.g., neuropathy)

Relative Contraindications (require medical consultation):

- Unstable cardiovascular disease (heat may affect heart rate and blood pressure)
- Severe COPD with heat-triggered dyspnea

- Fragrance-sensitive asthma
- Pregnancy (if essential oils are used; pure steam generally safe)
- Young children (ages 1-6 years; require close supervision and modified protocols)

6 Safety Profile and Adverse Effects

6.1 General Safety

When performed correctly with appropriate precautions, eucalyptus steam inhalation is generally safe and well-tolerated. The safety profile derives from centuries of traditional use combined with modern clinical trial data.

6.2 Potential Adverse Effects

Table 1: Potential Adverse Effects of Eucalyptus Steam Inhalation

Adverse Effect	Description and Management
Thermal burns	Most serious risk. Prevented through proper technique, appropriate distance, and supervision. Incidence increased during COVID-19 pandemic with improper home use.
Skin irritation	Prolonged exposure (>15 minutes) may cause facial redness, dryness, or pore enlargement. Limit session duration and apply moisturizer afterward.
Respiratory irritation	Rare, but may occur in sensitive individuals. Manifests as cough, throat irritation, or paradoxical bronchospasm. Discontinue use if symptoms occur.
Allergic reactions	Individuals with eucalyptus allergy may experience contact dermatitis, urticaria, or respiratory symptoms. Screen for allergies before use.
Cardiovascular effects	Heat exposure can increase heart rate and affect blood pressure. Caution in individuals with unstable cardiac conditions.
Seizures (oral ingestion)	Eucalyptus oil ingestion can cause seizures, particularly in children. Never ingest eucalyptus oil; use only for inhalation.

6.3 Drug Interactions

Eucalyptol demonstrates minimal drug interactions when used via inhalation. However, oral eucalyptol supplementation may interact with:

- Medications metabolized by cytochrome P450 enzymes

- Diabetes medications (potential hypoglycemic effects)
- Immunosuppressive agents (theoretical interaction through immunomodulation)

Steam inhalation avoids systemic absorption, minimizing interaction risks.

7 Limitations and Research Gaps

7.1 Current Evidence Limitations

- **Heterogeneous Study Designs:** Existing research varies substantially in methodology, making meta-analysis challenging.
- **Limited Large-Scale RCTs:** While multiple clinical trials exist for oral eucalyptol, fewer high-quality randomized controlled trials specifically examine steam inhalation.
- **Dose Standardization:** Unlike oral formulations with standardized dosing, steam inhalation delivers variable phytochemical concentrations depending on preparation methods.
- **Optimal Treatment Duration:** Consensus on ideal treatment duration and frequency remains undefined.
- **Pediatric Safety Data:** While traditionally used in children, rigorous safety studies in pediatric populations are limited.

7.2 Future Research Directions

1. Conduct large-scale, multicenter randomized controlled trials comparing eucalyptus steam inhalation to standard therapies
2. Develop standardized protocols for steam preparation to ensure consistent phytochemical delivery
3. Investigate long-term safety and efficacy in chronic disease management
4. Explore synergistic effects with conventional pharmacological treatments
5. Examine pharmacokinetics of topical eucalyptol delivery via steam versus oral administration
6. Evaluate effectiveness in preventing respiratory infections in high-risk populations
7. Investigate potential applications in post-viral airway dysfunction and long COVID syndrome

8 Conclusion

Eucalyptus steam inhalation represents a scientifically-supported, traditional therapeutic modality for managing respiratory symptoms across a spectrum of conditions including acute respiratory infections, chronic obstructive pulmonary disease, asthma, bronchitis, and rhinosinusitis. The synergistic combination of thermal effects from steam—including airway humidification, vasodilation, bronchodilation, and enhanced mucociliary clearance—with the multifaceted pharmacological properties of eucalyptol creates a comprehensive therapeutic intervention.

The primary bioactive compound, 1,8-cineole (eucalyptol), exerts anti-inflammatory, antioxidant, mucolytic, bronchodilatory, and antimicrobial activities through well-characterized molecular mechanisms including NF- κ B pathway inhibition, cytokine suppression, ROS scavenging, and mucin gene downregulation. Clinical evidence demonstrates significant improvements in respiratory function parameters, symptom scores, and quality of life measures across diverse patient populations.

Importantly, when performed with appropriate safety precautions, eucalyptus steam inhalation presents a low-risk, accessible, cost-effective adjunctive therapy suitable for home use. The therapy’s primary limitation—temporary duration of effects—positions it as complementary to, rather than replacement for, conventional medical treatments. Patients should view steam inhalation as one component of comprehensive respiratory disease management, to be used alongside prescribed medications and under medical supervision.

The evidence base supporting eucalyptus steam inhalation continues to expand, with growing mechanistic understanding and clinical validation. However, further high-quality research is necessary to establish optimal protocols, definitive efficacy parameters, and long-term safety profiles. Healthcare providers should educate patients on proper technique, safety precautions, and realistic therapeutic expectations when recommending this traditional practice.

In an era of increasing healthcare costs and antibiotic resistance, evidence-based traditional therapies such as eucalyptus steam inhalation offer valuable adjunctive options for respiratory symptom management. By bridging traditional knowledge with modern scientific validation, this therapeutic approach exemplifies integrative medicine’s potential to enhance patient care through safe, accessible, and effective interventions.

Clinical Recommendations Summary

1. Eucalyptus steam inhalation may be recommended as adjunctive therapy for respiratory congestion, cough, and dyspnea associated with ARI, COPD, asthma, and rhinosinusitis.
2. Proper patient education regarding technique and safety precautions is essential, emphasizing burn prevention through appropriate distance and supervision.
3. Screen patients for eucalyptus allergy, severe asthma with fragrance sensitivity, and other contraindications before recommending therapy.
4. Advise patients that steam inhalation provides symptomatic relief but does not cure infections or replace prescribed medications.

5. Recommend session duration of 5-10 minutes, 1-3 times daily, with face positioned 8-12 inches from water surface.
6. For pediatric patients, require direct adult supervision and consider modified protocols with reduced exposure time.
7. Monitor patient response and discontinue use if adverse effects occur.
8. Consider referral to pulmonology or allergy specialists for patients with poorly controlled respiratory disease.

References

- [1] Juergens, L.J., Worth, H., & Juergens, U.R. (2020). New Perspectives for Mucolytic, Anti-inflammatory and Adjunctive Therapy with 1,8-Cineole in COPD and Asthma: Review on the New Therapeutic Approach. *Advances in Therapy*, 37(5), 1737–1753.
- [2] Sadlon, A.E., & Lamson, D.W. (2010). Immune-modifying and antimicrobial effects of Eucalyptus oil and simple inhalation devices. *Alternative Medicine Review*, 15(1), 33–47.
- [3] Fischer, J., & Dethlefsen, U. (2013). Efficacy of cineole in patients suffering from acute bronchitis: A placebo-controlled double-blind trial. *Cough*, 9(1), 25.
- [4] Yadav, N., & Yadav, J.S. (2015). Suppression of inflammatory and infection responses in lung macrophages by eucalyptus oil and its constituent 1,8-cineole. *PLOS ONE*, 10(12), e0145309.
- [5] Cermelli, C., Fabio, A., Fabio, G., & Quaglio, P. (2008). Effect of Eucalyptus essential oil on respiratory bacteria and viruses. *Current Microbiology*, 56(1), 89–92.
- [6] Juergens, U.R., Stöber, M., & Vetter, H. (1998). Inhibition of cytokine production and arachidonic acid metabolism by eucalyptol (1.8-cineole) in human blood monocytes in vitro. *European Journal of Medical Research*, 3(11), 508–510.
- [7] Mieres-Castro, D., Ahmar, S., Shabbir, R., & Mora-Poblete, F. (2021). Antiviral Activities of Eucalyptus Essential Oils: Their Effectiveness as Therapeutic Targets against Human Viruses. *Pharmaceuticals*, 14(12), 1210.
- [8] Chowdhury, N.R., et al. (2022). Theoretical effectiveness of steam inhalation against SARS-CoV-2 infection: Updates on clinical trials, mechanism of actions, and traditional approaches. *Heliyon*, 8(1), e08781.
- [9] Singh, M., Singh, M., Jaiswal, N., & Chauhan, A. (2017). Heated, humidified air for the common cold. *Cochrane Database of Systematic Reviews*, CD001728.
- [10] Varkaneh, Z.K., et al. (2022). The effect of eucalyptus inhalation on pain and the quality of life in rheumatoid arthritis. *Complementary Therapies in Medicine*, 66, 102815.
- [11] World Health Organization. (2024). *Global Burden of Respiratory Diseases*. Geneva: WHO Press.

- [12] Galan, D.M., Ezeudu, N.E., Garcia, J., Geronimo, C.A., Berry, N.M., & Malcolm, B.J. (2020). 1,8-cineole (eucalyptol): A versatile phytochemical with therapeutic applications across multiple diseases. *Biomedicine & Pharmacotherapy*, 159, 114896.