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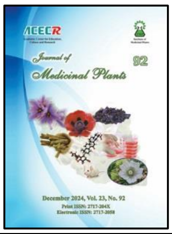

Review Article

The efficacy of 95% pure portable oxygen enhanced with essential Oils: A comprehensive review of oxygen and aromatherapy

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ABSTRACT

This review article explored the significance of 95% oxygen supplementation, particularly in recreational and therapeutic contexts. It explores the physiological advantages of oxygen, particularly in conjunction with natural essential oils like *Lavandula angustifolia*, *Boswellia carterii*, *Mentha piperita*, *Eucalyptus globulus*, *Citrus paradisi*, *Salvia rosmarinus*, and *Citrus sinensis*. The article highlights the possible benefits of oxygen supplementation for physical performance, recuperation, and general well-being by synthesizing evidence from several research and publications. The implications for athletes, wellness enthusiasts, and individuals seeking enhanced recovery are discussed, along with the recommendations for future research. Furthermore, the review addresses the practical applications of portable oxygen in urban environments, where air quality may be compromised. By considering the holistic benefits of oxygen and essential oils, this article aimed to provide a comprehensive understanding of their role to promote health and wellness.

1. Introduction

Oxygen is a fundamental element that plays a critical role in sustaining life. It is essential for the cellular respiration, a process that converts nutrients into energy, which is vital for all bodily functions. The average atmospheric oxygen concentration is approximately 21%, which is sufficient for most individuals under normal conditions. However, during periods of intense physical exertion or in environments with lower oxygen availability, the body may require additional oxygen to maintain optimal performance and recovery [1-3].

Supplemental oxygen consumption, especially at 95% concentrations, has become more and more common in recent years among athletes, wellness enthusiasts, and others looking to better their health. An increasing amount of

Abbreviations: AMS, Acute Mountain Sickness; Eos, Essential Oils; COD, Cerebral Oxygen Delivery; CVR, Cerebrovascular Resistance; COPD, Chronic Obstructive Pulmonary Disease; HACE, High Altitude Cerebral Edema; HAPE, High Altitude Pulmonary Edema; NO_2, Nitrogen Dioxide; PM, Particulate Matter; PEO, Peppermint Essential Oil; ROS, Reactive Oxygen Species; SO2, Sulfur Dioxide

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studies indicates that oxygen supplementation may improve general health, speed up recovery, and boost physical performance, which has propelled this trend. Furthermore, adding essential oils to oxygen supplements has become a cutting-edge strategy to enhance these advantages even more. Essential oils are extracted from a variety of plants and have been shown to have anti-inflammatory, analgesic, and respiratory effects [4-6]. This review's objective is to provide a thorough analysis of the most recent research on the advantages of 95 % oxygen supplementation, especially when paired with essential oils. This article discussed the physiological mechanisms underlying oxygen supplementation, the synergistic effects of essential oils, and the implications for various populations, including athletes and individuals seeking enhanced recovery. Furthermore, the article highlighted the potential applications of oxygen supplementation in the clinical and recreational settings, providing a valuable resource for healthcare professionals, researchers, and consumers [7, 8].

In recent years, the combination of essential oils and oxygen supplements has drawn interest due to its potential to improve performance and overall health. Essential oils provide a variety of medicinal advantages, whereas oxygen is necessary for cellular respiration and energy creation. In this review, the significance of 95 % oxygen is analyzed in a variety of contexts, such as urban environments with high air pollution, high-altitude mountaineering, and its synergistic effects with essential oils. By comprehending these dynamics, we can gain a more profound understanding of the function of oxygen and essential oils in the promotion of health and well-being [9-11]. See Figure 1 for the user demographics. Table 1 provides a summary of the physiological benefits of 95 % oxygen supplementation.

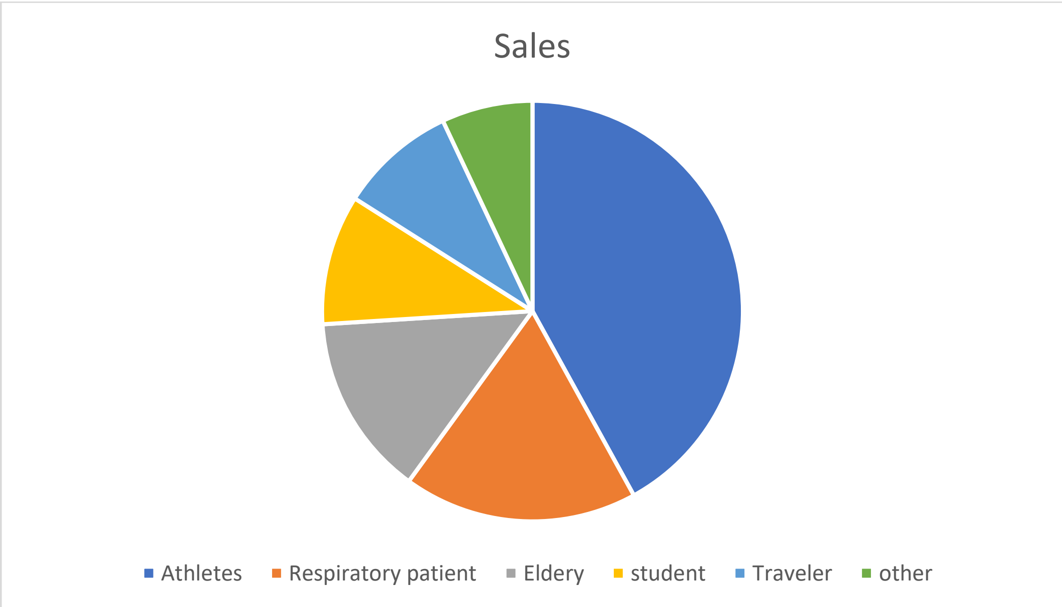

Fig. 1. User demographics

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Table 1. Summary of Physiological Benefits of 95% Oxygen Supplementation

Benefit	Description	Supporting Studies
Improved Endurance	Increases aerobic capacity	X. Woorons et al (2021), J. Suchy et al (2010)
Reduced Fatigue	Enhances recovery time	Y. Yokoi et al (2014), M. Segizbaeva et al (2009)
Acceleration of Recovery	Shortens muscle repair time	T. Mihailovic et al (2023), M. Mallette et al (2018)
Enhanced Respiratory Function	Supports individuals with pre-existing conditions	T.K.H. Fung et al (2021), H.M. Tran et al (2023)
Increased Mental Clarity	Potential psychological benefits	J. Suchy et al (2010), C. Zinner et al (2019)

1.1. Hypoxia of oxygen

A deficiency in the quantity of oxygen that reaches tissues is referred to as oxygen hypoxia, and it can result in a variety of physiological responses and health issues. It can manifest in a variety of settings, such as among elderly patients, athletes, mountaineers, and in air pollution-prone environments. Hypoxia can exacerbate pre-existing conditions in elderly patients, including chronic obstructive pulmonary disease (COPD), cardiac failure, and other respiratory conditions. Their overall lung function and physical resilience are often diminished in terms of aging, making them more susceptible to hypoxic episodes. As oxygen levels drop, symptoms can include confusion, lethargy, and increased heart rate, which can lead to severe complications if not addressed. Athletes, particularly those engaging in high-intensity training, may experience hypoxia during exertion. While they can often acclimate to lower oxygen levels, chronic hypoxia can result in the compromised performance, muscle fatigue, and prolonged recovery times. Intermittent hypoxia exposure, such as from altitude training, can enhance athletic performance, but excessive or prolonged hypoxia can be detrimental, leading to altitude sickness or other health issues [12-17].

Mountaineers have an inherent risk of hypoxia while climbing to high elevations owing to reduced atmospheric pressure and less oxygen supply. Acute Mountain Sickness (AMS) may arise from fast elevation gain, manifesting as headaches, nausea, and dizziness, perhaps progressing to more serious ailments like High Altitude Pulmonary Edema (HAPE) or High Altitude Cerebral Edema (HACE). Effective acclimatization and symptom awareness are essential for safety. In urban areas with high air pollution, people are often exposed to particulate matter that can impair lung function and lead to chronic respiratory conditions. Poor air quality can exacerbate present hypoxic conditions, as pollutants can cause inflammation and restrict airflow, further diminishing oxygen delivery to tissues. Vulnerable populations, such as the elderly or those with pre-existing health issues, are at greater risk for the deleterious effects of hypoxia in polluted environments. So, oxygen hypoxia poses significant risks across diverse contexts, highlighting an urgent need for appropriate monitoring, acclimatization strategies, and interventions to protect vulnerable populations. Increased awareness about the signs and symptoms of hypoxia can help mitigate its effects, promoting better health outcomes in the face of these risk factors [18-23].

1.2. Hyperoxia of oxygen

Hyperoxia is a condition defined by an elevated concentration of oxygen in the tissues and circulation, above normal physiological limits. Oxygen is essential for cellular metabolism; nevertheless, excessive quantities may result in harmful consequences owing to oxidative stress. Hyperoxia often arises from ambient exposure to elevated oxygen concentrations, therapeutic oxygen delivery, or when persons are subjected to hyperbaric chambers. In normal atmospheric conditions, oxygen concentration is around 21%. Breathing

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in oxygen-rich environments, such as those found in the hyperbaric therapy, can significantly increase oxygen saturation. While hyperbaric oxygen therapy is often used to treat conditions like decompression sickness, carbon monoxide poisoning, or chronic non-healing wounds, improper use can lead to hyperoxia. Physiologically, hyperoxia can lead to several complications. Oxidative stress, which happens when the body's antioxidant defenses are overpowered by the creation of reactive oxygen species (ROS), is one of the most serious issues. Lipid peroxidation, protein oxidation, and DNA damage are among the biological harms that might result from this process. In extreme situations, it may result in hyperoxic pulmonary edema, a condition in which the lungs fill with fluid and cause respiratory difficulties. [24–27]The symptoms of hyperoxia include visual disturbances, dizziness, respiratory problems, and, in extreme cases, convulsions or loss of consciousness. Central nervous system toxicity can occur with high pressure or prolonged exposure to elevated oxygen levels. Vulnerable groups, including elderly patients and those with certain medical conditions, may experience exacerbated effects of hyperoxia [28-30].

In clinical settings, oxygen administration is guided by careful monitoring, with oxygen therapy typically limited to the lowest effective dose to maintain adequate blood oxygen levels. The awareness of hyperoxia's potential risks is essential for healthcare providers, particularly in environments where supplemental oxygen is administered or in high-pressure scenarios. So, while oxygen is vital for life, hyperoxia represents a delicate balance that can have serious health implications if not managed properly. Understanding both its benefits and risks is crucial for safe therapeutic practices and preventing adverse effects [31-34].

1.3. The importance of using essential oils in the formulation of 95% pure oxygen

ISO characterizes essential oils as products derived from raw plant materials via processes like steam distillation, which can include methods, such as hydrodistillation, or other similar techniques. These oils are intricate blends of volatile substances, predominantly comprising high levels of terpenes, particularly monoterpenes, and sesquiterpenes. Essential oils (EOs) are sourced from various plants which are known for their active ingredients that possess therapeutic properties. Research indicates that several types of EOs offer a broad spectrum of health advantages. Prior studies have shown the potential of lavender essential oil in preventing and treating anxiety and depression symptoms. Numerous processes, such as the management of endocrine functions, the increase of neurogenesis, the stimulation of neurotrophic factor synthesis, and the manipulation of monoamine levels, may be responsible for the favorable outcomes [35, 36]. The active components of EOs can access the brain via two primary routes: the olfactory system and the respiratory system. Upon inhalation, EO molecules may target the olfactory mucosa directly or enter the respiratory tract. These delivery methods hint at varying mechanisms of action. Different physiological responses can be initiated, such as enhanced neurogenesis, hormonal regulation, the activation of specific brain regions, and changes in blood chemistry, all of which can ultimately influence mood and emotional states [35].

1.4. Eucalyptus globules (Eucalyptus) essential oil

Eucalyptus globulus, also called blue gum eucalyptus; Eucalyptus dives, also called broad-leaved peppermint eucalyptus; Eucalyptus citriodora, also called lemon-scented eucalyptus;

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Eucalyptus radiata, also known as narrow-leaved peppermint gum; Eucalyptus smithii, also called gully gum; and Eucalyptus polybractea, also called blue mallee, are important species of Eucalyptus that are known for producing essential oils. Numerous subspecies and chemotypes exist within each of these species, creating a complicated situation that produces essential oils with a range of chemical compositions and traits. Citronellal, cineole, camphene, fenchene, limonene, phellandrene, and pinene are the primary components often found in eucalyptus oils. Each species presents its own unique proportions of these components (estimated percentages are provided):

E. globulus: α-pinene (11%), *β*-pinene (0.15%), *α*-phellandrene (0.09%), 1,8-cineole (69%), limonene (3.3%), aromadendrene (1.6%), globulol (5.33%).

Eucalyptus dives: piperitone (40–50%), phellandrene (20–30%), globulol (6%), 1,8-cineole (0.45%), limonene (0.3%), terpineol-4 (4%), p-cymene (3.4%).

Eucalyptus citriodora: citronellal (56%), citronellol (8%), 1,8-cineole (2%), *γ*-terpinyl acetate (2%), citronellic acid (5.5%), citronellyl acetate (11.5%).

Eucalyptus radiata: α-pinene (15–21%), 1,8-cineole (57–71%), limonene (5%), p-cymene (0.3–1%).

Eucalyptus smithii: α-pinene (4.1%), *β*-pinene (0.1%), 1,8-cineole (81%), terpineol-4 (0.1%), globulol (2.4%).

Eucalyptus polybractea: α-pinene (0.9%), *β*-pinene (0.25%), 1,8-cineole (92%), limonene (1.1%), terpineol-4 (0.5%), globulol (0.05%) [37-41].

Eucalyptus essential oil is renowned for its therapeutic benefits, particularly in alleviating respiratory issues. It acts as a powerful anti-inflammatory agent, helping improve the inflammation of mucous membranes in the respiratory tract. Furthermore, eucalyptus oil is known to rejuvenate the skin and disinfect the respiratory passages, facilitating easier breathing and promoting overall respiratory health. The invigorating aroma of eucalyptus can enhance mental clarity and focus, especially useful during physical exertion or recovery [3, 42].

1.5. Citrus paradisi (Grapefruit) essential oil

Citrus paradisi is a significant species within Citrus genus, belonging to the Rutaceae family. It was utilized as a traditional remedy across numerous cultures in terms of its antibacterial, antifungal, anti-inflammatory, antimicrobial, antioxidant, antiviral, astringent, and preservative properties. Grapefruit is also known for its ability to prevent cancer, enhance heart health, lower cholesterol, promote cellular regeneration, detoxify, manage diseases including rheumatoid arthritis and lupus nephritis, and help with weight control. In order to provide researchers a thorough grasp of grapefruit's potential advantages, this paper attempts to highlight the fruit's pharmacological qualities for a range of therapeutic uses. Scientists may use this combined data to help create novel drugs that combine many effects into one formulation [43, 44]. Grapefruit essential oil improves mood and lowers daily stress, which has a major positive impact on mental health. People may be energized by its energizing and uplifting aroma, which makes it the ideal partner for morning routines or pre-workout rituals. while grapefruit essential oil and oxygen infusion are combined, they may improve emotional states and lessen sensations of exhaustion, which will encourage a more upbeat attitude while exercising [13]. The average amount of essential oil in *C. paradisi*, as determined by hydrodistillation, was 0.4%. The

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primary components of this oil were found to be monoterpene hydrocarbons ($C_{10}H_{16}$), with limonene accounting for 74.45% of the overall oil content, followed by myrcene (12.85%), alpha-pinene (3.74%), and 4(10) thujene (1.21%). Oxygenated monoterpenes, which included n-decanal (1.18%) and (+)-(S)-carvone (0.93%), made up 2.11% of the oil. Only copaene (0.96%) and trans-caryophyllene (1.55%) were found in the oil, which had a sesquiterpene ($C_{15}H_{24}$) concentration of 2.51% [43, 45, 46].

1.6. Mentha piperita (Peppermint) essential oil

Mentha piperita, sometimes called peppermint, is a genus of plants in the Lamiaceae family, also called the mint family, and it grows widely in temperate regions of the world. Peppermint essential oil (PEO) and other non-essential components are among the many chemicals found in this plant. A mixture of volatile metabolites, PEO is mainly made up of menthol, menthone, neomenthol, and iso-menthone. These compounds have a variety of uses, such as anti-inflammatory, antibacterial, antiviral, scolicidal, immunomodulatory, antitumor, neuroprotective, antifatigue, and antioxidant effects [47, 48]. The power of peppermint essential oil to improve alertness and attention is well known. Peppermint's cool and revitalizing aroma not only lifts your spirits but also gives you a boost of energy that you may feel almost instantly. For athletes who want to improve their performance, this oil is very helpful since it helps concentrate the mind, which makes it easier to be more determined and focused during training or competition [14, 49]. The aerial portions of the flowering plant are typically used to extract the essential oil from *M. piperita* through steam distillation. The unprocessed essential oil frequently undergoes additional redistillation or rectification after extraction to eradicate objectionable sulfur compounds, particularly dimethyl sulfide. This oil is typically a colorless to light yellow or greenish oily liquid that has a distinct fresh aroma and flavor. The essential oil is composed of the following main constituents: *α*-pinene, *β*-pinene, sabinene, myrcene, cis-ocimene, *β*-caryophyllene, *γ*-terpinene, germacrene D, carvone (3.5%), L-menthol (38-70%), L-menthone (0.4-35%), isomenthone (1.5-10%), menthyl acetate (0-20%), eucalyptol (1,8-cineole) (0.4-12%), menthofuran (0.1-21%), limonene (0.6-4.5%), pulegone (traces-7%), and neoisomenthol [50, 51].

1.7. Boswellia carterii (Frankincense) essential oil

The volatile oil derived from ***Boswellia carterii*** is predominantly composed of monoterpenes, sesquiterpenes, and ester compounds. A notable 97.3% of oil consists of monoterpenes, with E-*β*-ocimene and limonene being key components. The remaining 2.7% comprises sesquiterpenes, with E-caryophyllene serving as the primary constituent among them [52].

The monoterpenes identified include Boswellic acid(0.05-15%), 2-*β*-pinene (0.1%), *α*-thujene (6.6%), E-*β*-ocimene (32.3%), 2,4(10)-thujadiene (0.2%), camphene (0.6%), sabinene (5.2%), 1-β-pinene (1.8%), myrcene (6.9%), *α*-pinene (5.3%), 2-carene (0.8%), limonene (33.5%), Z-*β*-ocimene (0.2%), *γ*-terpinene (1.0%), terpinolene (0.4%), p-cymene (0.2%), 1,4-cyclohexadiene (0.1%), perillene (0.1%), isopentyl-2-methylbutanoate (0.1%), isomyl valerate (0.1%), 1,3,6-trimethylenecycloheptane (0.1%), β-thujone (0.1%), α-campholene aldehyde (0.2%), allo-ocimene (0.1%), trans-pinocarveol (0.1%), p-mentha-1,5-dien-8-ol (0.2%), 4-terpineol (0.2%), sabinyl acetate (0.1%), myrtenal (0.1%), α-terpineol (0.1%), *α*-phellandrene epoxide (0.1%), verbenone (0.1%),

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trans-(+)-carveol (0.1%), carvone (0.1%), and 1-bornyl acetate (0.1%) [53].

The identified sesquiterpenes include *α*-cubebene (0.1%), *α*-copaene (0.3%), *β*-bourbonene (0.1%), *β*-elemene (0.3%), *α*-gurjunene (0.1%), E-caryophyllene (0.9%), *α*-humulene (0.2%), allo-aromadendrene (0.1%), α-amorphene (0.1%), germacrene D (0.1%), *β*-selinene (0.1%), α-selinene (0.1%), *α*-muurolene (0.1%), *γ*-cadinene (0.1%), caryophyllene oxide (0.01%), and *γ*-muurolene (0.1%) [53].

Frankincense essential oil is renowned for its ability to heal the epidermis. It protects against the aging effects of environmental pollution and daily stress by assisting in the regeneration of the skin's collagen tissue. Frankincense oil is a valuable addition to oxygen therapy that is designed to enhance beauty by promoting skin rejuvenation, which helps facial skin appear fresh and radiant. Its grounding fragrance can also alleviate anxiety and tension, providing dual advantages for both physical and mental health [54].

1.8. Salvia rosmarinus (Rosemary) essential oil

The herb *Rosmarinus officinalis* L. (family Lamiaceae; also known as *Salvia rosmarinus* Schleid. and *Rosmarinus angustifolius* Mill.) is extensively employed worldwide. It is frequently implemented in traditional and local medicine to treat inflammation-related ailments. The anti-inflammatory properties of its essential oil have been recently demonstrated in recent research. Furthermore, rosemary has been acknowledged as an effective food preservative as a result of its potent antioxidant and antimicrobial properties [55]. 1,8-cineole, *α*-pinene, camphor, bornyl acetate, borneol, camphene, *α*-terpineol, limonene, *β*-pinene, *β*-caryophyllene, and myrcene are among the essential oil's primary chemical constituents. Caryophyllene (16.7%) and Rosmarinic acid (5%) were identified as the primary compounds in the oil extracted from the stems, while 1,8-cineole is the predominant component (35.8%) of phytochemicals derived from the oil of rosemary leaves. In contrast, caryophyllene oxide (11.9%) was the chief component present in oil taken from the flowers. However, the leaves are the most frequently used part of the plant for extraction purposes.

The essential oil phytochemicals of 40 distinct wild rosemary samples were comprehensively surveyed, revealing a total of 82 distinct molecules. These molecules were categorized into three main groups: monoterpene hydrocarbons, oxygenated monoterpenes, and sesquiterpenes. Components that did not belong to these categories were classified as "others." The most prevalent compounds were α-pinene (11.8–39.8%) and camphene (3.2–12.1%), with the proportion of monoterpene hydrocarbons in the overall oil content ranging from 20.9% to 65.6% in this analysis. In addition, limonene, β-pinene, terpinolene, and β-myrcene were identified as monoterpene hydrocarbons. The oil composition was predominantly composed of 1,8-cineole (0.1–62.7%) and camphor (2.6–30.5%), with notable concentrations of borneol, linalool, and verbenone. Oxygenated monoterpenes accounted for 27.7% to 74.3% of the oil. Lastly, sesquiterpenes accounted for 0.6% to 7.2% of the composition, with *β*-caryophyllene being the most prevalent; however, no single sesquiterpene exceeded 1%. The "others" category comprised 0.2% to 2.2% of the total sample, with no single compound exceeding 1%. Octan-3-one was the most prominent molecule in this group [56]. Rosemary essential oil is known for its capacity to improve blood circulation, which is essential for overall health. It has relaxing properties that relieve pain and enhance memory. When combined with oxygen supplementation, rosemary oil may help

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athletes recover more quickly from physical exertion while improving cognitive performance. The stimulating scent of rosemary can invigorate senses, enhancing alertness and focus during training or competition [18, 57].

1.9. Citrus sinensis (Orange) essential oil

Citrus sinensis is a plentiful source of vitamin C, a potent natural antioxidant that strengthens the immune system, and is widely cherished worldwide. Historically, it has been employed to ameliorate a variety of health conditions, such as constipation, cramping, indigestion, diarrhea, bronchitis, tuberculosis, coughing, colds, obesity, menstrual irregularities, angina, high blood pressure, anxiety, melancholy, and tension. This fruit is also recognized for its medicinal properties, which are attributed to the presence of a diverse array of secondary metabolites. The fruit, peel, leaves, juice, and roots of *C. sinensis* contain a variety of chemical compounds that can be categorized into the following groups: flavonoids, steroids, hydroxyamides, alkanes, fatty acids, coumarins, peptides, carbohydrates, carbamates, alkylamines, carotenoids, volatile compounds, and essential minerals such as potassium, magnesium, calcium, and sodium [58]. A substantial amount of monoterpene hydrocarbons, 96.11% and 97.08% of the total composition, is present in two samples of commercial orange oils. Limonene is the most prevalent monoterpene in both oils, with a concentration of 90.41% and 89.78%, respectively. Myrcene is the second most prevalent monoterpene, with a concentration of 3.19% and 3.05%, respectively. *γ*-terpinene and α-pinene were also detected in quantities exceeding 1% (1.75% and 1.12%, respectively). Linalool is the primary compound present in both kinds of commercial essential oils (0.55% and 0.83%, respectively) among the oxygenated monoterpenes. Furthermore, mentha-2,8-dien-1-ol, sabinene hydrate, and linalyl acetate have been identified. Also present are minor quantities of sesquiterpenes, including both hydrocarbon and oxygenated forms [59].Orange essential oil plays a vital role to enhance the respiratory system and blood circulation. Its soothing and anti-inflammatory properties make it a beneficial addition to oxygen supplementation, contributing to easier breathing and relaxation. The energizing scent of orange helps elevate mood, promoting a sense of happiness and motivation, which can be particularly advantageous for individuals engaged in rigorous physical activity [58, 60].

1.10. Lavandula angustifolia (Lavender) essential oil

The practice of aromatherapy is experiencing a resurgence in contemporary society, with lavender being the most widely purchased plant for essential oil extraction on a global scale. Lavender essential oil is renowned not only as an alternative medicine, but also as an ingredient in many over-the-counter health and beauty products. Historically, products derived from the well-known garden herb, Lavender (Lavandula spp.), were used for therapeutic purposes for centuries. The more recent development of essential oils extracted from these plants gained popularity as antibacterial agents during World War II. Traditionally, this oil is thought to possess sedative, carminative, antidepressant, and anti-inflammatory effects, alongside its well-documented antimicrobial properties. The main constituents of the analyzed lavender oil include linalyl acetate (28.9%), linalool (24.3%), caryophyllene (7.9%), trans-3,7-dimethylocta-1,3,6-triene (4.6%), 4-terpineol (4.0%),

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lavandulyl acetate (3.5%), borneol (2.6%), and eucalyptol (2.05%) [61, 62].

Perhaps one of the most extensively researched essential oils, lavender is recognized for its antimicrobial, anti-inflammatory, and tranquil properties. It has been demonstrated to enhance the quality of sleep and fortify the immune system by functioning as a potent antioxidant. Based on a 2022 study, lavender can induce relaxation by affecting the limbic system in the brain, which controls emotions. Another study in 2019 highlighted that inhaling lavender significantly reduced stress levels in participants. Incorporating lavender oil with oxygen can provide a foundational approach to reducing anxiety and promoting relaxation, essential for both physical performance and recovery (Table 2) [63, 64].

Table 2. Chemical composition of essential oils used in Oxygen supplementation

Essential Oil	Key Aromatic Components	Primary Health Benefits	Concentration of Key Aromatic Compounds in Essential Oil (%)
Eucalyptus	Eucalyptol	Respiratory health, antimicrobial	0.5 - 19%
Grapefruit	Limonene	Mood enhancement, stress reduction	55 - 85%
Peppermint	L-menthol	Improved alertness, pain relief	38 - 70%
Frankincense	Boswellic acid	Anti-inflammatory, stress relief, skin-repairing	Traces - 15%
Rosemary	Rosmarinic acid	Cognitive function support, antioxidant properties	1 - 5%
Orange	Limonene	Mood elevation, relaxation	50 - 90%
Lavender	Linalool	Anti-anxiety, relaxation	5 - 30%

1.11. The importance of Oxygen for high-altitude climbing

The atmospheric pressure decreases at elevations exceeding 8,000 feet (approximately 2,400 meters), leading to a substantial decrease in the partial pressure of oxygen. Symptoms of altitude sickness, such as migraines, vertigo, disorientation, and fatigue, may result from this decrease. These symptoms can impede the ascent of climbers and elevate the likelihood of severe health complications [65]. Oxygen supplementation provides climbers with a means to counteract the effects of reduced oxygen availability. By inhaling supplemental oxygen, climbers can increase their blood oxygen saturation levels, which helps maintain optimal physiological function. This is particularly important during strenuous activities, such as climbing steep ascents or navigating challenging terrain, where the demand for oxygen is heightened People and animals in high-altitude areas face challenges, such as cold temperatures, low humidity, elevated ultraviolet radiation, and reduced air pressure. Individuals who are unaccustomed may be vulnerable to altitude sickness while rising to heights beyond 2500 m. Nonetheless, the signs and symptoms of acute mountain sickness (AMS) are non-specific and may mimic a range of other medical diseases and environmental factors. The severity of AMS is affected by the rate of climb, the attained altitude, and individual physiological reactions to a low-pressure atmosphere. Ascending to high elevations exposes persons to a diminished ambient partial pressure of oxygen, leading to a reduction in oxygen availability for body tissues [65, 66]. Below are some of the main benefits of oxygen for climbers:

Enhanced Physical Performance: Supplemental oxygen can improve endurance and strength, allowing the climbers to perform at higher levels for extended periods. This is especially beneficial during long ascents or when tackling difficult routes that require sustained effort.

Improved Recovery: Climbing at high altitudes can lead to muscle fatigue and soreness. Oxygen supplementation aids in the recovery

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process by promoting faster healing and reducing inflammation, enabling climbers to bounce back more quickly between climbs [66].

Cognitive Function: Adequate oxygen supply is essential for maintaining cognitive function, including decision-making and coordination. Supplemental oxygen can help climbers stay alert and focused, reducing the risk of accidents and improving overall safety [66].

Reduced Risk of Altitude Sickness: By maintaining higher oxygen saturation levels, climbers can mitigate the risk of altitude sickness. This is particularly important for those attempting to summit peaks at extreme altitudes, where the likelihood of developing altitude-related illnesses is significantly increased [67].

Increased Confidence: Knowing that supplemental oxygen is available can provide climbers with a psychological boost, allowing them to push their limits with greater confidence. This mental aspect is crucial in high-stakes environments where fear and anxiety can affect performance [68].

Fig. 2 illustrates how cerebral oxygen delivery (COD) changes across various altitudes (150m, 3,610m, 4,750m, and 5,260m) during exercise intensities of 30%, 50%, 70%, and at VO2 max (maximal oxygen consumption). At sea level (150m), the body's ability to deliver oxygen to the brain remains relatively stable, even as exercise intensity increases. However, as altitude increases, cerebral oxygen delivery begins to decline, particularly at high altitudes of 4,750m and 5,260m, which corresponds to significant elevations where oxygen availability is naturally lower. The graph demonstrated that while oxygen delivery at baseline remains relatively stable across altitudes, a significant drop occurs at higher altitudes during intense exercise. At 3,610m, the delivery starts to decrease markedly when exercise intensity approaches 70% and reaches its maximum. This decline was more dramatic at 4,750m and especially at 5,260m, where oxygen delivery became severely impaired during maximal exercise efforts. This trend highlighted the physiological stress the brain experiences at high altitudes, where the reduced atmospheric pressure and oxygen availability led to compromised oxygen delivery. This graph supports the need for portable oxygen supplementation for mountaineers. Oxygen in a portable canister can help restore cerebral oxygen delivery, especially during periods of physical exertion when oxygen demands are highest. Thus, it can prevent altitude-related issues such as hypoxia, dizziness, and cognitive impairments [69].

Fig. 3 examines cerebrovascular resistance (CVR), which reflected the brain's blood vessel response to maintain adequate oxygen supply despite fluctuating oxygen levels. The graph shows how CVR varied across altitudes and exercise intensities. At sea level (150m), CVR remains relatively stable, even with increased physical effort. However, as the altitude increases, the body compensates for reduced oxygen levels by increasing cerebrovascular resistance, as shown by the significant upward trend at altitudes of 3,610m, 4,750m, and 5,260m, particularly at higher exercise intensities. This increase in CVR is a natural physiological response to preserve oxygen delivery to the brain in the face of declining oxygen availability. As altitude increases, the resistance reached its peak at 5,260m during VO2 max [70]. This was a crucial finding because the increased CVR can impair blood flow to the brain, exacerbating the effects of oxygen deficiency, and potentially leading to altitude sickness or worse, cerebral edema. The figure highlighted the importance of oxygen supplementation during mountaineering or other high-altitude activities. By providing an external source of oxygen, portable canisters can help reduce cerebrovascular

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resistance, allowing for better blood flow to the brain and ensuring a more stable oxygen supply. This would be particularly beneficial at extreme altitudes where the natural compensatory mechanisms of the body, such as increasing cerebrovascular resistance, might no longer be sufficient to meet the oxygen demands of the brain, especially during high-intensity activities [71].

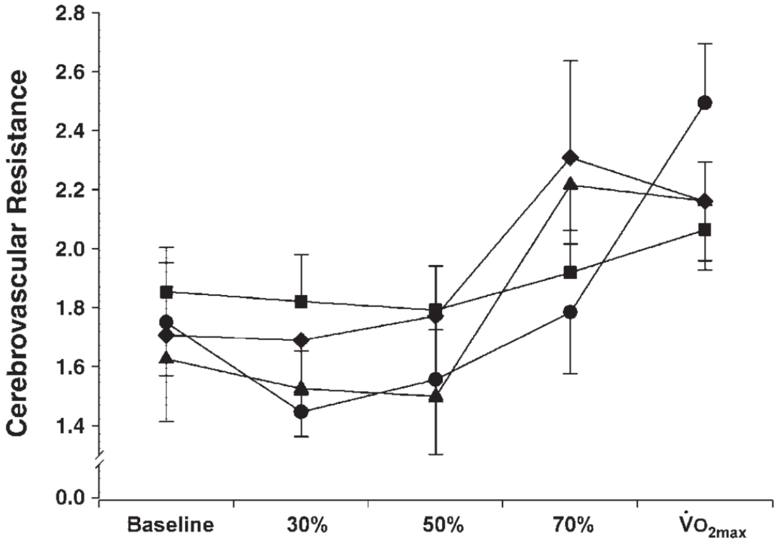

Fig. 2. Changes in cerebrovascular resistance at different altitudes (■, 150 m; ♦ , 3,610 m; ● , 4,750 m; ▲, 5,260 m). Values are means and SE. Resting values did not change with increasing altitude. Resting and V˙ O2 max values were not significantly different at 150 m but rose at 3,610 m ($P < 0.05$), 4,750 m (not significant), and 5,260 m ($P < 0.0001$)

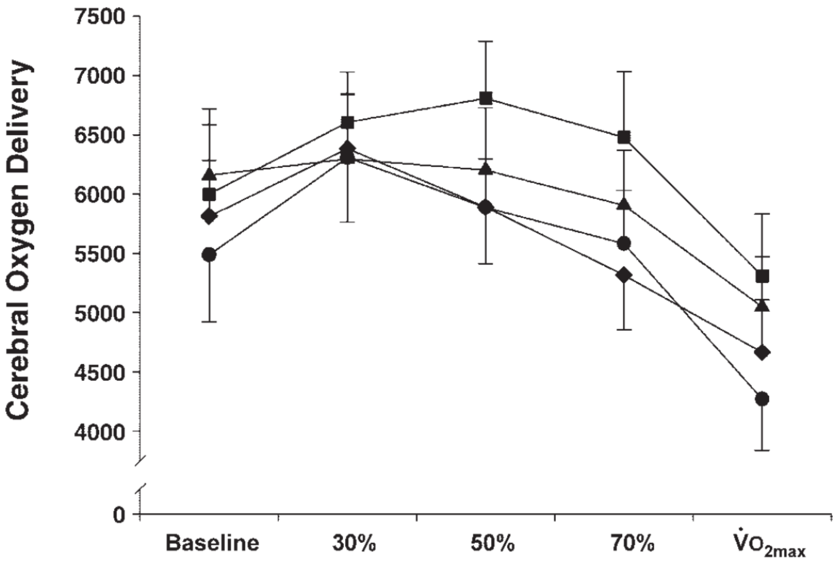

Fig. 3. Changes in cerebral oxygen delivery at different altitudes (■, 150 m; ♦ , 3,610 m; ● , 4,750 m; ▲ , 5,260 m). Values are means and SE. Resting values did not change with increasing altitude. Resting and V˙ O2 max values were not significantly different at 150 m but fell at 3,610 m ($P < 0.01$), 4,750 m ($P < 0.01$), and 5,260 m ($P < 0.01$).

1.12. The role of Oxygen VS air pollution on health

Densely populated urban areas often have substantial issues with air quality, mostly because to elevated pollution levels from cars, industrial operations, and many other sources. Subpar air quality may adversely impact population health, resulting in respiratory disorders, cardiovascular ailments, and diminished general wellness. In these conditions, portable oxygen has become an essential resource for persons aiming to alleviate the detrimental impacts of air pollution and sustain good health. Air pollution is a significant environmental risk factor that may aggravate pre-existing health disorders and facilitate the emergence of new ones. Common pollutants, including particulate matter (PM), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2), may irritate the respiratory system, resulting in symptoms such as coughing, wheezing, and dyspnea. Chronic conditions, such as asthma, chronic obstructive pulmonary disease (COPD), and cardiac disease, are linked to prolonged exposure to contaminated air. Particularly during peak traffic hours or in industrial zones, the concentration of these pollutants can reach hazardous levels in densely populated urban areas. Vulnerable populations, such as the elderly, infants, and those with pre-existing health conditions, are at higher risk [72]. Consequently, it is imperative for individuals who reside in or frequently visit these polluted environments to ensure that they have access to sufficient oxygen levels. Some of the advantages and importance of portable oxygen in polluted urban air are mentioned below:

Enhanced respiratory function: Portable oxygen can provide immediate relief for individuals experiencing difficulty breathing in terms of poor air quality. By inhaling supplemental oxygen, individuals can improve their oxygen saturation levels, alleviating symptoms of hypoxia and enhancing overall respiratory function.

Support for individuals with pre-existing conditions: For those with chronic respiratory conditions, such as asthma or COPD, portable oxygen can be a lifeline. It allows individuals to manage their symptoms effectively, enabling them to engage in daily activities without the fear of exacerbating their condition in terms of pollution.

Increased physical activity: Poor air quality can discourage outdoor activities, leading to a sedentary lifestyle. Portable oxygen enables individuals to exercise outdoors, even in polluted environments, by providing the necessary oxygen support to counteract the effects of pollution on their respiratory system.

Improved quality of life: Access to portable oxygen can significantly enhance the quality of life for individuals living in polluted cities. It allowed them to participate in social activities, pursue hobbies, and maintain an active lifestyle without being hindered by the adverse effects of air pollution.

Psychological benefits: The availability of portable oxygen can provide peace of mind for individuals concerned about air quality. Knowing that they have access to supplemental oxygen can reduce anxiety and stress related to health risks associated with pollution, allowing them to navigate urban environments with greater confidence [73-75].

1.13. Hyperoxia effect during moderate-intensity cycling

Fig. 4 shows the average blood lactate concentration (in millimoles per liter) during visits before and after hyperoxia (oxygen consumption) and normoxia (normal oxygen

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conditions). The graph comprises four primary sections: The blood lactate concentration is approximately 1.2 millimoles per liter prior to hyperoxia. The concentration of blood lactate increases significantly following hyperoxia, reaching approximately 1.5 millimoles per liter. Based on the asterisk (*), this difference is statistically significant ($P < 0.05$). Before normoxia, the blood lactate concentration is slightly above 1 millimole per liter, and after normoxia, the concentration of lactate significantly increased to about 1.8 millimoles per liter, which is statistically significant compared to other conditions ($P < 0.05$) [75].

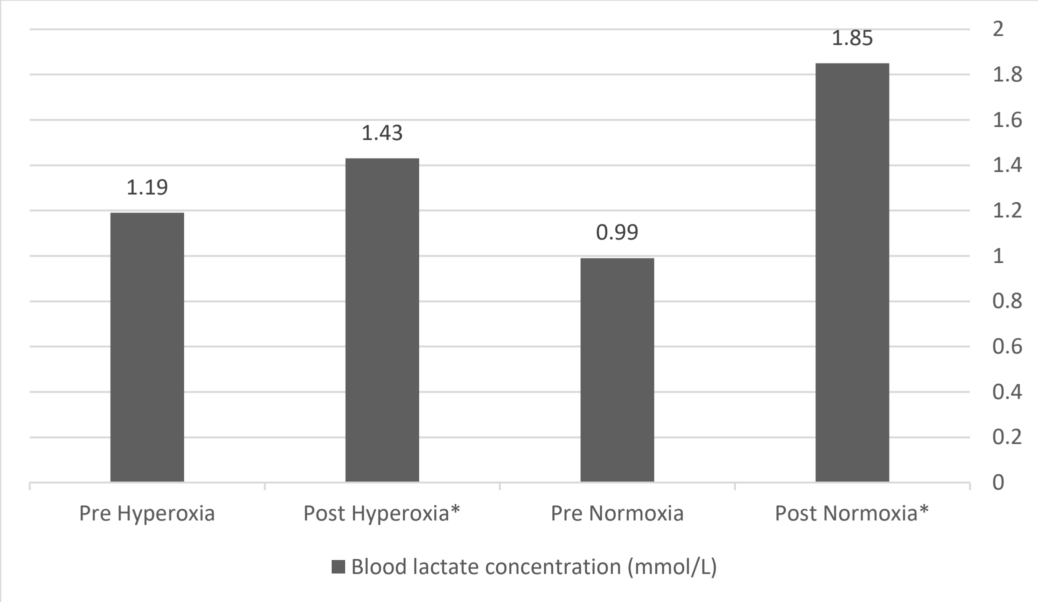

Fig. 4. Displays mean blood lactate concentration (mmol/L) during the pre and post hyperoxia and normoxic visits

These data indicate that following exercise in hyperoxic and normoxic conditions, blood lactate concentration increases; however, the increase in normoxia is greater than in hyperoxia. In Fig. 4, hyperoxia (higher oxygen consumption) compared to normoxia (normal oxygen conditions) indicated that the rise in blood lactate after exercise is less in hyperoxia. This implies that hyperoxia may assist in delaying the accumulation of lactate in the blood, a symptom of improved exercise performance capacity and reduced muscle fatigue. Consequently, hyperoxic conditions may be more advantageous for improving athletic performance and alleviating muscular tension in comparison to normoxia. Consequently, for cyclists or athletes, utilizing higher oxygen levels (hyperoxia) can assist in improving performance and preventing rapid increases in blood lactate that lead to fatigue [76].

1.14. Effects of Oxygen on skin freshness and beauty

The effects of oxygen on skin health and beauty are profound. Oxygen is essential for various cellular processes, particularly those involved in cellular respiration and metabolism. Adequate oxygen supply supports the production of collagen and elastin, two proteins vital to maintain skin structure and elasticity. As an individual ages or experiences stress, the oxygen supply to skin cells can diminish, leading to signs of aging, such as wrinkles, dullness, and uneven skin tone [77].

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High concentrations of oxygen, such as 95% oxygen supplementation, can enhance blood flow to the skin, promoting the delivery of nutrients and the removal of toxins. This enhanced oxygenation contributes to the rejuvenation of skin cells, resulting in a more youthful and radiant appearance. Particularly for women, it is imperative to prioritize epidermis health in order to preserve their overall appearance. Oxygen therapy can assist in the attainment of a fresh and radiant complexion by reducing the visible impacts of environmental damage and stressors. Moreover, oxygen treatments became a popular trend in the beauty industry, with many skincare professionals incorporating oxygen-infused products in facial treatments. These treatments promise to replenish the skin with the essential elements needed for revitalization, contributing to a firmer and more luminous complexion. Women can further enhance the skin-enhancing effects of essential oils that are known for their restorative properties by incorporating them into oxygen therapy. This approach to beauty is holistic, as it addresses both the physiological and aesthetic aspects of skin health [77, 78].

2. Discussion

2.1. Physiological Benefits of Oxygen Supplementation

The physiological benefits of oxygen supplementation are well-documented in the literature. Aerobic metabolism, which is essential for maintaining energy levels during physical activity, can be enhanced by increased oxygen availability. Studies have demonstrated that supplemental oxygen can considerably enhance endurance performance, enabling athletes to train for longer and harder. For instance, research indicated that individuals who use supplemental oxygen during high-intensity workouts experience reduced fatigue and quicker recovery times compared to those who do not. This phenomenon is attributed to the increased oxygen saturation in the bloodstream, which facilitates more efficient energy production in muscle cells [78].

In addition to enhancing performance, oxygen supplementation was shown to support recovery processes. The body experiences a variety of physiological changes following strenuous exercise, such as increased oxidative stress and muscle injury. By promoting quicker healing and reducing inflammation, supplemental oxygen can assist in mitigating these effects. For example, a study found that athletes who utilized oxygen supplementation post-exercise reported less muscle soreness and a quicker return to baseline performance levels. Table 3 shows study the effect of oxygen after exercise in a comparative way [79].

Table 3. Comparative recovery metrics (With vs. without Oxygen supplementation)

Benefit	Baseline (Without Oxygen Supplement)	With 95% Oxygen
Improved Endurance (%)	10%	30%
Reduced Fatigue (%)	20%	70%
Recovery Time (Days)	5 days	3 days

2.2. Essential Oils and Their Synergistic Effects

The integration of essential oils into oxygen supplementation offers a unique approach to enhancing the benefits of oxygen therapy. Essential oils, such as eucalyptus and peppermint are known for their respiratory benefits, promoting clearer airways and improving oxygen uptake. Eucalyptus oil, for example, was shown to have bronchodilatory effects, which can enhance lung function and increase the efficiency

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of oxygen delivery to tissues. This is particularly beneficial for athletes who rely on optimal respiratory function to support their performance.

Furthermore, certain essential oils have been linked to enhanced mental clarity and tension reduction. For example, lavender oil is recognized for its tranquil properties and has been demonstrated to alleviate anxiety and encourage relaxation. This can be particularly advantageous for athletes who experience performancee anxiety or stress related to competition. By combining oxygen supplementation with essential oils, individuals may experience not only physical benefits, but also psychological enhancements that contribute to overall performance [80]. Fig. 5 shows the Schematic of Oxygen Supplementation Enhanced with Essential Oils and its Effect.

Fig. 5. Schematic of Oxygen supplementation enhanced with essential oils and its effect

2.3. Studies and Findings

Numerous studies explored the effects of portable recreational oxygen supplements, revealing that these products can provide physiological benefits similar to those experienced in traditional hyperoxic environments. The utilization of portable oxygen during moderate-intensity exercise has been shown to result in enhanced performance outcomes, such as reduced perceived exertion and increased endurance, according to research published by Boost Oxygen. This suggested that oxygen supplementation may be a valuable tool for athletes looking to optimize their training and competition strategies [80].

Furthermore, the combination of high-concentration oxygen and essential oils may amplify these effects, offering a holistic approach to wellness. For example, a study examining the effects of inhaling oxygen enriched with essential oils found that participants experienced enhanced mood and increased energy levels. This highlighted the potential for oxygen supplementation to not only support physical performance but also improve mental well-being, which is crucial for athletes and active individuals [81- 83].

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Table 4. Comparative Analysis of User Experiences with and without Oxygen Supplementation

User group	With Oxygen & essential oils	Without Oxygen & essential oils	Key observations
Athletes	80% reported improved performance	50% reported fatigue after training	Enhancement in endurance and recovery rates
Urban Dwellers	70% experienced less respiratory discomfort	30% reported ongoing fatigue	Significant benefits in pollution exposure
Wellness Enthusiasts	75% noted improved mood and energy	40% reported normal energy levels	Enhanced mental clarity noted with oxygen
Climber	Death rate 3%	Death rate 8.3%	The death rate during descent
Individuals with Ailments	85% reported symptom relief	35% reported persistent symptoms	Noticeable improvement in overall well-being

2.4. Implications for Various Populations

The implications of oxygen supplementation extend beyond the realm of athletics. The individuals with respiratory conditions, such as chronic obstructive pulmonary disease (COPD) or asthma, may benefit from supplemental oxygen to improve their quality of life and enhance respiratory function. Furthermore, oxygen therapy has been implemented in clinical contexts to assist patients who are recuperating from surgery or have impaired respiratory function. The integration of essential oils into these therapies could provide added benefits, promoting relaxation and reducing anxiety during treatment [84-86].

For wellness enthusiasts, using oxygen supplementation can enhance recovery after workouts, improve energy levels, and support overall health. The growing popularity of portable oxygen products reflects a shift toward proactive health management, where individuals seek to optimize their physical and mental well-being through innovative approaches [87, 88].

3. Conclusion

Using 95% pure oxygen, particularly when combined with essential oils, presents a promising avenue to enhance physical performance and overall well-being. The physiological benefits of oxygen supplementation, such as accelerated recuperation, reduced fatigue, and enhanced endurance, are currently supported by current research. The synergistic effects of essential oils further enhanced these benefits, offering a holistic approach to wellness that encompasses both physical and psychological aspects.

As the climbing community continued to explore innovative approaches to high-altitude climbing, the integration of oxygen supplementation will undoubtedly play a pivotal role in shaping the future of the sport. In addition, portable oxygen is a critical resource for individuals who are concerned about their health and well-being in densely populated cities with elevated levels of air pollution. By enhancing respiratory function, supporting those with pre-existing conditions, promoting physical activity, and improving overall quality of life, portable oxygen can play a vital role in mitigating the adverse effects of urban air pollution.

As we continue to explore the benefits of oxygen supplementation and essential oils, it is clear that these tools can significantly contribute to improved health outcomes for athletes, the individuals in polluted environments, and those seeking holistic wellness solutions. Although additional research is required to gain a comprehensive understanding of the long-term effects and optimal application of oxygen supplementation with essential oils, the current findings indicate that this method can be a

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valuable resource for wellness enthusiasts, athletes, and those with respiratory conditions.

Author contributions

R. Gh: contributed to the study design and reviewing of the manuscript. M. Y: conducted the data gathering, writing and reviewing of the manuscript. F. N: contributed to the data gathering and reviewing of the manuscript. A. Kh: contributed to the data gathering and conducted the writing. R. H: conducted the data analysis and Editing.

Conflict of interest

The authors declare that there is no conflict of interest.

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