

Lavender, Peppermint, Neroli, and Eucalyptus in the Modulation of Pain and Anxiety: A Critical Review of Aromatherapeutic Approaches

Andrea Siqueira Santos Borges^{1,*}¹ Lake Washington Institute of Technology and Fred Hutchinson Cancer Center.

* Correspondence: andreasiqueira_@hotmail.com

Abstract: Aromatherapy, utilizing essential oils (EOs) obtained from plant parts, is a modality investigated for managing complex symptoms like pain and anxiety. This review critically synthesizes clinical and preclinical evidence focusing on Lavender (*Lavandula angustifolia*), Peppermint (*Mentha × piperita*), Neroli (*Citrus aurantium*), and Eucalyptus (*Eucalyptus globulus*). Systematic reviews demonstrate that aromatherapy significantly reduces pain, particularly in acute settings. Meta-analyses show beneficial effects of EOs on pain intensity in Musculoskeletal Disorders (MSDs), with the most favorable outcomes observed immediately after application. Lavender is widely studied, demonstrating efficacy in alleviating surgical pain, reducing opioid requirements post-surgery, and lowering anxiety preoperatively. Neroli, often combined with Lavender, effectively decreases anxiety, heart rate, blood pressure, and pain during stressful procedures like dental anesthesia in children. Peppermint is frequently utilized, appearing in blends for migraine management and post-operative symptom control. However, efficacy, especially for chronic conditions like fibromyalgia or cancer pain, is limited by methodological heterogeneity and the predominant use of unidimensional pain scales (e.g., VAS/NRS) rather than appropriate multidimensional tools (e.g., BPI). Further high-quality Randomized Controlled Trials (RCTs) are required for standardization.

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1. Introduction

Pain is a multidimensional experience, encompassing sensory, emotional, cognitive, and behavioral elements. Chronic pain conditions, such as fibromyalgia (FM) and migraine, represent a significant health burden. Many patients with chronic disorders, including “fibromigrânea” (the co-occurrence of FM and migraine), seek complementary treatments due to the complexity and persistence of their vast symptomatology, the latency of effects, or the negative side effects of conventional pharmacological treatments like gabapentin and pregabalin [3].

Aromatherapy, defined as the therapeutic use of essential oils (EOs) derived from plant secondary metabolism, offers a promising adjunct [1]. EOs, complex mixtures of volatile lipophilic substances, are primarily composed of terpenic derivatives like monoterpenes and sesquiterpenes. These compounds exert biological activities by modulating the nervous system, potentially offering analgesic, anti-inflammatory, and anxiolytic



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effects [8]. This critical review focuses specifically on the evidence supporting the use of Lavender, Peppermint, Neroli, and Eucalyptus in modulating pain and anxiety, highlighting the quality of the current scientific literature.

2. Materials and Methods

This article synthesizes findings from existing systematic reviews, meta-analyses, and randomized controlled trials (RCTs) regarding the application of EOs for pain and anxiety modulation.

2.1. Chemical Analysis

Literature Search and Source Selection

The underlying research summarized herein generally employed searches across major electronic databases such as PubMed/MEDLINE, Scopus, and Web of Science (WOS). Search strategies typically utilized a combination of MeSH terms and Boolean operators (e.g., “Essential oils AND Neuralgia”). Many reviews adhered to reporting guidelines, such as PRISMA 2020 [5] and PRISMA-P 2015 [13]. The research questions were often structured using the PICOS framework (Participants, Interventions, Comparisons, Outcomes, and Study design).

2.2. Statistical Analysis

The methodological quality of the synthesized evidence was assessed using validated tools: the PEDro scale (6) and the Risk of Bias 2 (RoB 2) tool [7]. Studies achieving a PEDro score of 9 or 10 were rated as excellent methodological quality.

2.3. Outcome Measures

Validated instruments were used across the evaluated trials:

Pain Intensity: Visual Analogue Scale (VAS) and Numerical Rating Scale (NRS). For multidimensional assessment, the Brief Pain Inventory (BPI) is preferred for cancer-related pain.

Anxiety: State-Trait Anxiety Inventory (STAI) and psychophysiological markers (heart rate, blood pressure). For pediatric studies, scales such as Facial Image Scale (FIS) and FLACC were used [8] [9].

2.4. Effect Size Reporting

Meta-analyses typically calculated the Standardized Mean Difference (SMD) between treatment and control groups to assess effect size [8] [9]. Cohen’s recommendations define an effect size ≥ 0.8 as large. Statistical heterogeneity was evaluated using the I^2 statistic, with values $\geq 75\%$ indicating high heterogeneity.

3. Results and Discussion

3.1. General Efficacy and Pain Characteristics

Meta-analyses focusing on pain relief reported that aromatherapy significantly reduced pain in various patient groups [8]. When comparing pain types, the effect size for aromatherapy in reducing acute pain ($n=398$) was substantial compared to chronic pain ($n=106$). The beneficial effect is seen in Musculoskeletal Disorders (MSDs), being most

significant immediately after topical application (Week 0) and persisting, albeit modestly, at Week 4.

EOs achieve their biological effects primarily due to components like monoterpenoids (e.g., linalool) [1] [11]. The student's t-test was utilized. A statistical significance threshold was consistently set at $p\text{-value} < 0.05$.

Lavender (*Lavandula angustifolia*)

Lavender essential oil (LEO) is one of the most commonly studied oils for both pain and anxiety. Its efficacy is attributed to linalool and linalyl acetate [1].

Pain Modulation:

LEO has demonstrated effectiveness across several contexts:

Postoperative Pain: Inhalation of LEO in morbidly obese patients after laparoscopic surgery reduced opioid requirements [8].

Musculoskeletal Pain: Aromatherapy massage with LEO improved spinal pain ($p=0.004$), cervical ($p=0.003$), and lumbar regions ($p=0.008$) in obese women.

Headache/Migraine: A combination of LEO and Peppermint improved quality of life and reduced migraine severity [12]. LEO was also compared to acetaminophen in Nitroglycerin-induced headache, showing statistically significant improvements in pain duration and intensity [12].

3.2. Anxiety Modulation:

LEO is widely recognized for its anxiolytic effects, reducing preoperative anxiety and agitation [1] [2] [4].

Peppermint (*Mentha × piperita*)

Peppermint essential oil (PEO) and its constituent menthol are known for analgesic effects via TRPM8 activation [8] [11].

PEO appears frequently in blends for migraine management and postoperative symptom control, and is cited in oncology contexts for alleviating Chemotherapy-Induced Peripheral Neuropathy (CIPN) [11].

Neroli (*Citrus aurantium*)

Neroli oil, rich in limonene and α -phellandrene, exhibits neuroprotective and anxiolytic potential [3] [4].

In a trial involving children undergoing dental anesthesia, a Lavender–Neroli blend significantly reduced anxiety, heart rate, blood pressure, and pain compared to control ($p<0.05$) [11].

Eucalyptus (*Eucalyptus globulus*)

Eucalyptus EO, composed primarily of 1,8-cineole, has recognized anti-inflammatory and antimicrobial properties. Though evidence directly linking Eucalyptus EO to pain modulation is limited, its inclusion in aromatherapy blends (e.g., with Lemongrass) shows promise for behavioral and CNS effects [8] [11].

4 Critical Discussion

Despite encouraging findings, limitations persist:

Methodological Quality: High heterogeneity ($I^2=96\%$) and variable blinding protocols reduce internal validity [4] [8].

Assessment Tools: Over-reliance on VAS/NRS limits multidimensional understanding of pain; BPI is preferable for cancer-related or chronic pain [9].

Chronic Pain: The effect size for aromatherapy in chronic pain ($SMD = -0.22$) is notably lower than in acute pain [8].

4. Conclusion

Aromatherapy involving Lavender, Peppermint, Neroli, and Eucalyptus offers an effective and safe adjunct for managing acute pain and anxiety, particularly in perioperative or procedural settings. Lavender and Neroli demonstrate strong anxiolytic evidence; Peppermint contributes to headache and postoperative relief. However, methodological standardization and high-quality RCTs are required to validate their efficacy for chronic pain conditions and to establish optimal dosing parameters.

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