

Exploring the Antidepressant Properties of Essential Oils: A Natural Approach to Mental Well-Being

Danishta Asif¹, Surabhi Shakya², Anurag Verma³, Kamal Kishore Maheshwari⁴ and Amit Kumar Verma^{1*}

^{1,2,4}Department of Pharmacy, M.J.P. Rohilkhand University, Bareilly, 243006, Uttar Pradesh, India

³Faculty, College of Pharmacy, Teerthankar Mahaveer University, Moradabad, 244001, Uttar Pradesh, India

*Corresponding Author Mail id: researchermjpru@gmail.com

*Orcid id: 000-0003-3851-2987

Received: 16th Dec, 2025; Revised: 8th Feb 2026; Accepted: 12th Feb, 2026; Available Online: 28th Feb, 2026

ABSTRACT

Depression is a multifactorial mental health disorder characterized by persistent low mood, anhedonia, cognitive impairment, and emotional dysregulation, affecting millions of individuals worldwide. Although conventional antidepressant therapies are effective, their long-term use is often associated with adverse effects, delayed onset of action, and variable patient compliance. Consequently, there is growing interest in complementary and alternative therapeutic approaches, particularly those derived from natural sources. Essential oils (EOs), concentrated volatile extracts obtained from aromatic plants, have gained considerable attention for their potential antidepressant properties and favorable safety profiles. This article reviews the antidepressant effects of commonly used essential oils, including lavender (*Lavandula angustifolia*), rosemary (*Rosmarinus officinalis*), bergamot (*Citrus bergamia*), chamomile (*Matricaria chamomilla*), and peppermint (*Mentha piperita*). Lavender oil is widely recognized for its anxiolytic and mood-stabilizing effects, mediated through modulation of the gamma-aminobutyric acid (GABAergic) system and reduction of stress-induced cortisol levels. Bergamot oil exhibits significant mood-enhancing and anxiolytic activities, primarily through regulation of serotonergic and dopaminergic neurotransmission. Rosemary oil has been shown to improve cognitive performance, alertness, and emotional state by influencing cholinergic activity and cerebral blood flow. Chamomile oil possesses calming and antidepressant properties attributed to its flavonoids and terpenoids, which exert mild sedative and neuroprotective effects. Peppermint oil demonstrates stimulating and energizing properties, contributing to improved mood, mental clarity, and reduced fatigue. Preclinical and clinical studies suggest that these essential oils exert antidepressant effects via multiple mechanisms, including neurotransmitter modulation, hypothalamic–pituitary–adrenal (HPA) axis regulation, antioxidant activity, and anti-inflammatory pathways. Collectively, essential oils represent promising adjunctive agents in the management of depression, offering holistic benefits for emotional well-being. Further well-designed clinical trials are required to establish standardized formulations, optimal dosing, and long-term safety profiles.

Keywords: *Essential oil, Depression, Lavender oil, Chamomile oil, Rosemary oil, Mental well-being.*

How to cite this article: Asif D, Shakya S, Verma A, Maheshwari KK, Verma AK, Exploring the Antidepressant Properties of Essential Oils: A Natural Approach to Mental Well-Being. *Int J Drug Deliv Technol.* 2026;16 (5s): 561-578; DOI: 10.25258/ijddt.16.5s.74

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

In recent years, the use of essential oils (EOs) in aromatherapy has become very popular. Essential oils were revealed to have an effect on the central nervous system and intimate personal relationship. Aromatherapy may have neuropharmacological effects and interact with mood disorders indirectly through sensory nerves; olfaction is part of the limbic system (Cho & Kim, 2023). It was widely assumed that aromatic volatiles would relieve only tenacious knots of melancholy, or at most the gray little humors of daily blues. However, EOs can encompass symptoms ranging of the doldrums. Most significantly, EOs relieves anxiety and bolster up the spirit,

functioning in a like manner to nerve tonic, antidepressants (ADs), and anxiolytics. The effectiveness of EOs in treating depressive symptoms was first documented by the International Medical Society on Aromatics. In the last decade, clinical trials have evidenced that essential oils can be effective in alleviating depression symptoms (Moghadam *et al.*, 2022). Currently, the concentrations are considered very high and the presentation high. Undiluted EOs should never be put directly on the skin, causing irritation and sensitivity. Such instances would have awaked foul emotions. Now panic reigns, as touch is denied and quarantines are norm. Let EOs serve as interval descriptions. Her venture shall cover citrus, herbal, and

*Author for Correspondence: researchermjpru@gmail.com

perhaps a revision; for research stands as soothing hedge (Fung *et al.*, 2021).

A variety of EOs from different plant species may work synergic effects, thus boosting their overall mood-boosting powers. In the epidermis, touch receptors such as Merkel's disks and Meissner corpuscles that are sensitive to mechanical stimulation are abundant (Vaou *et al.*, 2022). These tactile sensory pathways begin in the periphery, send electrical signals to the central ganglia, and fuse together to form the spinal tract. The terminals of the spinal tract go to the thalamic relay nuclei then connect to the cortical cortex of the brain. Pain receptors can operate under similar pathways. There is a growing body of evidence that suggests tactile sensation is implicated in the emotional processing system. Not only is emotional modulation able to transfer through the perception of touch, it is, in a way, preferred to receive emotional comforting via touch. Emotional response based on the perception of pain stimuli is considered a multisensory phenomenon as tactile sensation may serve as a motivational tool to assay one's own emotional state (Fung *et al.*, 2021).

TRADITIONAL USES OF ESSENTIAL OILS FOR EMOTIONAL WELL-BEING

The utilization of essential oils (EOs) for therapeutic purposes in humans dates back thousands of years to ancient civilizations including china, Egypt, Greece, and India. In general, EOs are generally used in aromatherapy for massage, bathing, perfumes, relaxants, and household products providing pleasant smells. Research on herbal medicine began to develop with an emphasis on treatments that lead to relief from symptoms of physical and mental illness (Cimino *et al.*, 2021). Due to the change in lifestyle and values associated with the increase in interest in health benefits and adversities in the average lifespan, there is a movement of interest to health products that maintain lifelong health. With the increase in voice-based and personalized interest, interest in health goods that provide comfort beyond general health and functional foods continues to grow (Yaqoob *et al.*, 2024). Longevity along with health quality is no longer considered a supplementary material, and interest in maintaining a healthy emotional mood in everyday life by relying on small things has increased demand for calming and comfortable health goods in daily life. In parallel with this movement, interest in the physiological effects of scent in the field of scientific experiments continues to grow and various studies have been conducted (Agnihotry *et al.*, 2024). On the basis of ongoing research on the psychological effects of scent and the benefits on mood and behavior, a substantial effort has been made to develop business products that induce comfort and emotional pleasure through the application of scents (Soares *et al.*, 2021).

DEPRESSION AND THE NEED FOR ALTERNATIVE THERAPIES

Depression and anxiety are the most common mental health disorders and are expected to be the leading causes

of disability worldwide by 2030. There are several limitations and disadvantages with the currently available pharmacotherapy. Furthermore, as many as 70% of patients with depression do not respond appropriately to the first prescribed medication (Shah *et al.*, 2021). Thus, the search for new pharmacological treatments is very important. Consequently, essential oils and their active ingredients are being studied as potential new drugs. Despite this growing interest in their pharmacological properties, research on the safety, toxicity and efficacy of essential oils, mainly when administered to humans, is still limited. In this review article, the currently available data on the safety, toxicity, and efficacy of essential oils are summarized in order to provide a useful support to toxicologists (Cao *et al.*, 2023). The textually available scientific evidence on the safety, toxicity, and efficacy of essential oils has been obtained from animal and in vitro studies. Taken together, the available data show that there are cellular, genetic, and histological alterations in rodents after essential oils exposure, but these effects occurred generally in the dose range of 2000-5000 mg/kg and for particular oil type and are thus rarely relevant for human safety (Solmi *et al.*, 2022). Furthermore, some reports provided contradictory results. The in vitro studies show that tested essential oils usually act as protective agents. However, these studies are rare and far to being representative of the authenticity of the natural interactions happening in a whole living organism. Similarly, a considerable number of studies have reported antioxidant activity in vitro, which is also not indicative of therapeutic use in humans when administered orally (Santomauro *et al.*, 2021). Although the in vitro studies clearly show that essential oils may have therapeutic uses in humans when applied topically or used for massages, such effects are better demonstrated for well-defined mixtures of pure compounds such as linalool, geraniol, pinene, cinnamaldehyde, and borneol. On the other hand, there is some evidence showing antimicrobial and antiviral activities both in vitro and in situ. Unfortunately, there are many methodological constraints that limit the extrapolation of the in vitro data to humans (Javaid *et al.*, 2023).

CLINICAL SYMPTOMS OF DEPRESSION

Depression is a mood disorder characterized by persistent low mood, feelings of sorrow, and disinterest in activities that people normally enjoy (Zhdanava *et al.*, 2021). It is also known to affect sleeping patterns, diet, daily routine, and emotional reactions. The prevalence of depression is increasing: in 2017, 264 million people of all ages and genders were affected across the globe (Abdullatif *et al.*, 2021). The WHO has estimated that by 2030, depression will be the leading cause of healthy years lost (Nguyen *et al.*, 2024). The main therapeutic strategy in depression is the administration of pharmaceutical drugs such as selective serotonin reuptake inhibitors (SSRIs), tricyclic antidepressants, and serotonin-noradrenaline reuptake inhibitors. However, these drugs exhibit low efficacy: only 60% of patients achieve remission following treatment. Furthermore, pharmaceutical drugs also produce a variety

of unwanted side-effects that decrease patient compliance (Fung *et al.*, 2021). Thus, the development of new antidepressant treatments or preventive agents from natural sources is necessary (Wu *et al.*, 2024; Armandpishe *et al.*, 2023).

MECHANISTIC BASIS OF ESSENTIAL OILS IN DEPRESSION MANAGEMENT

Hopelessness and anhedonia are hallmarks of depression (Fung *et al.*, 2021). Inhaling orange EO leads to decreases in the immobility time in the forced swimming test and tail suspension test, and also led to a decrease of the lipid peroxidation level in the hippocampus (Agarwal *et al.*, 2022). Stimulation of sensory receptors is another important mechanism underlying the effect of EOs. Each EO has distinctive chemical compositions and odors, so have different effects on the brain through the sense of

smell (Koyama *et al.*, 2021). The olfactory bulb, amygdala, hippocampus, and other limbic systems are closely linked to the sense of smell. Inhalation of EO enhances α -wave activity, partly through GABA(A)-ergic activity. EOs can also modulate 5-HT, often referred to as the ‘hormone of happiness’. The inhalation of lavender EO and sweet orange EO increases the expression of tryptophan hydroxylase-2 (TrpH-2) in dorsal raphe serotonergic neurons; the up regulation of TrpH-2 exacerbated the release of 5-HT in the synaptic cleft. This in turn had an anti-anhedonic action. WD-application of compound anshen EO as well as EO from *Asarum heterotropoides* exerted anti-anhedonic effects. There are increased 5-HT-immunoreactive neurons in the dorsal raphe nucleus of the compound anshen EO or *Asarum heterotropoides* inhalation group (Derbyshire, 2025) (Fig 1).

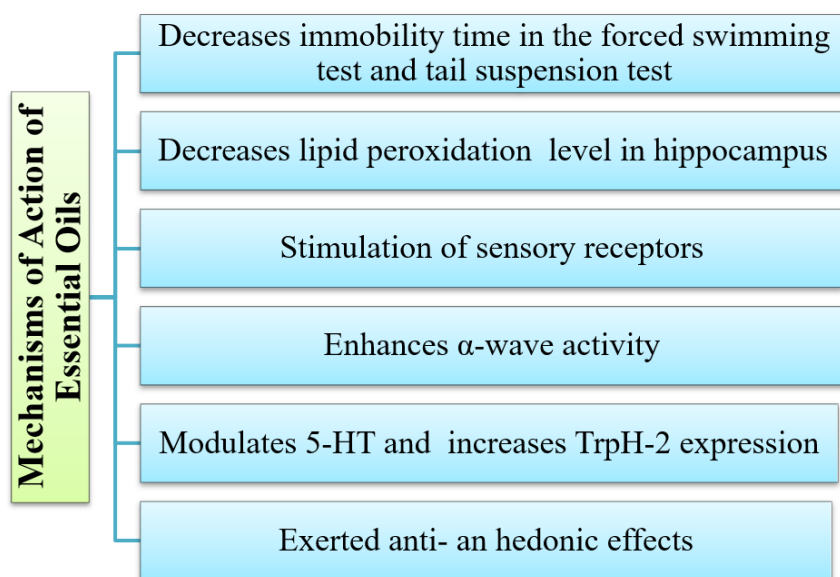


Fig 1: Mechanisms of Action of Essential Oils

LAVENDER OIL:

In recent years, much attention has been paid to the effect and mechanism of essential oils, a natural product from aromatic plants, on mood disorders such as anxiety and depression (Cui *et al.*, 2022). Therefore, it is important which effective method can be used to treat anxiety and depression. Inhaling essential oils could be an effective complementary and alternative treatment for anxiety and depression. Some researchers believe that inhaled essential oils could regulate the autonomic nervous system. Researchers are also interested in the application of inhaled aromas to treat depression and anxiety (Fung *et al.*, 2021). Aromatherapy has been used as complementary or alternative therapy for improving depression. Essential oils of lavender, rose, orange, Roman chamomile, and frankincense have been studied as agents to reduce depression. The most effective agent that reduces the depression level is lavender essential oil. Aromatherapy with these agents has been shown to improve symptoms of depression, anxiety, and stress (Jafari-Koulaee *et al.*, 2020). Aromatherapy is the most popular home health care

method for treating mental illness. The hippocampus is the part of the brain most involved in emotions and has been shown to have a close connection with olfaction. Inhaling essential oils can activate odor-sensitive receptors in limbic system cells, such as piriform lobes, amygdaloid nuclei, and entorhinal cortices, thereby improving mood states and emotions. Moreover, limbic system receptors are closely linked to mono-aminergic signaling pathways, which are involved in the pathophysiology of mood related disorders such as depression and bipolar disorder (Hedigan *et al.*, 2023). Therefore, aroma inhalation can affect emotional disorders and other diseases. Among the essential oils used in aromatherapy, lavender EO (*Lavandula angustifolia*) is one of the least toxic EOs. Enjoyable lavender essential oil has an antidepressant effect (Luan *et al.*, 2023). Antidepressant aromatherapy has been used increasingly more as part of complementary and alternative medical care for mood disorders. Many patients have difficulty tolerating the side effects of conventional pharmacotherapy. For these patients, aromatherapy can serve as an alternative for improving

mental health. The aim of this study was a systematic review of the effects of aromatherapy with lavender essential oil in treating patients with depression (Tan *et al.*, 2023).

Clinical and Preclinical Evidence of Lavender's Antidepressant Activity

Upon trial, linalool significantly potentiated the animal models' antidepressant-like effects of *Citrus aurantium* EO and similar effects from *Lavender angustifolia* EO were not found. Of the 150 hadrosidioids, hesperidin presents in all Citrus species (Al-Harrasi *et al.*, 2022). Post hoc analyses of different doses of hesperidin revealed an inverted-U dose response curve in animal models for the EE's antidepressant-like effect. Contradictorily, in 1995, Dobetsberger and Buchbauer found that, rather than inducing retention and/or aggressive feelings, the EO of orange *Citrus sinensis* fruits decreased by a significant amount the level of aggression in an animal model regarding territoriality. Study results support the significant suppressor effect elicited by the interaction of hesperidin with 1,8-cineole on depressive symptoms produced by citrus oil exposure (Xia *et al.*, 2024). Due to its lower affinity for the main pharmacological targets in the CNS, hesperidin does not potentiate linalool anxiolytic and antidepressant responses. Execution of more clinical trials is especially recommended to boost research impact within the psychological and psychiatric settings (Ferber *et al.*, 2020). Currently, there is a growing scientific interest in exploring the pharmacological, cognitive, and emotional effects of essential oils (EOs) via modulation of the opioid system in the brain. Comparison of day 3 and day 10 after the unpredictable chronic mild stress to rats after fentanyl with selective antagonists revealed significant differences in the potential opioid involvement in the depressive symptoms (Eddin *et al.*, 2021). The μ -opioid receptor blockade prevented the effect of the Fe or R-hesperidin + 1,8-cineole on the anhedonia-like effect. The D1/D2-like receptor recruitment was revealed by the L-741,741 inhibition of the EE's activity and by a +80% increase in [(3)H]-DAMGO binding in relevant forebrain areas (Jafari-Koulaee *et al.*, 2020).

BERGAMOT OIL:

Bergamot EO is produced from the peel of *C. bergamia*. According to traditional medicine, bergamot EO can uplift mood, alleviate symptoms of depression, and reduce stress. Currently, as people have begun to show concern about mental health, research on the effects of bergamot EO on depression has become a trend. Bergamot EO was reported to have stress-reducing effects, which was relevant to previous studies showing that it decreased pulse rate, blood pressure, and serum cortisol levels. Inhalation of bergamot EO contributed to improving positive feelings and physiological indexes related to the autonomic nervous system. Conversely, a significant increase was found in the parasympathetic INDEX and high frequency/wavelength, which was likely to be associated with relaxation (Al-Harrasi *et al.*, 2022). There were also decreasing trends in the other sympathetic

INDEXES and low frequency/wavelength, which had been reported to be anti-depressive. Concerning stress, while the inhalation of lavender EO might attenuate the stress response induced by thunderstorm noise, bergamot EO was shown to reduce blood pressure and heart rate in a stressful mental arithmetic task. In addition, it also had stress-reducing effects as analyzed by rose-colored autonomic nervous system indexes. There were also previous studies showing that inhalation of bergamot EO at 10 min decreased the heart rate of patients severely affected with schizophrenia. Considering the present study and these previous findings, it could be claimed that bergamot EO has the potential to alleviate symptoms of depression, secondary depressive symptoms, and stress (Fung *et al.*, 2021). On the other hand, it was also found that consumption of bergamot juice improved anxiety and depression levels in postmenopausal women. Therefore, it was postulated that antidepressant effects could occur following oral administration of bergamot EO. Originally, it could act on the olfactory receptors located in the nose in inducing potent natural sedative effects. It might modulate the ANS and, subsequently, the psychological and physiological health. Furthermore, a vast amount of molecules of bergamot EO are absorbed by the olfactory system, as well as by the olfactory-olfactory renovo-cerebral pathway, which interacts with the limbic system consisting of the hippocampus, amygdala, and hypothalamus (Gusmão, 2024). Newfoundland pig inhalation of melissa EO exhibited ameliorative effects on positive human interactions, as well as skewed the sociality and emotionality of the animals. In addition, lemon and basil EOs provided an improvement in mood. The pleasant scent could result in positive feelings and mitigate depressive symptoms. Considering the present study and previous results, inhalation of bergamot EO could provide relaxation and calmness, elevate the mood, and improve depressive conditions. Therefore, similar to the anxiolytic and antidepressant effects of the EOs, bergamot EO could also have the potential to alleviate mild symptoms of patients diagnosed with the most prevalent affection worldwide (Daniel & Zolnikov, 2023).

Mood-Modulating Effects of Bergamot Oil

The emotions are easily affected by smellings, therefore a type of therapeutics called 'aromatherapy' is getting attention as a psychological treatment. Essential oil is typically used in the aromatherapy (Chen *et al.*, 2023). The essential oil is a concentrated hydrophobic liquid that contains volatile aroma compounds from plants, and it is usually extracted from the flowers, leaves, stems, bark, roots, or other elements from plants. Olfactory receptor neurons detect the odors and deliver them to the olfactory bulbs, hence the odors have an impact on the brain (Pierson *et al.*, 2021). The odor-mood regulation pathway is expected to occur by multipath mechanism, one of which mechanism involves synapses between the olfactory bulbs and the amygdala (Fung *et al.*, 2021). Mood is managed by regulating stress, anxiety, and depression. The depression is caused by serial stress mechanism. The essential oils play a significant role to remedy the

depression, since it can interrupt and revert mood regulating pathway (Fung *et al.*, 2021). Because the odor-mood regulation pathway includes various compounds and mechanisms, a broad band of effects can be expected by various types of the essential oil. Actually, each type of essential oil has own function; lavender is well-known as an agent for relaxation and sleep enhancement, yuzu has a potential for reduction of anxiety and for relaxation, and pine is beneficial for recovery from high-strung nerves (Qneibi *et al.*, 2024).

Bergamot is a type of fruit the size of the lemon, orange, or mandarin orange but takes on a distinctive pear shape (Bozova *et al.*, 2024). Bergamot is classified as a bitter orange. It is popular to leave bergamot fruit at a certain time after it is harvested to obtain the rind with aromatic properties (Kim *et al.*, 2022). Due to the special aroma, the bergamot oil is used as a major ingredient for a wide range of perfumery and toiletry products. The broad band of bergamot oil's properties is well known, such as antimicrobial activity, reduction of heart rate, stimulation and refreshment (Chang *et al.*, 2024).

CHAMOMILE OIL:

An aroma therapeutic approach to managing depression focuses on exerting the soothing effects of fragrances on the individual via inhalation. This strategy is a popular traditional remedy used in many societies (Alven *et al.*, 2022). Recently, major established drugstore chains have begun to promote essential oils for relaxation and mood improvements in addition to stress relief. Fragrance inhalation activates the nose-brain pathway that transmits stimulatory and suppressive signals between the olfactory system and the central nervous system, locally to adjust behavioral effects to emotional status, perceptions, alertness, hunger, and memory (Zhang *et al.*, 2024).

Popular anxiolytic oils include those of *Anthemis nobilis* (chamomile), *Salvia sclarea* (clary), *Rosmarinus officinalis* (rosemary), *Lavandula angustifolia* (lavender), and *Rosa damascena* (rose) (Xia *et al.*, 2024). In the United States, chamomile is best known as an ingredient in herbal tea preparations that are widely distributed, advertised, and used to improve mood and relax. A double-blind, placebo-controlled clinical trial was carried out on chamomile extract, which confirmed the traditional use of the plant as an ethno-medicine, with the treatment group displaying more significant relief in depressive symptoms compared to the placebo group, implying the antidepressant properties of chamomile (Liang *et al.*, 2021). Chamomile essential oils (EOs) have not been previously reported to possess strong anti-depressive properties. Rats are frequently used as models of human behavior, stressing their survival instincts, and the rat forced swim test is commonly used to evaluate an animal's capacity for coping with changes in the environmental situation, diagnosed as depression-like symptoms. Depressant rats move more feebly than non-depressing rats. Prior to the forced swim test, the animals were inhaling the EO and carrying out on the test day to assess the depressive defense of the treated letters (Wang & Heinbockel, 2018).

Chamomile's Calming and Antidepressant Effects

According to a Greek myth, Chamomile springs from the earth goddess Demeter and has been celebrated for its calming properties. Roman warriors going into battle consumed Chamomile for courage and also for good luck. Chamomile remains famous for its characteristic apple-like scent. Its "deep azure" is reminiscent of the sea shades portrayed by Vincent van Gogh. It has been described as "a way of the sun" due to its intolerance to shade. The Aztecs learned from the Spaniards the usefulness of Chamomile in treating depression, and the herb was given as tribute. The "botanical" journal mentions Chamomile as "having an agreeable scent", and the "medicinal" journal states it as "good for nothing: no food, no medicines," with garlands made of Chamomile hung in the houses to ward off diseases and enchantments (Sah *et al.*, 2022).

The U.S. National Library of Medicine refers to Chamomile tea as a stimulant and a warm and calm drink. Hanover's "Little Book for Village Doctors" in 1595 suggests the use of Chamomile for heats, freckles, "a young fat sow burnt, "smallage leaves, and dust incense". In 1778, the Montpellier May 12 issue mentions Chamomile tea for treatment of hypochondriac and melancholy diseases. The word depression is a Latin word for deprimere, meaning "to press down". Chamomile extracts have potential antidepressant activity and play a role in ameliorating the symptoms of depression. Chamomile might exert its CNS activity by modulating central neurotransmitter systems.

ROSEMARY OIL:

The body and mind are inextricably linked in ways that we are only beginning to understand. Sleep deprivation affects mental stability; feelings of stress can manifest as physical pain (Cassioli & Baldari, 2022).

It is natural that other aspects of cognition and mood would be linked as well. Unlike some other relationships between body and mind, those benefits too often go only one way. This means that brightness, mental clarity, and healthy cognition are prized – but emotions are treated as something separate, and are often left by the wayside. If a drug fixes one, the other must be handled by shouting at it to pull itself together (Sayorwan *et al.*, 2012). However, both facets of a healthy brain are linked, and numerous enzymatic and paracrine links regulated the lymphatic, cardiovascular, and nervous systems (Curreli *et al.*, 2021).

This is the new chemical messengers of emotions: the neural links that allow mood to take on cognition. Lymphocytes, the white blood cells that make up the body's adaptive immune response, were long thought to be completely autonomous entities (Semenzato *et al.*, 2024). More recent understanding has modified that view, and it is known that one of the secrets to the human body's complexity of causal and feedback loops is the system of lymphatic circulation and drainage through the lymphatic tissues that transport fluid and signaling proteins through the body, and that contain a substantial proportion of the body's antioxidant enzymes (Swiatczak, 2021).

Neuropsychological Effects of Rosemary Oil

Rosemary, obtained from the leaves of *Rosmarinus officinalis*, has a fresh, sweet, and slightly medicinal aroma. Of interest is the oil's ability to increase mental clarity or improve attention (Fonseca *et al.*, 2023). An item-level analysis of post-exposure clarity ratings disclosed a 1,8-cineole dose-dependent increase in the number of mental clarity-related positive affect adjectives that were endorsed. This outcome accords with a medicinal list from the European Middle Ages, which recommended the "heating" fruit (i.e., seed or nut) of rosemary oil to enhance mental acuity (Niu *et al.*, 2025). The Carolus Clusius *Florum*, an influential 17th century herbalist, concurred that the "heating" fruit of *R. officinalis* increases mental clarity or vigilance. Lastly, an 18th-century British herbarium associated the "hot" seeds of *R. officinalis* with the capacity to reinforce cerebral functions. Collectively, these ratings and historical recipes suggest that rosemary oil has the potential to enhance mental clarity (Oresanya & Orhan, 2024). The question is whether a pleasant-smelling rosemary inhalation is also effective against depressive symptoms. In a forced swim test of immobility, rats exposed to a masked aversive rosemary oil odor displayed significantly less immobility than rats exposed to clove oil or nonodorous oil; this outcome was interpreted as indicative of an antidepressant-like activity. The analysis of Single-Frame Measure readings during the forced swim test revealed that rosemary oil-exposed rats exhibited a pronounced shift toward a "flight" arousal mode. This was evidenced by a higher frequency of ANS state-transitions from "parasympathetic-LOW" to "parasympathetic-HIGH" and from "parasympathetic-LOW" to "desynchronized-HIGH" arousal states. Thus, the onset of active escape attempts in rosemary oil-exposed rats is invariably preceded by a marked phasic arousing gradient. By contrast, significant reductions in automatic arousal precede the passive floating state in both clove and non-odorous oil-exposed animals. In the "flight/locomotion" subprotocol, rats exposed to the masked aversive rosemary oil again displayed significantly less immobility than the clove/nondisclosed vehicle group (Dahchour, 2022). Evidently, the mismatch between hedonic appraisal and the inherent aversiveness of unmasked rosemary odor has not prevented the manifestation of an active coping mode in a subpopulation of animals. Taken together, the results suggest that (a) 1,8-cineole rich rosemary oil improves the execution of long-term cognitive tasks and aids in mental arithmetic performance in the cognitive and mood assessment battery test but elicits a robust alerting response in the healthy young adults tested here; (b) prior rosemary scent exposure also encourages a "parasympathetic-LOW to desynchronized-HIGH" and "parasympathetic-LOW to parasympathetic-HIGH" switch, thereby facilitating the establishment of active alert coping strategies under aversive conditions similarly to the broad-spectrum TCAs. Contrary to clove, rosemary oil odor conveys an aversive tag to humans and mobile rats (Ekeanyanwu *et al.*, 2021).

YLANG-YLANG OIL:

There are controversies surrounding the use of ylang-ylang essential oil for mood disorders (Tripathi *et al.*, 2023). This study aimed to explore the therapeutic effect of ylang-ylang essential oil underlying the interaction between the olfactory and emotion neural networks, as well as the relationship between these interactions and respiration (Fung *et al.*, 2021). Results suggest that ylang-ylang essential oil can reduce depressive mood, and that the olfactory system plays an essential role in the induction of mood changes by ylang-ylang essential oil (Gusmão, 2024). Furthermore, the mood-modulating effect of ylang-ylang essential oil is associated with a reversal of inhibition in the cessation of breathing during inhalation (Vandresen *et al.*, 2024). Controlled respiration at a rate of 0.1–0.2 Hz may enhance the anti-depressive effect of ylang-ylang essential oil (Fung *et al.*, 2021; Borgonetti *et al.*, 2022).

Depression is a disease that requires treatment, and it affects people of all ages (Cui *et al.*, 2022). Depression is the leading cause of disability worldwide, and the rate of increase in cases due to the current global crisis is utterly unexpected. Among various therapeutic approaches, the concept of "holistic healing" is gaining attention, with the harmony of mind, body, spirit, and the outside world representing the core of healing. In this context, the use of essential oils is rapidly becoming an essential element valued for their mood-improving effects (Alvarado-García *et al.*, 2022). Essential oils can be inhaled, ingested, or absorbed through the skin, with odour inhalation being the most convenient method. Several studies have reported that the inhalation of essential oils has anxiolytic, sedative, and anti-depressive effects (Wang *et al.*, 2022). In addition to basic scientific research, many hospitals around the world also actively use essential oil aroma therapy in patients, and research results have demonstrated the effectiveness of this approach to relieve anxiety before surgery, depression symptoms in patients, and stress in their operating room staff (Liang *et al.*, 2021).

FRANKINCENSE OIL:

Frankincense essential oil (FEO) has the potential to promote relaxation and emotional healing. This fragrant and relaxing EO is a very successful treatment for anxiety and anxiety disorders (Wang & Heinbockel, 2018). FEO may cause the promotion of emotional healing, mood regulation, and stress relief by activating the olfactory sensory system and brain network responsible for the regulation of emotions and behavior. The beneficial effects of the antiepileptic, anxiolytic, and anti-depressive properties of FEO on neurotransmitters, hormones, and neural activities have been demonstrated by the modulation of the GABA and DA systems, an increase in the rise in cortisol levels in serum and vasomotor skin activities, and a decrease in the blood oxygenation level-dependent (BOLD) signal responses in different functional magnetic resonance imaging (fMRI) brain regions (Fung *et al.*, 2021).

Popular FEO includes “*Boswellia carterii*, *B. frereana*, and *B. serrata*.” Blending, and distillation are the 2 most vital FEO extraction techniques. The BOLD signal results showed that mood centers including “frontal cortex,” “cingulate cortex,” “amygdala,” “insula,” “thalamus,” “hippocampus,” “hypothalamus,” and “accumbens” are significantly and directly implicated in the impact of FEO on mood and relaxation. The impact of FEO fragrance stimuli on neuronal activities might cause baroreflex stimulation and neural activities similar to slow and regular respiration. The FEO fragrant scent has potential to reduce hypothalamic stress activity measured by the serum level of cortisol, vasomotor skin activities, and emotional behaviors of BCI and ANX. The results also suggest that the mood improvement and baroreflex-like neuronal activities induction of FEO may be related to fragrance inhalation stimulation to the olfactory bulb (OB) and subsequent central processing in the expanded limbic-prefrontal-periaqueductal pathway. Finally, FEO may also promote mood and relaxation through the potential emotional healing actions of the promotion of the release of mood stabilization hormones and treatment of emotional behavior disorders.

Frankincense in Emotional and Spiritual Well-Being

The *Boswellia carteri* or frankincense tree grows throughout Oman, Yemen, Ethiopia, and Somalia, and it is the source of one of the oldest and the most precious essential oils (Mensing, 2023). From the sap of the tree, frankincense oil is steam distilled or CO₂ extracted. Frankincense oil is known to have a calming effect on the mind and mood, and these uses are often associated with spiritual and emotional well-being (Cohen, 2021). Depression is a mood disorder characterized by a loss of interest or pleasure, low energy, a feeling of guilt or low self-worth, disturbed sleep or appetite, and poor concentration. In severe cases, it can lead to suicide. Frankincense oil can be used aromatically, applied topically, and ingested as a dietary supplement. The fragrance of frankincense was known to have been associated with biologically active compounds affecting areas of the brain. From the analysis of *Boswellia* plant resins, alpha-pinene was shown to be one of the major components. The compositions and amount of essential oils vary widely depending on the time of collection, and whether the plant material is fresh or dried, among other factors (Lizarraga-Valderrama, 2021).

A widely used method to measure depression is the Tail Suspension Test in rat models, which is based on the principle that a rodent put in a stressful situation will become immobile. The time spent immobile will indicate the level of despair. Thus, compounds with antidepressant activity should decrease the immobility time. (4-*o*-methyl) honokiol is an essential oil derived from *Magnolia*. For recently published research, identical methods were used measuring the same time parameter investigating the effects of the same essential oil on rat models (Cui *et al.*, 2022).

GERANIUM OIL:

Aromatherapy has been used for thousands of years as a mind and body management tool. Inhalation of floral essential oil and woodworking smells has been shown to improve mood states such as “joy,” “comfortable,” and “happy”—as well as the intraocular color sensitivity and parasympathetic nervous activity—for healthy young subjects (Aćimović, 2021). Anxiety and depression likely have etiological commonality, and the analogous symptoms of a hypersensitive scale to be a biological dysfunction affecting anxiety lead to heightened tension (Choi *et al.*, 2022).

Our prior research has demonstrated the effectiveness of essential oils in alleviating depression, anxiety, and stress symptoms in adults (Kim *et al.*, 2023). Additionally, previous work has indicated that the inhalation of lavender and chamomile essential oils helped alleviate the symptoms of depression, anxiety, and stress among the elderly (Prosche & Stappen, 2024). Essential oils show promise in terms of the ability to ameliorate symptoms of depression and secondary depressive symptoms related to various chronic conditions like anxiety disorders. Animal experiments have also proven the therapeutic effects of essential oils (Qneibi *et al.*, 2024). For example, after inhaling lavender essential oil, both locomotor activity and open arm timing were shown to increase, suggesting anxiolytic potentiation by lavender essential oil; in addition, the decrease of immobility suggested an antidepressant effect made by lavender essential oil (Chavda *et al.*, 2025). The anti-anxiety effects of essential oils have been discovered to be associated with an increase in the level of serotonin or dopamine, while an increase in the level of brain-derived neurotrophic factor expression was correlated with an antidepressant effect. Would amount (0.1, 0.2, and 0.5 mg per rat) have differing results after scopolamine treatment in a passive avoidance test with ICR rats (Liang *et al.*, 2021).

Geranium in Health Management

The essential oil obtained from *Pelargonium graveolens* was extracted via hydro-distillation in a Clevenger-type apparatus (Xie *et al.*, 2021). The antifungal properties of geranium oil were evaluated with different concentrations. The essential oil of geranium inhibits the growth of *Rhizoctonia solani*, a notorious pathogenic fungus causing various crop diseases (Raouf *et al.*, 2022). This suggests that the hydrophobic compounds are responsible for the antifungal properties of geranium. Geranium essential oil was screened for its antifungal properties. After 6 days, it was observed that the essential oil harvested from *P. graveolens* displayed remarkable antifungal properties against *Rhizoctonia solani* (Imara *et al.*, 2024). The potential of geranium oil as an insect repellent and larvicidal agent was investigated (Rozhkova *et al.*, 2021).

The biological activities like antibacterial, antifungal, antioxidant and α -glucosidase inhibitory activities were tested (Imara *et al.*, 2024). In vitro biological activities demonstrate the potent bioactivities of the basil, geranium and mint oil, and the likely bioactive compounds that

contribute to these bioactivities. The treatment groups were compared to the six standards and the control group. Geranium oil has potent anti-microbial activities against a wide variety of pathogenic bacteria. Preliminary screening identified numerous Gram-negative and Gram-positive bacteria that were sensitive to the essential oils. Disc diffusion assay was performed for the extracts against different strains (Wafa *et al.*, 2023). Out of the different oils, geranium EO displayed significant anti-inflammatory properties. The antioxidant properties of the oils were then evaluated using DPPH radical scavenging assay, where basil and geranium at all concentrations exhibited potent antioxidant properties. Geranium EO treated group was successful in reducing the yellow DDPH radicals in a dose-dependent manner. This study seems to support the use of essential oils as potential alternatives to conventional treatment (Georgiev *et al.*, 2022).

CITRUS OILS (LEMON, ORANGE, GRAPEFRUIT): ENERGIZING AND UPLIFTING EFFECTS

Citrus oils such as lemon, orange and grapefruit are considered “staples” of the essential oil industry. They are well known for their cleansing, anti-bacterial, and environmental detoxification properties. Mood-wise, citrus oils are well-known for their energizing and uplifting effects. In one clinical trial, a blend of lavender oil, bergamot oil, and frankincense oil was diffused for 2 hours. The degree of mental health and concentration, depression, anxiety, and stress was tested before the aroma exposure and repeated 7 days later. Exposure to the blend of lavender, bergamot, and frankincense improved mental health and concentration after a 7-day interval (Fung *et al.*, 2021). Orange oils also have been demonstrated in numerous clinical reports to have a significant anti-anxiety effect, and in some cases, they are thought to have an anti-depressant effect. In an animal study, the inhalation of the Japanese citrus fruit Yuzu essential oil reduced the levels of dopamine and noradrenaline. Dysfunction of the monoamine system, including the serotonergic, noradrenergic, and dopaminergic systems, has been suggested in the etiology of mood disorders. Several lines of evidence have suggested that the EOs could exert antidepressant effects via their interaction with the monoamine systems. In a mouse study, cerebral levels of serotonin, noradrenaline, and dopamine were all found to be enhanced following the inhalation of Citrus lemon oil, suggesting activation of monoamine release. In another mouse study, components of *Citrus aurantium* essential oil all significantly increased both monoamine and glutamate levels in the olfactory bulb. After being dosed with *Citrus aurantium* oil, the serotonergic artificial fiber-induced response was blocked, suggesting modulation of monoamine transmission.

Citrus Oils and their Refreshing Effects

Feelings of sadness, fatigue, and lethargy often affect individuals when they are fatigued both mentally and physically (Liang *et al.*, 2021). At such times, the refreshing properties of citrus oils can be of immense help. They clear up feelings of sadness and bring a sense of

release by easing anxiety. Well-known oils for this purpose include bergamot, grapefruit, lemon, lime, and orange. Specific examples of citrus oils that can deliver relief from weariness and inspire hope are petitgrain and neroli (Kaur *et al.*, 2024). Citrus oils should be diluted, since they are photo-sensitive and can cause some people to itch or develop red rashes if they are used undiluted during the daytime and expose the skin to sunlight or indoor ultraviolet light for an extended period; this is especially a problem with sweet orange and bergamot oils. Recently, the antidepressant activity of citrus EOs obtained from *Citrus aurantium* amara, *Citrus jambhiri*, and *Citrus sinensis* was again investigated. Mainly due to the fragrance of the oils, they were found to have anxiolytic-like and antidepressant activities. This view is supported by the observed behavioral changes following treatments, as well as by pharmacological evidence with regard to the mechanism of action of the EOs. In addition, there is suggestive evidence of the involvement of 5-HT1A receptors in the modulation of the observed effects (Costa *et al.*, 2013). It is believed that the resulting knowledge on pharmacological properties of pharmaceuticals or health-care products aimed at treating mood disturbances may be expanded following this and other studies, and that the utilization of EO with anxiolytic or antidepressant activity is a simpler and, for many practitioners, more traditional method (Fonseca *et al.*, 2023). The historical use of fragrance and aromatherapy in the modulation of mood and mental state can be reinterpreted on a scientific basis, to clearly demonstrate the efficacy of plant products (Dutta *et al.*, 2025).

PEPPERMINT OIL

It is well known that odors have the power to trigger emotions and inspire mental clarity. They can effectively induce stimulation, relaxation, and mood enhancement. The fragrance bottle industry has apparently spread a new term called "mood enhancing perfumes." Essential oils can be seen as the most natural experimental condition to investigate the mood and mental effects of odor (Fung *et al.*, 2021). Hence, this group could be seen as a rich source of EO and could make a relevant comparison. Nevertheless, other edible species include an extensive number of species and many of them are also rich sources of EO. Peppermint EO with high levels of menthol and menthone showed some promising preliminary results, since this essential oil is traditionally believed to act against mental fatigue, to enhance psychophysical performance, and to increase attention and memory (Kim and Song, 2022). This essential oil is traditionally believed to boost mood and mental clarity. On the other hand, peppermint EOs with high levels of menthol and menthone appear to improve mood and enhance memory formation and attention. Working memory speed was also found to be increased by this effect. Despite the cognitive facilitatory effect, it did not produce the "wired" effect that otherwise occurs following caffeine intake, modafinil, or other stimulant drugs. Conversely, a slight amelioration in performance errors was registered (Kennedy *et al.*, 2018). Essential oils (EOs) are defined as hydrophobic liquids

containing odors that are volatile at room temperature. Experimental research findings have supported the advantageous therapeutic effect of inhaled EOs. A study examined the therapeutic effect of EO inhalation in 34 adults and 34 rats (Lizarraga-Valderrama, 2021).

Their results indicated that, following EO inhalation, levels of brain monoamines increased, while respiratory rates fell. Anxiolytic, sedative, and antidepressant influences were observed in these animals. Meanwhile, the maturation of stabilizing blood pressure was noted in the adult group. These results suggested that the suppression of the activity of the autonomic nervous system as well as an interaction between the nervous and respiratory systems were associated with the therapeutic mechanism of Eos (Cui *et al.*, 2022).

Mood-Enhancing Potential of Peppermint

The energizing, refreshing, and stimulating effect of peppermint is an uncommon recent mention in the treatment of depression. Peppermint has been used for medicinal purposes since ancient times and is traditionally known for its benefits in treating indigestion and irritable bowel syndrome, reducing pain, and improving memory (Fung *et al.*, 2021). Depression has been associated with gut permeability, and probiotics are useful in treating the disorder. Ginger and Siberian ginseng are psycho stimulants and have antidepressant effects, while ginseng also improves cognitive function. Transparent blue ginseng and *P. ginseng* exert antidepressant effects in animals (Kazemi *et al.*, 2023). Ginseng also exhibits positive effects on cognitive function, which is generally impaired in patients with depression. Eleutherosides and ginsenosides are the active compounds of *Siberian ginseng* and *P. ginseng*, respectively. In addition, significant improvements in the attention, speed, processing accuracy, and memory functions were demonstrated in a dose- and time-dependent manner (Zhao, 2022). Palpitation was the most common adverse event, which was usually transient and did not cause discomfort. Another pair of interconnected organs in traditional Chinese medicine theory is the lung and colon. The relationship between qi and respiration is not only an ancient Chinese healing principle but is also widely recognized in psychology and psychophysiology. The energizing and refreshing quality of an aroma is considered to be related to the lung. Since ancient times in the West, peppermint has been used for stimulating mind and memory. In medical aromatherapy, peppermint oil is recommended to reduce fatigue and stress and to improve concentration by the inhalation of vapors from the oil. Suppression of the adaptive increase in internal body temperature from rotational stress using peppermint oil probably promotes a more efficient performance. According to one study in humans and another in animals, Siberian ginseng and ginger essential oils used by inhalation exert clear stimulating effects on respiration (Mughal, 2022).

PATCHOULI OIL:

Patchouli (*Pogostemon cablin*; Blan.) essential oil (PEO), one of the most widely used essential oils, is valued for its

characteristic fragrance and therapeutic properties. Due to its unique herbaceous smell, Patchouli is commonly used in incenses, perfumes, and aroma-therapeutic products (Ouyang *et al.*, 2024). In traditional Chinese medicine, it is used to relieve cold, stomachache, headache, and fever, as well as to reduce saline soils, mosquitoes, inflammation, and pain. Patchouli is also traditionally burnt for protection against negative energies, to attract wealth, and for grounding. Among the essential oils, PEO shows the strongest antimicrobial activities, physical and magical characteristics. Approximately, 140 volatile compounds are found in PEO, with most of them belonging to sesquiterpenoids and oxygenated sesquiterpenoids. Emotionally and energetically, patchouli is grounding and calming. The rich, spicy, earthy, and herbal aroma of PEO imparts a sense of security and grounding, and its fragrance is considered to be a shield against emotional uncertainty. A past study of the aphrodisiac sedative effects of patchouli concludes that emotional stability may be revised by PEO (Fung *et al.*, 2021). Meditation with PEO helps improve emotional stability, enhances the attentiveness to the present moment, and deepens the level of consciousness, which in turn reduces the occurrence of emotional problems.

Patchouli in Anxiety and Emotional Balance

Patchouli, known by its scientific name as *Pogostemon cablin*, is a perennial herb indigenous to Malaysia, India, China, and some South East Asian countries. Fully grown, the plant can reach 3 feet in height (Koriam *et al.*, 2021). The essential oil is procured from the leaves of the plant via steam distillation. Prominent in the marketplace for its fixative capacity in the perfume industry, the product has come into increased use because of a range of health benefits. The oil demonstrates both anti-inflammatory and antidepressant properties, as well as inspiring muscular action and serving as a neuro-protectant. Oils from patchouli have proved in various studies to have a mitigating influence on pro-inflammatory substances such as cytokines like malondialdehyde, nitric oxide and TNF- α . Furthermore, various trials have also shown the capacity of patchouli oil to withstand oxidative stress of a neurotoxic kind by suppressing, respectively, elevated ROS, nitric oxide, and glutathione levels in brain tissue (Dahhour, 2022). Because of its anti-inflammatory and antioxidant actions, the product has therapeutic potential as a neuroprotectant against free radicals, malonaldehyde, beta-amyloids, and peroxide that can significantly destroy the central nervous structure and have been related to numerous neurodegenerative disorders. Herbs are traditional cure-alls and seem to have taken deep roots in different cultures across the world. In traditional medicines various herbs and plant extracts have been utilized to deal with various diseases, including infectious diseases (Araújo *et al.*, 2021). NEs are employed as substitutes and adjuvants for conventional drugs, due to their diversity and medicability they are healthier than those agronomic and synthetic. There is an upsurge in the use of the NEs in the medical field to ensure efficacy and a more satisfactory therapeutic effect, among that the main way of NEs

administration is the aromatherapy that prolongs systemic circulation and delivering the active components to the target site (Ekeanyanwu *et al.*, 2021). Taking aromatic drugs is secure with no lethal and side-effects and aromatherapy is a non-invasive means and it could promptly expand the therapeutic benefits. In the aromatherapy method essential oils are volatile liquids that have been extracted from plants, shrubs, trees, roots, flowers, and herbs. Essential oils enriched herbs could trigger the limbic system in humans and exhibits positive impacts on mood and emotions. During aromatherapy the components are inhaled and absorbed through the lungs to act on the nervous system. Four cardinal CNS systems have been recognized by a variety of neurological activities including olfactory, taste, nociception, and thermo-nociception. Through stimulating the central nervous system via the sense of smelling the aromatic compounds could impart beneficial effects and create cognitive, behavioral, and emotional responses (Dahchour, 2022). Astoundingly, the aromatic medicines transferred through inhalation could cross the blood-brain barrier, reach the central nervous system, and provide further therapeutic impacts (Fung *et al.*, 2021) depicted the balancing function of patchouli oil to create a calming effect on the brain. Like the antidepressant activity of essential oils, patchouli oil also possesses the anti-anxiety effect. Due to its balm-like quality, an agreeable fragrance and an ability to ensure physical and emotional equilibrium, patchouli has been used therapeutically by humans for centuries (Araújo *et al.*, 2021).

SANDALWOOD OIL:

People have used essential oils for emotional well-being for centuries, but scientific investigation of essential oils for the treatment of mood disorders has been limited (Fonseca *et al.*, 2023). In a study that scientifically demonstrates the antidepressant effect of sandalwood essential oil in a rat model of depression. When animals were exposed to sandalwood essential oil for 6 weeks, depressive behavior was found to decrease. The antidepressant effects of sandalwood essential oil were shown to be associated with the inhibition of over expression (Tran *et al.*, 2023). Since inhalation of the aroma of sandalwood is relatively inexpensive and harmless, sandalwood intervention can be quickly translated into a clinical application to treat depression cases. Essential oil is a natural compound, derived from various parts of plants, which contains a high concentration of volatile chemical components. Inhaling essential oils can modulate the physiological response in the respiratory system due to the connection of olfactory cells and the brain via the olfactory bulb. The well-known health-boosting effects of essential oils include anti-inflammation, anti-oxidation, and anti-bacteria. Essential oil also has a great influence on the emotional system. The representation of emotions is associated with the respiratory control system in the brain, which displays a direct link between the emotional and respiratory systems. Since more than thousand years ago the ancient Egyptians used essential oils to massage and embalm and to store the

bodies of mummies. They could have mental support effect, but it needs empirical and scientific support to prove this idea (Nguyen *et al.*, 2024).

Effects on the nervous system

Sandalwood is a type of essential oil derived from aromatic woods, which can produce a wide range of biologically active compounds (Liu *et al.*, 2022). The circulating levels of the potent vasodilator nitric oxide and autonomic balance have been suggested as potential markers to predict the development of depression. However, there is a dearth of information regarding the effect of different essential oils on the circulating levels of nitric oxide, stress hormone, and the autonomic function of the cardiovascular system in the prediction and management of depression (Begum & Ravikumar, 2021).

Sandalwood essential oil can suppress sympathetic activity and has a calming effect on heart rate and neural controller dynamics, thus facilitating the parasympathetic nervous system (Godfrey, 2022). Furthermore, cotton pad saturation with sandalwood essential oil and inhalation of it for 30 min or longer plays a role in improved cardiovascular autonomic function by enhancing very low frequency components of both blood pressure and heart rate variability (Caballero-Gallardo *et al.*, 2025). Sandalwood inhalation can elicit nitric oxide synthesis and reduce the arterial baroreflex effectiveness index (Ahmad & Pratap, 2024).

Methods of Application and Dosage of Essential Oils for Depression

Essential oils (EOs), also known as volatile oils, are aromatic oily fluids extracted from various parts of plants, such as petals, leaves, and roots. Given their fungicidal, antibacterial, antioxidant, and analgesic properties, EOs has been widely applied as food additives, in the pharmaceutical industry as preservatives and flavoring agents, and in cosmetics. In recent years, their application in aromatherapy has also been studied in the context of psychological health, focusing particularly on depression. The effectiveness of EOs has been suggested in a variety of studies. An investigation found that inhalation of orange EOs reduced demand for antidepressants among women suffering from post-traumatic stress disorder. Furthermore, a study provided quantitative data that transdermal absorption of jasmine EOs alleviated depression through possible pharmacokinetic profile changes (Fung *et al.*, 2021). Nevertheless, proper methods of application and dosage of EOs for depression, as well as their active ingredients and mechanisms among individuals, are not yet well-understood. With depression affecting over 264 million individuals worldwide, revealing the antidepressant properties of EOs is both timely and crucial.

Essential oils (EOs) are volatile secondary metabolites of plant growth that have a complex combination of compounds with antifungal, antibacterial, anti-inflammatory, anti-anxiety and antidepressant properties. EOs can be inhaled, massaged or consumed to exert benefits on both mental well-being and physical health.

When inhaled, the EOs can be delivered to the circulatory or nervous systems via the pulmonary system, then transferred to the brain via the olfactory system. The pharmacological and psychological effects are mediated by the central nervous system (CNS) and autonomic nervous system (ANS). The stimulation of the olfactory system is also effective in treating depression, anxiety, and insomnia. In addition to volatile fragrance compounds, EOs contain natural biologically active chemicals. The mechanism of action is due to the EOs crossing the blood–brain barrier through the olfactory bulb or blood circulation (Fung *et al.*, 2021). When inhaled in an aroma environment, EOs can modulate the parasympathetic nervous system (PSNS) and sympathetic nervous system (SNS) and reduce the concentrations of adrenocorticotropic hormone and nitrate metabolites in elderly people with depression. EOs are commonly used in aromatherapy for their mood enhancing effects, among other therapeutic purposes. Several clinical trials explored the effectiveness of EOs in patients diagnosed with symptoms of depression. Symptoms of depression have been reduced by performing 20 min of reflexology massage using a blend of lavender and orange EOs. The effectiveness was further supported by decreases in mean scores on the Beck Depression Inventory. Honey massage with EOs of lavender, damask rose, geranium, and rosewood was also found to decrease the intensity of depressive symptoms. Patients using jasmine oil fragrance reported a greater decrease of symptoms of depression than the control group. When compared to the control group, patients with essential oil nursing inhalation showed a statistically significant greater reduction in depression score. Aromatherapy can also be inhaled through olfaction, absorbed via the skin, or ingested. Inhalation is the most popular and easiest way for EOs to enter the human body. EOs can be mixed with carrier oil for massage. When applied to the skin, volatile oils penetrate and are absorbed by the stratum corneum to reach the dermis. The absorption of volatile fragrance compounds through the middle skin has a high bioavailability. Although oral usage is common for capsule or pill administration in the world of aromatherapy, the main route is inhalation (Cao *et al.*, 2023). After inhalation, the volatile fractions present in the EOs have a multi-layered effect on different internal systems and cross the blood-brain barrier. Results have exposed the natural flexibility of the EOs and their capacity to provide benefits in diverse symptoms of mood disorders. EOs used alone or in combination with a carrier can relieve associated symptoms of mood disorders, such as sleeping problems, or be adapted according to the respondents' preferences. Further explorations on the effectiveness of EOs in alleviating symptoms of mood disorders in humans can be carried out to provide public access to this alternative therapy.

Safety Considerations and Potential Side Effects of Essential Oils

Essential oils (EOs), natural volatile components of plants, have attracted much attention for their use in complementary and alternative therapies of mental disorders. The volatile components of EOs can be inhaled, vaporized, or absorbed through the skin, and are believed to exert pharmacological effects through the limbic system and brain neurotransmitters at the cellular level. The use of EOs is called aromatherapy and it has been used for various ailments in Asia for at least a thousand years. Although no significant adverse effects were reported after the use of EOs, consumption without proper advice can give rise to complications. Thus, it is necessary to monitor the possible adverse effects and drug interactions associated with these natural products to ensure the safe use of EOs in preventing and treating depression. Aromatherapy is widely accepted as a therapy for mood enhancement, and EOs has shown potential antidepressant effects by the oral administration of geraniol or limonene; however, memory deficit or neurological injury was also observed after essential oil exposure. Metabolomics has been considered to be a promising approach for understanding the effects of therapeutic intervention. Thus, the aim of this study was to investigate the metabolic responses to the aerial diffusion of essential oils in a rat model. Plasma and urine samples were collected over a 24-hour period, and plasma samples were subjected to both chemical and pharmacokinetic analyses using gas chromatography time-of-flight mass spectrometry.

Essential oils (EOs) have been used for a wide variety of purposes, including holistic medicine (Zhong *et al.*, 2021). It has been shown that EOs can exhibit inhibitory effects on the central nervous system (CNS) after inhalation. Natural terpenoids found in EOs have the capacity to modulate the GABAergic system and have potential for the treatment of a wide range of neurological diseases, such as anxiety disorders, depression, epilepsy, and cognitive memory deficiencies (Qneibi *et al.*, 2024). Terpenoids are not only positive modulators of synaptic and extra-synaptic GABA-A receptors, but they can also bind to GABA transporters and GABA biosynthetic enzymes, thereby dynamically regulating the GABA concentration in the brain. Various other constituents of EOs, such as aldehydes, alcohols, and phenols, can target the GABAergic system in a similar way (Sattayakhom *et al.*, 2023). It is anticipated that the pharmacological and neuroprotective profiles of various EOs and their safe use in creation of a healthy lifestyle can be investigated. In recent years, the biological activities of the chemical composition of multiple EOs have been characterized, thereby shedding light on their pharmacological capabilities and clinical potential (Fung *et al.*, 2021). The analgesic, anti-inflammatory, anti-oxidative, and anesthetic effects of EOs derived from plants have been systematically reported, suggesting their potential application in novel drug discovery for various treatments, such as circulatory and respiratory problems. To access the

CNS, aroma compounds penetrate the blood-brain barrier (BBB) following the inhalation pathway and are then transferred to the CNS along the cranial nerve, olfactory nerve pathway. EOs containing oxygenated compounds, such as alcohols, phenols, and ketones, can also interact with Na⁺ channels in neurons and lead to bouts of arrhythmic seizure-like events in the hippocampus. The combination of these findings suggests the safety of EOs and it is recommended that only a small amount be used when taking EO baths or receiving aromatherapy treatments (Cui *et al.*, 2022). Likewise, the continuous or cumulative use of EOs should be avoided. It is important to note that many EOs have anti-inflammatory activity at low concentrations, but paradoxically, they exhibit a pro-inflammatory response at high concentrations (Al-Harrasi *et al.*, 2022).

COMPARATIVE EFFECTIVENESS: ESSENTIAL OILS VS. TRADITIONAL ANTIDEPRESSANTS

Major depressive disorder represents a leading cause of disability worldwide. A growing body of evidence suggested that essential oils exert beneficial effects on human health and well-being. In recent years, essential oils isolated from natural sources have gained widespread acceptance to combat anxiety and depression (Xiao *et al.*, 2021). The antidepressant potential of lavender has been evaluated, the results confirming that the mechanism of action physically involved the monoamines and functional group of alcohols, but not of ketones, expect of 1,8-cineole. *Citrus reticulata* Blanco essential oil (CBEO), derived from the peel of mandarine, exerted potential antidepressant-like effects on animal models in the forced swim test (Nguyen *et al.*, 2024). The forced swim test is a screening method for antidepressant substances used to predict the effectiveness of new pharmaceuticals by observing the behavior of laboratory rodents when placed in a situation where they have no option but to swim in an inescapable container for a long time (Lizarraga-Valderrama, 2021). Since mandarins are one of the top 10 most consumed fruits in the world, the promotion of citrus essential oils has attracted great enthusiasm (Yuan *et al.*, 2022). This study attempts to examine the potential antidepressant properties of CBEO and to identify its main bioactive components guaranteed by state-of-the-art technologies (Xiao *et al.*, 2021). First, the CBEO profile was analyzed using gas chromatography-mass spectrometry. Thereafter, a network pharmacology approach discovered the accomplishment of essential oil components on top of signaling pathways in the context of anti-depressant properties (Yuan *et al.*, 2022). For in-depth analysis and observatory animal testing, the antidepressant potential of CBEO was confirmed by evaluating immobility time and sensitivity in the forced swim test. In addition, the potential function and the core compounds of CBEO were examined by GO and KEGG analyses, together with the protein-protein interaction network. Third, to unearth the pharmacological mechanism, the synergistic targets/pathways between CBEO and depression are disclosed by a bioinformatic

method. Finally, the results are further verified by in vitro gene assays (Lizarraga-Valderrama, 2021).

ESSENTIAL OILS V/S CONVENTIONAL ANTIDEPRESSANTS

Major depression is a widely prevalent and disabling condition. The main class of drugs used as antidepressants is the class of selective serotonin reuptake inhibitors (SSRIs) but however, they present a slow onset of therapeutic effect and a limited response. Recent laboratory and clinical studies demonstrated the anxiolytic and antidepressant activity of several essential oils paving the way for a natural alternative to the conventional synthetic drugs (Liang *et al.*, 2021). A global exploration of the effect and the effectiveness of the antidepressant activity of a multitude of essential oils is here presented using meta-analysis of preclinical studies to try to estimate the size effect of essential oils with respect to the conventional drugs and if and how the animal model or the route of administration may affect this size (Nguyen *et al.*, 2024). This evaluation was performed on 65 studies describing the activity against depression and/or anxiety of a total of 23 mono- and multi-component essential oils, by means of a Bayesian hierarchical model with binomial likelihood and probit link function (Tran *et al.*, 2023). The results obtained showed that essential oils possess a significant antidepressant activity and have an effect similar to that of drugs at lower doses. Moreover, their effect was comparable to that of the synthetic drugs paroxetine and fluoxetine, resulted to be the most effective in treating depression-like symptoms in rodents. Finally, the animal model and the route of administration can affect the size effect of the essential oils thus underlining the importance of this choice in the experimental design (Chang *et al.*, 2021; Fonseca *et al.*, 2023). Several authors have proposed the anxiolytic and antidepressant potential of CBEO; nevertheless, no comprehensive pharmacological exploration has been offered yet. This study explored for the first time the antidepressant potential of CBEO to scrutinize the chemical composition in charge of that effect (Chang *et al.*, 2021). A network pharmacology investigation was conducted to better apprehend the bioactivity and related mechanisms of the main components discerned via GC-MS in CBEO (Abbasi-Maleki & Maleki, 2021). Data showed that the 18 compounds recognized by GC-MS in CBEO affected a multiplicity of genes and signaling pathways entangled in MDD (Fonseca *et al.*, 2023). Topological analysis exposed that the main active components of CBEO against MDD are linalool, p-cymene, α -terpinene, terpinen-4-ol, and α -terpineol. Furthermore, GO, KEGG, and Wiki enrichment analyses verified the implication of neurodegeneration and neuroinflammation in the antidepressant effects of CBEO, and PPI analysis exposed some keystone proteins, encouraged for use in further studies (Rani *et al.*, 2023).

FUTURE DIRECTIONS IN RESEARCH: THE POTENTIAL OF ESSENTIAL OILS FOR DEPRESSION

Due to the limitations of the currently available pharmacological regimens for depression, there is an increased demand for complementary treatments, which have a potential for the development of new and effective therapeutic agents, such as essential oils. Essential oils used in aromatherapy have gathered increased attention. The clinical efficacy of essential oils in patients with depression requires further rigorous trials. However, commercial pharmacological interventions for depression unfortunately remain suboptimal for many individuals. The significant limitations and barriers to the treatment of unipolar depression include the moderate efficacy and delayed onset of action of traditional antidepressants, as well as various potential side effects. In view of this, there is an escalating demand for the development of complementary and alternative treatments in mood disorders over the last decade, suggesting essential oils might be another promising complementary therapeutic agent for depression that can be easily self-administered in the community (Cao *et al.*, 2023). In line with this, pre-clinical and human pilot studies indicate that essential oils have potential for antidepressant action. Essential oils are volatile liquids comprising the odorous principles of plants, and have been widely used in aromatherapy, perfume, ingredient of household goods, and medical products. Essential oils and many of their constituents are reported to exert biological effects. In light of this, the main aims of this report are to describe the available pre-clinical works that have investigated the antidepressant-like activity of essential oils and to suggest potential directions for future research. It is anticipated that this article will promote additional pre-clinical studies and lead to controlled clinical trials on the therapeutic benefit of essential oils in patients with depression who do not usually respond well to conventional pharmacotherapy (Cui *et al.*, 2022; Shamabadi & Akhondzadeh, 2021; Li *et al.*, 2025; Liang *et al.*, 2021).

Recently, the trend toward complementary and alternative medicine has been strengthening. Aromatherapy, a complementary medicine based on the olfactory system, is a simple and non-invasive intervention that is widely applied to improve mood, relaxation, and cognitive performance. Essential oils used in aromatherapy are suggested to act on the central nervous system (CNS) as well as the olfactory system, probably via affecting the limbic system and its associated brain regions. Limited but growing clinical trials demonstrated the effectiveness of essential oils from varied plant origins on symptoms of mood disorders in populations ranging from children to post-menopausal women, mostly by inhalation or massage. However, the underpinning mechanism of the therapeutic effect of essential oils, and the feasibility, to which the alleviation of psychiatric emotion disorders could be facilitated by simple inhalation of odors, remains largely unexplored (Cao *et al.*, 2023). Given that, the present study aimed at examining the behavioral and molecular

effects of inhaled essential oils on depressive-like behaviors, as well as to demonstrate the assistance of essential oils inhalation by unique setups on panic-, anxiety- and depression-like symptoms elicited pharmacologically in experimental animals – rats.

CONCLUSION: THE PROMISE OF ESSENTIAL OILS IN MANAGING DEPRESSION

In the past, EO was mainly used for the prevention of infectious diseases. Research has shown that EOs have anti-allergic, antioxidant, anti-inflammatory, and anticancer effect. With the discovery of no negative side effects after using EOs for the management of major depression disorder, essential oil research now is one of the major fields under look. Previously, some evidences have shown the relationship between the nervous system and the olfaction system, the entry of EO through diet or skin cream has a direct effect on the nervous system leading to changes in behavior, mood and emotion. There is also a proven relationship of EOs with other physiological systems, such as the respiratory system. The olfaction system and the respiratory system are anatomically related, both the olfactory and respiratory mucosa are found in the nasal cavity, and stimulation by EO of one system can unintentionally stimulate the other system. It has been reported that the intranasal administration of selected drugs was effective in the treatment of both mental and respiratory diseases in murine models. It was found that EO with an antidepressant effect after inhalation was involved in monoaminergic metabolism, similar to traditional antidepressant drugs. That is probably EOs target the 5-hydroxy-tryptaminergic system. This mechanism of action is not only observed in animal experiments, but the antidepressant effect of EOs has also been proven in clinical trials.

Depression is a mood disorder characterized by a variety of symptoms that range from mild to severe. Currently, depression is the third most common reason for disease and is expected to be the second by 2030. Depression can be successfully treated; however, due to the high risk of resistance and relapse, the search is ongoing for alternative or complementary drugs to ameliorate depressive symptoms. Currently, about 90% of available antidepressants are synthetics and may result in nausea, headaches, poor sexual performance, dry mouth, and sometimes more dangerous side effects, such as hypertension, hypotension, or even insomnia (Fung *et al.*, 2021). Therefore, the study and use of natural healing substances have become ever more popular. Approximately 100 essential oils (EOs) have been screened for their antidepressant activity in humans, accounting for over 50,000 peer-reviewed articles over the past several decades (Cao *et al.*, 2023).

EOs are volatile, odoriferous lipophilic secondary metabolites extracted from plants. The extraction of EOs analogous to their content differs between manufacturers. Generally, EOs are extracted under reduced pressure or using steam. At the time of extraction, the pressure of the

steam must be monitored, as it can cause the formation of thermostable toxins. To avoid the decomposition of thermolabile compounds, very high temperatures during extraction, and track chemicals (usually under vacuum), must be applied.

ACKNOWLEDGEMENT:

I wish to express my deep gratitude and sincere thanks to Prof. K.P. Singh, Vice Chancellor of MJP Rohilkhand University, Bareilly, U.P. for his encouragement and for all the facilities that he provided us through the project. Thank you for the generosity and support.

REFERENCES

- Abbasi Maleki S (2021) Antidepressant-like effects of *Foeniculum vulgare* essential oil and potential involvement of dopaminergic and serotonergic systems on mice in the forced swim test. *Pharma Nutrition*. 15, 1-6.
- Abdullatif M, Farooq S, Altheeb A, Rishmawi F, Jaradat H and AlAbady K (2021) Prevalence of depressive disorders and associated factors among adult population of Dubai 2019. *Dubai Medical Journal*. 4(4), 291-300.
- Ácimović M (2021) Essential oils: Inhalation aromatherapy—a comprehensive review. *J Agron Technol Eng Manag*. 4(2), 547-557.
- Agarwal P, Sebghatollahi Z, Kamal M, Dhyani A, Shrivastava A, Singh K K, Sinha M, Mahato N, Mishra A K, and Baek K H (2022) Citrus Essential Oils in Aromatherapy: Therapeutic Effects and Mechanisms. *Antioxidants*. 11(12), 2374.
- Agnihotry S, Chopra D, Singh J, Negi S, Srivastav A K, Upadhyay J and Sharma G (2024) Aromatherapy Evolution and Blending Basics of Essential Oils. *IN: Aromatherapy: The Science of Essential Oils*, Bentham Science Publishers. pp. 1-30
- Ahmad S and Pratap P D (2024) Unravelling the environment, aroma and molecular effects on mood fluctuations: A review. *Research & Reviews. A Journal of Neuroscience*.
- Al-Harrasi A, Bhatia S, Behl T, Kaushik D, Anwer M K, Muqtader A M, Sharma P B, Sharma A, Kabir M T and Mittal V (2022) *Role of Essential Oils in the Management of COVID-19* (1st ed.). CRC Press.
- Alvarado-García P A A, Soto-Vasquez M R, Rosales-Cerquin L E, Rodrigo-Villanueva E M, Jara-Aguilar D R and Tuesta-Collantes L (2022) Anxiolytic and antidepressant-like effects of *foeniculum vulgare* essential oil. *Pharmacognosy Journal*. 14(2), 425-431.
- Alven S, Peter S, and Aderibigbe B A (2022) Polymer-Based Hydrogels Enriched with Essential Oils: A Promising Approach for the Treatment of Infected Wounds. *Polymers*. 14(8), 1-18.
- Armandpish S, Pakzad R, Jandaghian-Bidgoli M, Abdi F, Sardashti M and Soltaniha K (2023) Investigating factors affecting the prevalence of stress, anxiety and depression among citizens of Karaj city: A population-based cross-sectional study. *Heliyon*. 9(6), 1-9.
- Arshad J, Muneeb A, Afzal A, Zahid M, Sultan W, Tariq M H, Raza M, Butt M H, and Javeria J (2024) Role of aromatherapy in the management of stress and depression. *In: Zafar MA, Abbas RZ, Imran M, Tahir S and Qamar W (eds), Complementary and Alternative Medicine: Essential oils*. Unique Scientific Publishers, Faisalabad, Pakistan, pp: 54-62.
- Begum S N and Ravikumar K (2021) The Sandalwood Trade: An Overview. *In: Pullaiah T, Das S C, Bapat V A, Swamy M K, Reddy V D, Murthy K S R. (eds) Sandalwood: Silviculture, Conservation and Applications*. Springer, Singapore. 185-198.
- Borgonetti V, López V and Galeotti N (2022) Ylang-ylang (*Cananga odorata* (Lam.) Hook. f. & Thomson) essential oil reduced neuropathic-pain and associated anxiety symptoms in mice. *Journal of ethnopharmacology*. 294, 1-7,
- Bozova B, Gölükçü M and Giuffrè A M (2024) The effect of different hydrodistillation times on the composition and yield of bergamot (*Citrus bergamia* Risso) peel essential oil and a comparison of the cold-pressing method. *Flavour and Fragrance Journal*. 39(5), 263-270.
- Caballero-Gallardo K, Quintero-Rincón P and Olivero-Verbel J (2025) Aromatherapy and Essential Oils: Holistic Strategies in Complementary and Alternative Medicine for Integral Wellbeing. *Plants*. 14(3), 1-24.
- Cao X, Zhou J, Liu J, Chen H and Zheng W (2023) Aromatherapy in anxiety, depression, and insomnia: A bibliometric study and visualization analysis. *Heliyon*. 9(7), 1-13.
- Cassoli C and Baldari CT (2022) The Expanding Arsenal of Cytotoxic T Cells. *Front. Immunol*. 13:883010, 1-7,
- Chang H T, Chang M L, Chen Y T, Chang S T, Hsu F L, Wu C C and Ho C K (2021) Evaluation of motor coordination and antidepressant activities of *Cinnamomum osmophloeum* ct. linalool leaf oil in rodent model. *Molecules*. 26(10), 1-11.
- Chang J, Yang H, Shan X, Zhao L, Li Y, Zhang Z, Kofi Abankwah J, Zhang M, Bian Y and Guo Y (2024) Bergamot essential oil improves CUMS-induced depression-like behaviour in rats by protecting the plasticity of hippocampal neurons. *J Cell Mol Med*. 28:e18178, 1-15.
- Chavda V, Balar P and Apostolopoulos V (2025) A review on essential oils: A potential tonic for mental wellbeing in the aging population?. *Maturitas*. 192.
- Chen Z, Gu J, Lin S, Xu Z, Xu H, Zhao J and Wang P (2023) Saffron essential oil ameliorates CUMS-induced depression-like behavior in mice via the MAPK-CREB1-BDNF signaling pathway. *Journal of ethnopharmacology*. 300, 115719.

- Cho K and Kim M (2023) Effects of aromatherapy on depression: a meta-analysis of randomized controlled trials. *General Hospital Psychiatry*. 84, 215-225.
- Choi N Y, Wu Y T, Park S A (2022) Effects of Olfactory Stimulation with Aroma Oils on Psychophysiological Responses of Female Adults. *Int. J. Environ. Res. Public Health*. 19(5196), 1-11.
- Cimino C, Maurel O M, Musumeci T, Bonaccorso A, Drago F, Souto E M B, Pignatello R and Carbone C (2021) Essential Oils: Pharmaceutical Applications and Encapsulation Strategies into Lipid-Based Delivery Systems. *Pharmaceutics*. 13(3), 1-35.
- Cohen J (2021) Essential Oils to Boost the Brain and Heal the Body: 5 Steps to Calm Anxiety, Sleep Better, and Reduce Inflammation to Regain Control of Your Health. *Essential oils to boost the brain and heal the body*. (n.d.). Google Books.
- Costa C A., Cury T C, Cassettari B O, Takahira R K, Flório J C and Costa M (2013) Citrus aurantium L. essential oil exhibits anxiolytic-like activity mediated by 5-HT(1A)-receptors and reduces cholesterol after repeated oral treatment. *BMC complementary and alternative medicine*, 13, 42.
- Cui J, Li M, Wei Y, Li H, He X, Yang Q, Li Z, Duan J, Wu Z, Chen Q, Chen B, Li G, Ming X, Xiong L and Qin D (2022) Inhalation Aromatherapy via Brain Targeted Nasal Delivery: Natural Volatiles or Essential Oils on Mood Disorders. *Front. Pharmacol.* 13(860043), 1-15.
- Curreli C, Pappalardo F, Russo G, Pennisi M, Kiagias D, Juarez M and Viceconti M (2021) Verification of an agent-based disease model of human Mycobacterium tuberculosis infection. *J Numer Meth Biomed Engng*. 37(7), 1-15.
- Dahchour A (2022) Anxiolytic and antidepressive potentials of rosmarinic acid: A review with a focus on antioxidant and anti-inflammatory effects. *Pharmacological Research*. 184.
- Daniel D R and Zolnikov T R (2023) The use of bergamot essential oil for PTSD symptomology: a qualitative study. *American Journal of Qualitative Research*. 7(4), 1-32.
- de Araújo F Y R, Chaves Filho A J M, Nunes A M, de Oliveira G V, Gomes P X L, Vasconcelos G S, Carletti J, de Moraes M O, de Moraes M E, Vasconcelos S M M, de Sousa F C F, de Lucena D F and Macedo D S (2021) Involvement of anti-inflammatory, antioxidant, and BDNF up-regulating properties in the antipsychotic-like effect of the essential oil of *Alpinia zerumbet* in mice: a comparative study with olanzapine. *Metabolic Brain Disease*. 36, 2283-2297.
- Derbyshire E (2025) Nutrition for ADHD and Dyslexia: Unlocking the Potential for Learning and Wellbeing. *Jessica Kingsley Publishers*
- Dutta S, Chatterjee S, Ghosh S, Basu B, Prajapati B and Ali N (2025) Exploring the Anxiolytic and Antidepressant-Like Effects of Citrus Maxima Oil and its Inclusion Complex: A Focus on GABAergic and Serotonergic Pathways. *Journal of Pharmaceutical Innovation*. 20(2), 34.
- Eddin L B, Jha N K, Meeran M N, Kesari K K, Beiram R and Ojha S (2021) Neuroprotective potential of limonene and limonene containing natural products. *Molecules*. 26(15), 1-26.
- Ekeanyanwu R C, Nkwocha C C and Ekeanyanwu C L (2021) Behavioural and biochemical indications of the antidepressant activities of essential oils from *Monodora myristica* (Gaertn) seed and *Xylopia aethiopica* (Dunal) fruit in rats. *IBRO Neuroscience Reports*. 10, 66-74.
- Fonseca E C M, Ferreira L R, Figueiredo P L B, Maia C D S F, Setzer W N and Da Silva J K R (2023) Antidepressant effects of essential oils: A review of the past decade (2012–2022) and molecular docking study of their major chemical components. *International journal of molecular sciences*. 24(11), 1-23.
- Fung T K H, Lau B W M, Ngai S P C and Tsang H W H (2021) Therapeutic Effect and Mechanisms of Essential Oils in Mood Disorders: Interaction between the Nervous and Respiratory Systems. *International journal of molecular sciences*. 22(9), 1-17.
- Fung T K H, Lau B W M, Ngai, S P C, Tsang H W H (2021) Therapeutic Effect and Mechanisms of Essential Oils in Mood Disorders: Interaction between the Nervous and Respiratory Systems. *Int. J. Mol. Sci.* 22(4844) 1-17.
- Fung T K, Lau B W, Ngai S P and Tsang H W (2021) Therapeutic effect and mechanisms of essential oils in mood disorders: Interaction between the nervous and respiratory systems. *International journal of molecular sciences*. 22(9), 1-17.
- Georgiev Y N, Dzhambazov B M, Batsalova T G, Vasicek O, Dobreva L I, Denev P N and Krastanov A I (2022) Structural characterization of polysaccharides from *Geranium sanguineum* L. and their immunomodulatory effects in response to inflammatory agents. *Journal of Ethnopharmacology*. 294, 115390.
- Godfrey H D (2022) Healing with essential oils: The antiviral, restorative, and life-enhancing properties of 58 plants. *Healing with Essential Oils: The Antiviral, Restorative, and Life-Enhancing ...* - Heather Dawn Godfrey - Google Books
- Goldstein Ferber S, Namdar D, Hen-Shoval D, Eger G, Koltai H, Shoval G, Shbiro L and Weller A (2020) The “Entourage Effect”: Terpenes Coupled with Cannabinoids for the Treatment of Mood Disorders and Anxiety Disorders. *Curr Neuropharmacol*. 18(2), 87-96.
- Gusmão C T P (2024) Evaluation of the effects of essential oils on the re-duction of stress: a rapid narrative re-view.

- Brazilian Journal of Aroma-therapy and Essential Oil. **1**(1), 1-7.
- Hedigan F, Sheridan H and Sasse A (2023) Benefit of inhalation aromatherapy as a complementary treatment for stress and anxiety in a clinical setting—A systematic review. *Complementary therapies in clinical practice*. **52**, 101750. 1-16.
- Imara D A E, El-Mohammady M S, Hanafy S A and Yousef R S (2024) Induction of Resistance and Defense Mechanisms of Geranium Plants Against Root Rot Disease Using Gallic Acid and 3, 5-dinitrobenzoic Acid. *Egyptian Journal of Phytopathology*. **52**(1), 109-150.
- Jafari-Koulaee A, Elyasi F, Taraghi Z, Sadat Ilali E and Moosazadeh M (2020) A Systematic Review of the Effects of Aromatherapy with Lavender Essential Oil on Depression. *Central Asian journal of global health*. **9**(1), 1-14.
- Javaid S F, Hashim I J, Hashim M J, Stip E, Samad M A and Ahbabi A A (2023) Epidemiology of anxiety disorders: global burden and sociodemographic associations. *Middle East Current Psychiatry*. **30**(1), 1-11.
- Kaur H, Kaushik U and Choudhary N (2024) Therapeutics Effects of the Genus Citrus in Anxiety Disorder. *Journal of Pharmacology and Pharmacotherapeutics*. **15**(4), 373-388.
- Kazemi A, Iraj A, Esmaealzadeh N, Salehi M and Hashempur M H (2025) Peppermint and menthol: a review on their biochemistry, pharmacological activities, clinical applications, and safety considerations. *Critical reviews in food science and nutrition*. **65**(8), 1553–1578.
- Kennedy D, Okello E, Chazot P, Howes M J, Ohiomokhare S, Jackson P, Haskell-Ramsay C, Khan J, Forster J and Wightman E (2018) Volatile Terpenes and Brain Function: Investigation of the Cognitive and Mood Effects of Mentha × Piperita L. Essential Oil with In Vitro Properties Relevant to Central Nervous System Function. *Nutrients*. **10**(8), 1-17.
- Khanh Nguyen N P, Kwon J H, Kim M K, Tran K N, Huong Nguyen L T and Yang I J (2024) Antidepressant and anxiolytic potential of *Citrus reticulata* Blanco essential oil: a network pharmacology and animal model study. *Frontiers in pharmacology*. **15**(1359427), 1-18.
- Kim C and Song C (2022) Physiological and psychological relaxation effects of fir essential oil on university students. *International journal of environmental research and public health*. **19**(9), 1-12.
- Kim C, Lee G and Song C (2023) The Effect of Short-term Inhalation of Fir Essential Oil on Autonomic Nervous Activity in Middle-aged Women. *Explore (New York, N.Y.)*. **19**(6), 820–826.
- Kim Y, Kim H W, Kim B, Kim Y, Kim H W and Kim B (2022) Antimicrobial activity of essential oils and single fragrance ingredients for cosmetic applications. *Asian Journal of Beauty and Cosmetology*. **20**(4), 417-426.
- Korciem K M M, Fadl N N, El-Zayat S R, Hosny E N, Abbas El-Shamy K, Arbid M S and El-Azma M H (2021) Geranium oil and anise oil inhibit brain cerebral cortex and hippocampus inflammation in depressed animal model. *Nutrition & Food Science*. **51**(2), 439-456.
- Koyama S, Kondo K, Ueha R, Kashiwadani H and Heinbockel T (2021) Possible use of phytochemicals for recovery from COVID-19-induced anosmia and ageusia. *International Journal of Molecular Sciences*. **22**(16), 1-71.
- Li W J, Bian L H, Li W H, Yin Y, Li J, Wang S Q and Guo J Y (2025) Essential oils as therapeutic and protective instruments in depression based on animal models: A systematic review and meta-analysis. *Journal of Essential Oil Bearing Plants*. **28**(1), 24-36.
- Liang X, Wang X, Zhao G, Huang X, Xu X and Dong W (2021) Research progress of essential oil as a new complementary therapy in the treatment of depression. *Mini reviews in medicinal chemistry*. **21**(16), 2276-2289.
- Liu X, Zhang Q, Hong Z and Xu D (2022) Induction of heartwood formation in young Indian sandalwood (*Santalum album* L.) by gas elicitors. *Frontiers in Plant Science*. **13**, 1-12.
- Lizarraga-Valderrama L R (2021) Effects of essential oils on central nervous system: Focus on mental health. *Phytotherapy research: PTR*. **35**(2), 657–679.
- Luan J, Yang M, Zhao Y, Zang Y, Zhang Z and Chen H (2023) Aromatherapy with inhalation effectively alleviates the test anxiety of college students: A meta-analysis. *Front. Psychol.* **13**(1042553), 1-11.
- Mensing J (2023) The Research of the Fragrance Effect: On Consciousness, Emotion and Mood for More Well-Being and Enjoyment—From the Stone Age to Current Brain Research. In *Beautiful SCENT: The Magical Effect of Perfume on Well-Being*, Berlin, Heidelberg: Springer Berlin Heidelberg. pp 1-33.
- Moghadam Z E, Delmoradi F, Aemmi S Z, Vaghee S and Vashani H B (2022) Effectiveness of aromatherapy with inhaled lavender essential oil and breathing exercises on ECT-related anxiety in depressed patients. *Explore*. **18**(6), 683-687.
- Mughal S S (2022) Peppermint oil, its useful, and adverse effects on human health: a review. *Innovare Journal of Ayurvedic Science*. **8**(6), 1-4.
- Nguyen L T H, Nguyen N P K, Tran K N, Choi H J, Moon I S, Shin H M and Yang I J (2024) Essential oil of *Pterocarpus santalinus* L. alleviates behavioral impairments in social defeat stress-exposed mice by regulating neurotransmission and neuroinflammation. *Biomedicine & pharmacotherapy*. **171**(116164), 1-11.

- Niu Y, Xu L, Qiao M and Wang Y (2025) The Anti-depression Effect and Mechanism of Harmonious Rosemary Essential Oil and its Application in Microcapsules. *Materials Today Bio.* 31, 1-16.
- Ola A R B, Adar D, Salu A, Belli H L L, Karyawati A T, Marawali A and Darmakusuma D (2024) "The 30/100 Classification System as a Reference for Price of Sandalwood (*Santalum album*) Wood in Sandalwood Oil Industry". *International Journal of Innovative Science and Research Technology.* 9(3), 59-362.
- Oresanya I O and Orhan I E (2024) Deciphering Neuroprotective Effect of *Rosmarinus officinalis* L. (syn. *Salvia rosmarinus* Spenn.) through Preclinical and Clinical Studies. *Current Drug Targets.* 25(5), 330-352.
- Ouyang P, Kang D, You W, Shen X, Mo X and Liu Y (2024) *Pogostemon cablin* essential oil affects anxiety- and depressive-like behaviors and the gut microbiota in chronic unpredictable mild stress model rats. *Frontiers in nutrition.* 11(1303002), 1-12.
- Pierson M, Fernandez X and Antoniotti S (2021) Type and magnitude of non-compliance and adulteration in neroli, mandarin and bergamot essential oils purchased on-line: potential consumer vulnerability. *Scientific reports.* 11(11096), 1-10.
- Prosche S and Stappen I (2024) Flower Power: An Overview on Chemistry and Biological Impact of Selected Essential Oils from Blossoms. *Planta Medica.* 90(7-08), 595-626.
- Qneibi M Bdir S Maayeh C Bdair M Sandouka D Basit D and Hallak M (2024) A comprehensive review of essential oils and their pharmacological activities in neurological disorders: exploring neuroprotective potential. *Neurochemical research.* 49(2), 258-289.
- Rani M, Jindal S, Anand R, Sharma N, Ranjan K R, Mukherjee M D and Mishra V (2023) Plant essential oils and their constituents for therapeutic benefits. *Inamuddin (ed.) Essential Oils: Extraction Methods and Applications*, Scrivener Publishing LLC. pp 977-1008.
- Raouf A E, Reem M, AwadAlla S S, Hassanin M M H and Hassanein A M A (2022) EFFECT OF SOME METHODS FOR CONTROLLING WEEDS AND WILT DISEASES ON THE PRODUCTIVITY OF GERANIUM PLANTS. *Scientific Journal of Flowers and Ornamental Plants.* 9(4), 373-395.
- Rozhkova T O, Zhuravska I A, Nemerytska L V, Mozharovskiy S V, Matsyura A V, Stankevych S V and Popova L V (2021) Effects of essential oils on mycoflora and winter wheat seed germination. *Ukrainian Journal of Ecology.* 11(1), 163-170.
- Sah A, Naseef P P, Kuruniyan M S, Jain G K, Zakir F and Aggarwal G (2022) A Comprehensive Study of Therapeutic Applications of Chamomile. *Pharmaceuticals (Basel, Switzerland).* 15(10), 1-16.
- Santomauro D F, Herrera A M M, Shadid J, Zheng P, Ashbaugh C, Pigott D M and Ferrari A J (2021) Global prevalence and burden of depressive and anxiety disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic. *The Lancet.* 398(10312), 1700-1712.
- Sattayakhom A, Wichit S, Koomhin P (2023) The Effects of Essential Oils on the Nervous System: A Scoping Review. *Molecules.* 28(3771), 1-23.
- Sayorwan W, Ruangrunsi N, Piriyaunporn T, Hongratanaworakit T, Kotchabhakdi N and Siripornpanich V (2012) Effects of Inhaled Rosemary Oil on Subjective Feelings and Activities of the Nervous System. *Sci. Pharm.* 81(2), 531-542.
- Semenzato G, Teramo A, Calabretto G and Zambello R (2024) T-cell clones of uncertain significance. When is the rogue clone dangerous?. *Haematologica.* 110(1), 37-46.
- Shah S M A, Mohammad D, Qureshi M F H, Abbas M Z and Aleem S (2021) Prevalence, psychological responses and associated correlates of depression, anxiety and stress in a global population, during the coronavirus disease (COVID-19) pandemic. *Community mental health journal.* 57(1), 101-110.
- Shamabadi A and Akhondzadeh S (2021) Advances in alternative and integrative medicine in the treatment of depression: a review of the evidence. *Arch Iran Med.* 24(5), 409-418.
- Soares G A B E, Bhattacharya T, Chakrabarti T, Tagde P and Cavalu S (2021). Exploring Pharmacological Mechanisms of Essential Oils on the Central Nervous System. *Plants (Basel, Switzerland),* 11(1), 21.
- Solmi M, Radua J, Olivola M, Croce E, Soardo L, Salazar de Pablo G and Fusar-Poli P (2022) Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Molecular psychiatry,* 27(1), 281-295.
- Swiatczak B (2021) Struggle within: evolution and ecology of somatic cell populations. *Cellular and Molecular Life Sciences.* 78(21-22), 6797-6806.
- Tan L, Liao F F, Long L Z, Ma X C, Peng Y X, Lu J M and Fu C G (2023) Essential oils for treating anxiety: a systematic review of randomized controlled trials and network meta-analysis. *Frontiers in public health.* 11(1144404), 1-20.
- Tran K N, Nguyen N P K, Nguyen L T H, Shin H M and Yang I J (2023) Screening for neuroprotective and rapid antidepressant-like effects of 20 essential oils. *Biomedicines.* 11(5), 1-30.
- Tripathi L, Kumar P, Swain K and Pattnaik S (2023) Clinical applications of essential oils. *Essential Oils. In: Extraction Methods and Applications.* 933-951.
- Vandresen F, de Oliveira F S, Romeral R D A F, Veronezzi F and Olier V G A (2024) Alternative therapeutic

- approach for anxiety and depression: Review on the use of different essential oils. *Research, Society and Development*. **13**(8), 1-12.
- Wafa S S A E, El-Ashmawy A A, Kassem H A, Eissa I H, Abu-Elghait M, Younis N A and Younis I Y (2023) Optimization of oil yield of *Pelargonium graveolens* L'Hér using Box-Behnken design in relation to its antimicrobial activity and in silico study. *Scientific Reports*. **13**(1), 1-16.
- Wang C, Wang Y, Gong B, Wu Y, Chen X, Liu Y, Wei J (2022) Effective Components and Molecular Mechanism of Agarwood Essential Oil Inhalation and the Sedative and Hypnotic Effects Based on GC-MS-Qtof and Molecular Docking. *Molecules*. **27**(3483), 1-18,
- Wang Z J and Heinbockel T (2018) Essential Oils and Their Constituents Targeting the GABAergic System and Sodium Channels as Treatment of Neurological Diseases. *Molecules (Basel, Switzerland)*. **23**(5), 1-24.
- Wu Y, Fan L, Xia F, Zhou Y, Wang H, Feng L, Xie S, Xu W, Xie Z, He J, Liu D, He S, Xu Y, Deng J, Wang T, Chen L (2024) Global, regional, and national time trends in incidence for depressive disorders, from 1990 to 2019: an age-period-cohort analysis for the GBD 2019. *Ann Gen Psychiatry*. **23**(28), 1-15.
- Xia N, Wang J, Guo Q, Duan J, Wang X, Zhou P, Li J, Tang Y, Li T, Li H, Wu Z, Yang M, Sun J, Guo D, Chang X, Zhang X (2024) Deciphering the antidepressant effects of *Rosa damascena* essential oil mediated through the serotonergic synapse signaling pathway. *Journal of Ethnopharmacology*. **328**, 118007.
- Xiao S, Huang J, Huang Y, Lai H, Zheng Y, Liang D, Xiao H and Zhang X (2021) Flavor Characteristics of Ganpu Tea Formed During the Sun-Drying Processing and Its Antidepressant-Like Effects. *Front. Nutr*. **8**(647537), 1-14.
- Xie Y, Jiang L, Li J, Zhu J, Tu C, Guo Q and Liu J (2021) Antifungal activity screening for 32 essential oils against *Rhizopus stolonifer*. In *IOP Conference Series: Earth and Environmental Science*, IOP Publishing. **792**(1), 12-14.
- Xie Y, Li G, Ma W, Chen B, Li M, Wang L, Li J, Zhu Y, Lei N, Liu N and Xiong L. Uncovering the Nose-to-Brain Delivery Pathway of Cang Ai Volatile Oil and Bioactive Constituents for Potential Antidepressant Effects. Available at SSRN 5079009.
- Yaqoob R, Zohra A, Usman M, Farhana, Sajjad M F, Kazmi S U E F, Sultan F, Lodhi I, Muneer M H and Muhyuddin S (2024) The healing power of aromatherapy: essential oils in medical sciences. In: *Zafar MA, Abbas RZ, Imran M, Tahir S and Qamar W (eds), Complementary and Alternative Medicine: Essential oils*. Unique Scientific Publishers, Faisalabad, Pakistan, pp: 35-42.
- Yuan C, Yao Y, Liu T, Jin Y, Yang C, Loh X J and Li Z (2022) Research progress on natural compounds exerting an antidepressant effect through anti-inflammatory. *Current Medicinal Chemistry*. **29**(5), 934-956.
- Zhang J, Fan C, Tao T, Wang L and Gao W (2024) A visual analysis based on CiteSpace for Aromatherapy's impact on mental health. In *Proceedings of the 2024 International Conference on Smart Healthcare and Wearable Intelligent Devices*. pp. 252-259.
- Zhao H, Ren S, Yang H, Tang S, Guo C, Liu M, Tao Q, Ming T and Xu H (2022) Peppermint essential oil: its phytochemistry, biological activity, pharmacological effect and application. *Biomedicine & pharmacotherapy*. **154**(113559), 1-13,
- Zhdanava M, Pilon D, Ghelerter I, Chow W, Joshi K, Lefebvre P and Sheehan J J (2021) The prevalence and national burden of treatment-resistant depression and major depressive disorder in the United States. *The Journal of clinical psychiatry*. **82**(2), 1-10.
- Zhong Y, Zheng Q, Hu P, Huang X, Yang M, Ren G, Du Q, Luo J, Zhang K, Li J, Wu H, Guo Y and Liu S (2019) Sedative and hypnotic effects of compound Anshen essential oil inhalation for insomnia. *BMC complementary and alternative medicine*, **19**(1), 1-11.