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Aromatherapy: Historical, Phytochemical Insights, and Therapeutic Applications

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Abstract

This chapter delves into the holistic practice of aromatherapy, which harnesses the therapeutic potential of aromatic compounds in essential oils derived from medicinal plants to support physical, emotional, and mental health. The chapter traces the historical roots of aromatherapy, emphasizing its revered role in ancient civilizations, where aromatic substances were utilized for their healing properties. Examining aromatherapy through chemical, biochemical, and pharmacological lenses underscores the diverse therapeutic applications of essential oils. A focal point of the chapter is the introduction of the aroma wheel, a tool that categorizes and elucidates the intricate scents of essential oils, aiding in their practical application. The chapter also explores the extensive trade of spices and aromatic substances—such as musk, ambergris, camphor, and sandalwood—during the medieval period, particularly in the East and Spain. A notable figure in this historical narrative is the Spanish physician and aromatherapist Albucasis, who extensively addressed the use of aromatherapy in the nineteenth book of his influential work, *Kitab al-Tasrif*. By offering a comprehensive overview of the historical, chemical, and therapeutic dimensions of aromatherapy, this chapter serves as a valuable resource for researchers and practitioners in natural medicine, illustrating how the power of scent can significantly enhance health and well-being.

Keywords

aromatherapy | medicinal plants | essential oils | phytochemicals | therapeutic properties | aromatic compounds | biochemical pathways | pharmacological effects | holistic healing

Author Information

Chapter sections

1. Introduction

Aromatherapy, the practice of using aromatic plant extracts to promote physical, emotional, and spiritual well-being, boasts a rich history across various cultures [ ]. Ancient civilizations in India, China, Egypt, and Greece recognized the profound effects of aromatic plants, essential oils, and perfumes on health and spirituality [, ,]. For example, perfumes were integral to treatments and rituals in Pharaonic, Greek, and Roman societies [ ]. The Arabic terms "El-tib" or "Tyyb" and "Itr" or "Ottor" refer to fragrant substances used for enhancing aromas or treating illnesses, encompassing both animal and botanical elements such as musk, ambergris, cloves, camphor, sandalwood, and aloeswood [ ]. The term "aromatherapy," coined in the early twentieth century by René-Maurice Gattefossé, refers to the use of essential oils through various methods, including massage, baths, and inhalation [ ]. The related field of "aromachology" studies the physiological effects of scents [ ]. Today, aromatherapy is gaining renewed interest as a complementary therapy, with research focusing on how essential oils interact with the body and mind to reveal their therapeutic potential [ ]. The historical trade of perfumes and aromatic plants has evolved into a vibrant field of study, expanding our understanding of their holistic health benefits [,].

2. Historical perspectives of aromatherap

2.1 Origin of aromatherapy

The origins of aromatherapy can be traced back to ancient
aromatic plants and spices were traded along early routes i
Ancient Egyptians pioneered the use of aromatic oils for m

evidenced by inscriptions in temples, such as Deir el-Bahari, Philae, and Edfu [ ]. Cleopatra's use of jasmine oil to captivate Mark Antony underscores the cultural significance of aromatics [,]. Egyptians developed advanced methods for extracting essential oils, such as chamomile, which were used in therapeutic treatments and mummification, reflecting their knowledge of preservation and medicinal qualities [ ].

In China, aromatics were primarily used in incense, an early form of aromatherapy, to cleanse spaces and promote health, integrated into traditional medicine and spiritual practices [ ]. Ayurveda in India extensively utilized aromatherapy, with substances like saffron and milk plasters employed for their medicinal and aromatic properties. For example, these materials were used to purify air during the construction of the Temple of Minerva [,].

Romans incorporated aromatic oils into daily routines, such as bathing, to promote relaxation and enhance sensory experiences, highlighting their appreciation for luxury and well-being [,]. The amalgamation of Greek, Arabic, and Islamic traditions significantly advanced aromatherapy. Greek scholars like Hippocrates and Dioscorides documented the medicinal uses of aromatic plants, a knowledge preserved and expanded during the Islamic Golden Age. Arab merchants from the Quraysh tribe were instrumental in spreading perfumes throughout the Middle East [, , ,]. Innovations in extraction techniques such as steam distillation were advanced by Islamic scholars like Jābir ibn Hayyān (Geber) and Al-Kindi (Alkindus), with figures like Avicenna (Ibn Sina) refining floral oil distillation. Abū al-Qāsim al-Zahrawī (Albucasis) detailed distillation methods in his seminal work, *Kitab al-Tasrif*, which includes insights into perfume preparation and therapeutic applications [, ,].

2.2 Modalities of aromatherapy in traditional systems

Traditional systems utilize a range of methods to harness the therapeutic benefits of essential oils and aromatic plants [ ]. Ayurveda employs oils like sandalwood and jasmine through massage, steam inhalation, and baths to balance doshas [ ]. Traditional Chinese Medicine (TCM) uses aromatics like camphor and ginger to harmonize Qi, often in combination with acupuncture and herbal treatments [ ].

Unani medicine, rooted in Greek humoral theory, classifies substances based on their qualities and therapeutic effects. Albucasis categorized perfumes into types based on their temperament: hot and dry (amber, nutmeg), cold and wet (sour fig, lichen), cold and dry (rose water, camphor), and hot and wet (cubeb) ( ) [ ]. He described external methods like sitz baths, steam inhalation, incense, and perfumed ornaments; topical methods including aromatic oils, massage agents, and aromatic detergents; and internal methods such as snuff and aromatic water [ ]. Fragrances were tailored by gender, age, and season, highlighting a sophisticated unde
In our days, the Saudi Arabian perfume company Abdul Sa
notable perfume companies that have developed the conce
relying on the rich Arab heritage in the production and cre

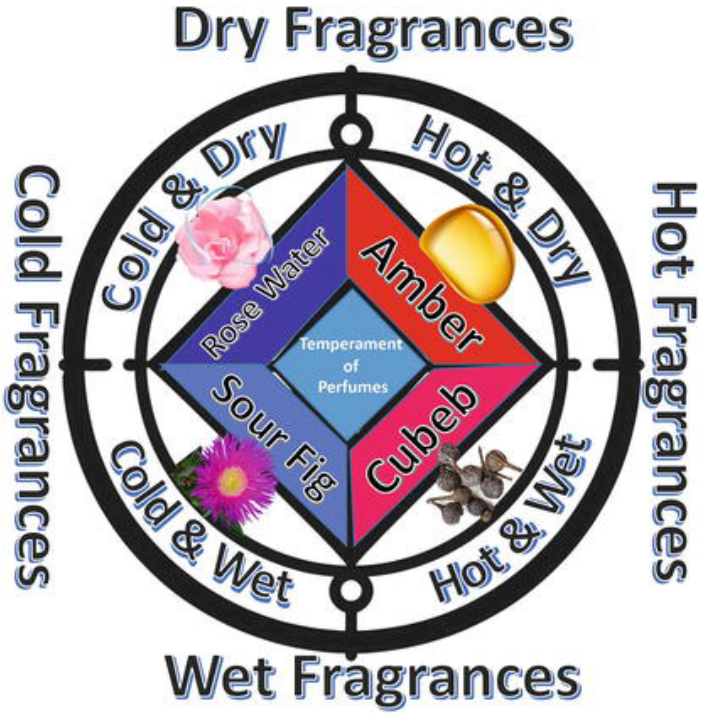

Figure 1.
Temperament of perfumes.

The circle represents the four moods of scents in Unani medicine: hot, cold, dry, and wet. Each mood is associated with specific scents: hot and dry (amber), cold and wet (sour fig), cold and dry (rose water), and hot and wet (cubeb). This figure is an original design by the author, inspired by interpretations of ancient manuscripts by Albucasis.

The classification of perfumes based on the temperament in Unani medicine (UM) aligns with the humoral theory. Each category reflects the qualities of the perfumes and their potential therapeutic effects.

3. Phytochemical insights of aromatherapy

3.1 Chemical structures

Understanding the chemical structures of essential oils is c
Essential oils are concentrated plant extracts consisting of
and supplementary compounds that enhance scent and eff

3.1.1 Main compounds

Essential or volatile oils are concentrated extracts from pla
and are composed of various chemical groups, each contri
effects. The primary constituents are terpenoids, which in
Monoterpenes, such as limonene, pinene, and myrcene, ar

effects, providing fresh, bright citrus notes and are commonly found in citrus oils and coniferous plants. Sesquiterpenes, like caryophyllene, farnesene, and bisabolol, are heavier molecules that contribute to earthy scents and are recognized for their anti-inflammatory and analgesic properties. They are typically found in oils like chamomile and sandalwood [, , ,].

Other significant compounds include aromatic esters, aldehydes, ketones, and phenylpropanoids. Aromatic esters, such as linalyl acetate, benzyl acetate, and ethyl butyrate, are appreciated for their sweet, fruity aromas, and calming effects, commonly used in perfumes and found in oils like lavender and ylang-ylang. Aldehydes and ketones, including citral, vanillin, and cinnamaldehyde, are valued for their fresh, citrusy, or sweet notes, contributing pleasant aromas and antimicrobial properties to both natural and synthetic perfumery. Phenylpropanoids, such as eugenol, cinnamaldehyde, and anethole, impart spicy notes and are known for their antimicrobial and antioxidant properties, with eugenol in clove oil being notable for its pain-relieving effects ( ) [, ,].

Figure 2.
Volatiles wheel.

This original infographic design by the author represents t
found in essential oils: monoterpenes (e.g., limonene, pine
caryophyllene, farnesene, and bisabolol), phenylpropanoi
anethole), aromatic esters (e.g., linalyl acetate, benzyl acet
ketones (e.g., citral, vanillin, and cinnamaldehyde). Each g
representations of these example compounds.

The Volatiles Wheel showcases the diversity of chemical compounds that contribute to the aromatic profiles of essential oils. Monoterpenes and sesquiterpenes form the backbone of these profiles, imparting citrus and earthy notes, respectively. Phenylpropanoids add spiciness, while aromatic esters and aldehydes/ketones contribute floral and sweet aromas. This figure, is inspired by the chemical composition of volatile oils.

The diversity of these compounds not only defines the aromatic profile of essential oils but also influences their therapeutic properties, which are shaped by factors like extraction methods and cultivation conditions [ ].

Animal-derived scents and synthetic fragrances also contribute to the complexity of aromatherapy. Animal-derived scents include hydrocarbons, alcohols, and esters, while synthetic fragrances are categorized by chemical structures, such as hydrocarbons, alcohols, esters, and aldehydes [, ,].

3.1.2 Complementary compounds

Complementary compounds enhance the efficacy and safety of aromatherapy products. Carrier oils like jojoba and sweet almond oil dilute essential oils for safe topical use and aid in skin absorption [,]. Waxes such as beeswax provide structural integrity to candles [ ]. Emulsifiers and surfactants stabilize emulsions in lotions and creams [ ]. Ethanol dissolves aromatic compounds in perfumes, facilitating their release [ ]. Fixatives like terpenoid-rich resins extend the longevity of scents [ ]. Propellants in deodorants enable fine spray applications [ ]. While charcoal and binders are used in incense [,]. Understanding the chemical structures of these compounds is essential for their effective use in aromatherapy and perfumery.

3.2 Analytical techniques

3.2.1 Chemical analysis techniques

Essential oils can be analyzed using several techniques. Gas chromatography (GC) separates and analyzes volatile compounds [ ]. Mass spectrometry (MS) identifies molecular weight and structure [ ]. Optical rotation (OR) measures the angle of polarized light to assess purity [ ]. The refractive index (RI) evaluates light refraction to determine oil quality [ ]. Specific gravity (SG) is used to verify authenticity and concentration [ ]. Finally, structure–activity relationships (SAR) analyze the chemical structure and biological activity of the compounds [ ].

3.2.2 Techniques for assessing fragrances

Various methods are used to evaluate fragrances. The Perfumery Radar (PR) methodology categorizes perfumes into olfactory families [ ]. Sensory experiments include techniques such as intensity ranking, semantic profiling, and panel testing [, ,]. the relationship between aroma and taste, emphasizing ho perception [ ]. Additionally, the electronic nose system r rapid and objective odor analysis [ ].

3.3 Categorization of aromatherapy ingredients

Fragrances in aromatherapy are categorized based on thei their chemical structures. For example, citrus scents like li

scents like octanal, and oriental scents like vanillin are categorized this way. Other examples include fruity scents like isoamyl acetate, fougère scents like coumarin, watery (marine) scents like calone, conifer scents like alpha-pinene, chypre scents like labdane, herbaceous scents like eucalyptol, green scents like cis-3-hexenal, spicy scents like cinnamaldehyde, woody scents like santalol, fresh scents like cis-3-hexenol, aromatic scents like linalool, musk scents like muscone, animal-like scents like civetone, and vegetable-like scents like hexanal ( ) [ ].

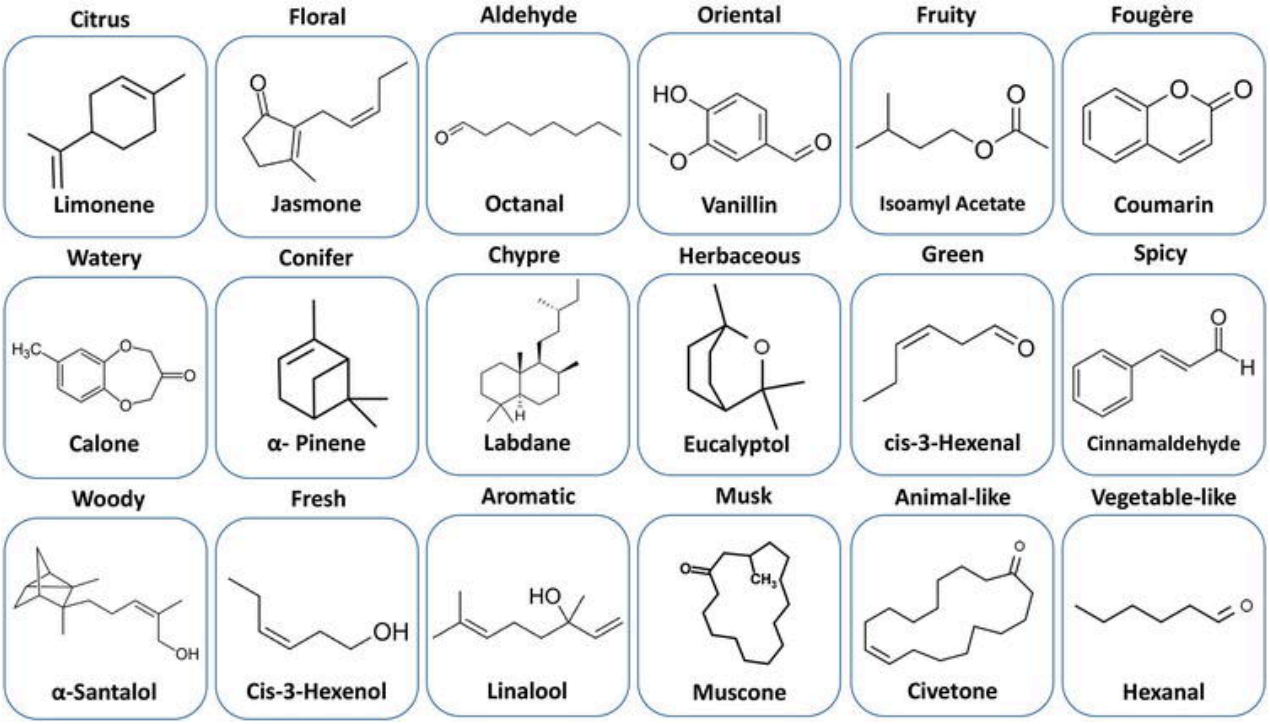

Figure 3.

Chemical structures of notable aromatherapy fragrance compounds.

This figure presents the chemical structures of key fragrance compounds found in aromatherapy, organized by their scent profiles. Examples include citrus (limonene), floral (jasmone), aldehyde (octanal), and oriental (vanillin) scents. The figure also includes other scent profiles, such as fruity (isoamyl acetate), fougère (coumarin), watery/marine (calone), conifer (alpha-pinene), chypre (labdane), herbaceous (eucalyptol), green (cis-3-hexenal), spicy (cinnamaldehyde), woody (santalol), fresh (cis-3-hexenol), aromatic (linalool), musk (muscone), animal-like (civetone), and vegetable-like (hexanal). Each scent profile is illustrated with its corresponding chemical structure to highlight the relationship between molecular composition and fragrance characteristics.

The figure expands on the traditional aroma wheel by categori
each represented by a specific chemical compound. This organi
chemical structure of a compound and its associated scent proj
of a fragrance ingredient determines its aromatic properties.

The categorization of aromatherapy ingredients extends b
organized scent families, as depicted in the fragrance whee
families such as floral, oriental, woody, fresh, and aromati
encompasses subgroups like floral, soft floral, and floral or
rose water, characterized by fresh-cut flowers, aldehydes, j

oriental family includes soft oriental, oriental, and woody oriental subgroups, with scents like ambergris, noted for incense, amber, and oriental resins. The woody family comprises woods, mossy woods, dry woods, and aromatic woods, with examples like frankincense and sandalwood, characterized by dry woods, leather, oakmoss, and vetiver. The fresh family includes citrus, fruity, green, and water subgroups, with scents such as lavender and sweet orange, characterized by aquatic notes, green notes, fruits, and citrus oils. The aromatic family features scents like rose water [,].

Uniquely, the fougère family is positioned at the center of the fragrance wheel, combining elements from all four other families, which gives it universal appeal. Oak moss is a classic example of a fougère scent [,]. Fragrances are also structured within a pyramid, where top notes represent the initial light scents, middle notes provide the core character, and base notes offer long-lasting depth [ ]. Additionally, perfumes are classified by concentration levels, ranging from the intense Parfum (Extrait) to the lighter Eau Fraîche [ ].

Synthetic aroma chemicals, integral to modern perfumery, are divided into three categories: commodities, which are basic and widely used; specialties, which are unique ingredients for distinct fragrances; and captives, proprietary compounds exclusive to certain fragrance houses [ ]. To support the categorization and understanding of these fragrances, various databases and tools, including the Modified Hexagon (MH), H&R Catalog (H&R), Fragrantica (FR), and Osmoz (OZ), are utilized [,]. Furthermore, major fragrance houses like Firmenich and Givaudan contribute significantly to the industry with their extensive research databases [ ].

4. Therapeutic applications of fragrance substances

Aromatherapy employs fragrance compounds, such as essential oils, for therapeutic purposes; these oils can be inhaled or applied topically to influence the limbic system, which is responsible for emotions, memories, and physiological responses [ ]. This review will categorize these oils based on their therapeutic applications and their pharmaceutical, nutraceutical, and cosmeceutical forms.

4.1 Physical health

Essential oils provide numerous benefits for physical health, including:

Respiratory health: Eucalyptus and peppermint oils alle
infections [ ].

Digestive health: Ginger and fennel oils support digestic

Pain relief: Lavender and chamomile oils possess analg
].

Immune system support: Tea tree, eucalyptus, and thyme oils enhance the body's natural defenses [81].

Antibacterial properties: Certain essential oils, such as tea tree, oregano, and thyme, exhibit antibacterial activity against various pathogens [ ].

Antiviral activity: Oils like peppermint, lemongrass, and cinnamon may help fight viral infections [ ].

Antifungal properties: Clove, lavender, and peppermint oils are effective against fungal infections [ ].

Cytotoxic and anticancer properties: Essential oils like thyme, lemongrass, and ginger have shown cytotoxic effects on cancer cells [,]. These oils may exert anticancer effects through several mechanisms, including the induction of apoptosis by triggering programmed cell death in cancer cells, cell cycle arrest by halting cancer cell proliferation, inhibition of angiogenesis by blocking the formation of new blood vessels needed for tumor growth, and modulation of signaling pathways involved in cancer progression [, , ,].

4.2 Emotional and psychological well-being

Aromatherapy is widely recognized for its emotional and psychological benefits [ ].

Reducing stress: Lavender and bergamot oils are known for their calming effects [,].

Enhancing mood: Citrus oils like orange and lemon uplift and energize [ ].

Improving seep: Oils such as valerian and sandalwood promote restful sleep [ ].

Spiritual and holistic benefits: Many cultures utilize aromatherapy for spiritual and holistic healing, using essential oils like frankincense and myrrh in rituals to enhance meditation and spiritual practices [ ]. Aromatherapy is also incorporated into holistic health practices to balance the body, mind, and spirit. Drawing on techniques from various
being used in spa and massage therapy as complement
supports skin health, detoxification, and emotional ba

4.3 Skin and beauty

Essential oils significantly contribute to skin care [,

Antiaging: Oils like rose and frankincense help reduce signs of aging [ ].

Acne treatment: Tea tree oil is effective for managing acne [ ].

Moisturizing: Oils such as jojoba and almonds with aromatic oils provide hydration [ ].

Hair care: Essential oils stimulate hair follicles and promote growth, such as rosemary oil, lavender oil, and peppermint oil [, ,]. Additionally, essential oils can help maintain a healthy scalp by addressing dandruff and irritation, such as tea tree oil and cedarwood oil [,].

4.4 Pharmaceutical forms of aromatherapy

Internal: Essential oils are incorporated into products like herbal teas [ ] and aromatic beverages, including those made with oregano and thyme [ ]. Capsules such as Rowatinex® (Rx) contain essential oils like α-pinene, β-pinene, camphene, borneol, anethol, fenchone, cineole, and olive oil, which are used internally to promote urinary health [ ]. Additionally, essential oils serve as functional foods and dietary supplements [ ]. Their application as natural additives for extending the shelf life of food products has also gained significant attention [ ].

Topical: Essential oils find extensive use in topical applications such as massage oils [ ]; lotions, creams, and other cosmetic preparations [ ]; and balms and salves [ ]. They are also integrated into bath oils and salts [,], as well as shampoos and conditioners [ ]. Additionally, hydrosols—commonly known as floral waters—are applied directly to the skin, offering a variety of benefits [ ].

External: Essential oils are externally applied in various ways, including through diffusers and sprays to disperse scents into the air [, ,], as well as in inhalation products that offer respiratory relief [,]. They are also used in aromatic candles and incense to create a calming atmosphere [,]. Natural perfumes provide both aromatic and therapeutic benefits [, ,]. Additionally, essential oils are incorporated into household cleaning products and linen sprays, which offer antiseptic properties and refreshing scents, promoting a healthier living environment [,].

5. Safety considerations in aromatherapy

5.1 Toxicity and contraindications

Essential oils should be used with caution to avoid adverse effects. Dilute them to 1–5% in a carrier oil to prevent skin irritation [ ], and perform a patch test to check for allergies or irritation [,]. Consult a professional before using essential oils during pregnancy or on children due to potential risks [ ]. Avoid sun exposure for 12 hours after applying photosensitive oils like bergamot, lemon, and lime [ ]. Ingestion should only occur under the guidance of a healthcare professional, as essential oils can be toxic if swallowed [ ].

5.2 Interactions with medicines

Essential oils can interact with various medications, potentially altering their effectiveness or increasing side effects [ ], such as enhancing bleeding risk with blood thinners [ ], causing serotonin syndrome with antidepressants, affecting blood sugar levels with diabetes medications, counteracting antihypertensives, and increasing sedation with sedatives [ ], so consultation with a healthcare provider is essential.

5.3 Regulatory guidelines

These guidelines include the International Fragrance Association (IFRA), which sets safety standards for fragrance ingredients in consumer products [ ], and the Cosmetic Ingredient Review (CIR), which assesses the safety of cosmetic ingredients, including fragrances [ ].

6. Future directions and innovations in aromatherapy and fragrance industries

The aromatherapy and fragrance industries are undergoing significant evolution driven by technological innovations, expanded therapeutic applications, and integration with modern medicine.

6.1 Technological advancements

Innovations in biotechnology are enabling sustainable frag
unique, non-natural aromas [ ]. Advanced extraction ar
chromatography and nuclear magnetic resonance spectros
and efficacy of essential oils in therapeutic uses [,].
like microencapsulation and nanoemulsions are enhancing
products, leading to the development of solid fragrances a

6.2 Expanded applications

Research is extending aromatherapy's role in managing chronic conditions, mental health issues, and cognitive enhancement. For example, lavender oil is studied for its calming effects, while peppermint oil is used for cognitive stimulation and headache relief [ ]. The trend toward functional fragrances, which offer mood enhancement and stress relief, is also gaining traction as consumers seek products that support overall well-being [ ].

6.3 Integration with modern medicine

Aromatherapy is increasingly integrated into conventional medicine, with healthcare professionals using essential oils in clinical settings to improve patient care. Lavender and peppermint oils are commonly used for their anxiolytic and anti-nausea properties, respectively [ ]. Essential oils are also employed in complementary therapies alongside conventional treatments in areas like palliative care and mental health support [ ].

6.4 Advanced delivery systems

New delivery systems are enhancing the user experience of aromatherapy products. Microencapsulation ensures long-lasting fragrance release, used in scented textiles and personal care items [,]. Nanoemulsions improve the stability and penetration of essential oils in skin care and aromatherapy [,]. Solid fragrances and gels offer portability and convenience [,].

6.5 Personalized fragrances and consumer trends

The rise of artificial intelligence (AI) and genetic testing is enabling the creation of personalized fragrances tailored to individual preferences and body chemistries [,]. Additionally, there is increasing demand for sustainable, eco-friendly practices in the industry, with companies adopting ethical sourcing and eco-friendly packaging to meet consumer expectations [ ].

6.6 Digital and interactive fragrance experiences

The digitalization of fragrance experiences is an emerging trend, with virtual reality (VR) and augmented reality (AR) technologies creating immersive scent explorations in virtual environments [,]. Digital scent technologies, though still experimental, hold potential for future applications in digital media and entertainment [ ].

7. Conclusion

Aromatherapy exemplifies the integration of ancient wisd
foster holistic health and wellness. This practice, rooted in
substances by ancient civilizations, has evolved into a soph
historical contributions of figures such as Albucasis have le

practices, especially within the perfume industry, bridging traditional knowledge with current therapeutic methodologies.

Today, aromatherapy is widely recognized as a comprehensive practice within complementary, alternative, and traditional medicine (CAM/TM). It encompasses a diverse range of techniques, including perfume therapy, functional fragrances, and scent therapy. These methods leverage essential oils and other fragrant substances across pharmaceutical, cosmeceutical, and nutraceutical domains, as well as environmental applications. The growing body of research underscores the potential of aromatherapy as a complementary approach to holistic health, demonstrating its efficacy in enhancing patient experiences and outcomes.

The extensive range of fragrance compounds—both natural and synthetic—plays a pivotal role in tailoring treatments to address specific therapeutic or sensory needs. This versatility extends beyond perfumery to encompass skincare, beauty, and overall well-being. Understanding and utilizing the full spectrum of aromatic substances is crucial for optimizing their therapeutic benefits.

Recent trends highlight not only the sensory pleasure derived from fragrances but also their significant therapeutic effects. Scents influence the central nervous system through the limbic system, affecting relaxation, mood, and overall well-being. This interaction suggests that incorporating pleasant fragrances into daily routines can offer substantial improvements in mental and emotional health.

Looking ahead, ongoing research and technological innovations are expected to unveil new applications for aromatherapy and enhance our understanding of the therapeutic properties of scents. Advances in "perfume engineering," integrating chemistry, neuroscience, and psychology, are advancing our knowledge of how fragrance compounds impact human perception and well-being. This interdisciplinary approach is paving the way for more precise and effective aromatic therapies.

Sustainability presents both challenges and opportunities in the field. Responsible harvesting of aromatic plants is crucial, particularly as demand for eco-friendly products increases. Essential oils are emerging as promising alternatives to harmful chemicals used in pesticides, preservatives, and cleaning agents. Additionally, the growing concern over bacterial resistance highlights the potential of natural compounds like essential oils to complement traditional antibiotics in combating pathogens.

Future research should explore the classification of essential oils based on their temperamental qualities, such as cooling versus warming properties. Understanding how oils with opposing characteristics interact could lead to innovative therapeutic applications and enhance the efficacy of aromatherapy.

In conclusion, the future of aromatherapy is promising, m
expanded therapeutic applications, and greater integratio
recognition of therapeutic fragrances and the evolving fiel
acknowledgment of the benefits of essential oils for holisti
technological progress, and deeper connections with healt

industries are poised for significant growth and a dynamic future, reflecting the continuous evolution of this ancient practice into a modern therapeutic tool.

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Additional information

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The author created all figures presented in this manuscript.

Acronyms and abbreviations

TCM	Traditional Chinese Medicine
UM	Unani medicine

IFRA	International Fragrance Association
CIR	Cosmetic Ingredient Review
GC	gas chromatography
MS	mass spectrometry
OR	optical rotation
RI	refractive index
SG	specific gravity
SAR	structure–activity relationships
PR	Perfumery Radar
NMR	nuclear magnetic resonance spectroscopy
FW	fragrance wheel
MH	Modified Hexagon
H&R	H&R Catalog
FR	Fragrantica
OZ	Osmoz
Rx	Rowatinex®
CAM/TM	complementary, alternative, and traditional medicine

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