Review

Antiviral properties of Essential Oils: What do we know?

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Abstract: This narrative review delves into the antiviral properties of essential oils and aromatherapy, a field gaining prominence recently. Essential oils are noted for their pharmacological effects, particularly their antiviral capabilities. The review pays special attention to essential oils' effectiveness against influenza and coronaviruses. A comprehensive review in this context underscores the diverse chemical compounds in essential oils that offer broad-spectrum antiviral mechanisms. This is crucial given the growing resistance to conventional antiviral drugs, positioning plant-derived essential oils as potential novel antiviral agents. The hypothesis posited in this review is that essential oils could be effective natural antiviral agents, potentially useful as complementary or alternative therapies in viral infections. The review underscores the significance of essential oils' antiviral properties in enhancing human health, advocating for more focused research in this area.

Keywords: Essential Oil; Antiviral; Aromatherapy.

1. Introduction

Aromatherapy and the use of essential oils have gained significant attention in recent years for their potential therapeutic benefits. One area of particular interest is the antiviral properties of these natural compounds. This narrative review aims to explore the latest scientific findings on the antiviral capabilities of essential oils and aromatherapy, focusing on research from the past few years [1, 2].

Essential oils and their compounds have been recognized for a range of pharmacological effects, including antiviral activities. A study by Reichling et al. [3] delves into the potential antiviral and virucidal activities of essential oils and their components, examining their mechanism of action and the results of in vitro and in vivo studies. These studies have highlighted essential oils' effectiveness against both enveloped and non-enveloped viruses, with certain oils demonstrating the ability to prolong the life of infected animals, reduce virus titers in tissues, and inhibit the synthesis of proinflammatory cytokines and chemokines [3].

In the context of influenza and coronaviruses, essential oils have shown promise as well [3, 4]. A comprehensive review focuses on the antiviral potential of essential oils and their chemical constituents against these viruses [4]. This review highlights the variety of chemical compounds in essential oils that contribute to their broad-spectrum mechanisms of action and their ability to combat viral infections [4]. About this, the need for novel antiviral agents, especially in the face of resistance to existing drugs, has led to an increased focus on plant-derived essential oils [5]. Ma and Yao [5] provides an updated overview of the antiviral efficacy of essential oils from various plant species, discussing their mechanisms of action and comparing them with commercial drugs. Also points out the inadequacies in current research and suggests directions for future studies [5].

We hypothesize that essential oils are promising natural antiviral agents that can be used as complementary or alternative therapies for viral infections. Here, we performed

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a critical narrative review about the importance of antiviral properties of essential oils and its impact in human health.

2. Material and Methods

The purpose of this review is to summarize and evaluate the current evidence on the antiviral effects of essential oils and aromatherapy, and to identify the gaps and challenges in this field. This topic is of great interest and importance, as viral infections pose a major threat to global health and security, and there is a need for safe and effective alternative treatments. We searched the following databases: PubMed, Scopus, Web of Science, and Cochrane Library, using the keywords: essential oils, aromatherapy, antiviral, influenza, coronavirus, and their combinations. We included articles published in English from January 2020 to December 2023, that reported original research or reviews on the antiviral activity of essential oils and aromatherapy in vitro, in vivo, or in clinical trials. We excluded articles that were not peer-reviewed, that had low quality or insufficient data, or that were not relevant to our research question.

We extracted the following data from each article: authors, year, title, journal, type of study, essential oils or compounds used, viruses tested, methods of evaluation, results, and conclusions. We performed a narrative synthesis of the data, grouping the articles by the type of virus, the type of essential oil or compound, and the type of antiviral effect. We also discussed the possible mechanisms of action, the limitations, and the implications of the findings.

3. The mechanisms and modes of action of essential oils against different types of viruses, such as influenza, herpes, and coronavirus

Essential oils are natural, aromatic compounds extracted from various parts of plants, such as leaves, flowers, fruits, seeds, bark, and roots. They have been used for centuries for their therapeutic, cosmetic, and culinary properties. One of the most interesting and promising applications of essential oils is their antiviral activity, which has been demonstrated against a wide range of viruses, such as influenza, herpes, and coronavirus [6]. In this study, we briefly summarize the main mechanisms and modes of action of essential oils against these types of viruses and provide some review paper references for further reading.

3.1 Essential oils against coronavirus

Coronavirus is a large family of RNA viruses that cause various respiratory and gastrointestinal diseases in humans and animals, such as the common cold, SARS, MERS, and COVID-19. Essential oils have been shown to inhibit coronavirus replication and infection by various mechanisms, such as binding to viral proteins, inhibiting viral proteases, reducing viral load, and enhancing the antiviral response. Some of the most effective essential oils against coronavirus are lemongrass, basil, oregano, cinnamon, and laurel [7-9].

These essential oils contain various terpenoids, such as citral, linalool, carvacrol, cinnamaldehyde, and eugenol, that have antiviral properties. These terpenoids can interact with the coronavirus spike protein, which mediates the binding and fusion of the virus with the host cell membrane. By blocking the spike protein, these terpenoids can prevent the virus from entering the host cell and initiating the infection cycle. Moreover, these terpenoids can inhibit the coronavirus main protease and papain-like protease, which are essential for the cleavage and maturation of the viral polyprotein. By inhibiting the viral proteases, these terpenoids can impair the viral replication and assembly. Furthermore, these terpenoids can reduce the viral load and enhance the antiviral response by modulating the expression of various genes and cytokines involved in the innate and adaptive immunity [10, 11].

Essential oils can be used as complementary or alternative therapies for coronavirus infection, either by inhalation, topical application, or oral administration. However, the

optimal dosage, frequency, duration, and safety of essential oils for antiviral purposes are not well established. Therefore, more clinical trials and studies are needed to evaluate the efficacy and potential adverse effects of essential oils for coronavirus infection [9].

3.2 Essential oils against influenza

Influenza virus is a highly contagious respiratory pathogen that causes seasonal epidemics and occasional pandemics, with significant morbidity and mortality worldwide. Essential oils have been shown to inhibit influenza virus replication and infection by various mechanisms, such as interfering with viral attachment, entry, uncoating, transcription, translation, assembly, and release. Some of the most effective essential oils against influenza virus are eucalyptus, tea tree, thyme, oregano, cinnamon, and clove [12, 13].

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These essential oils contain various monoterpenes, such as 1,8-cineole, terpinen-4-ol, thymol, carvacrol, cinnamaldehyde, and eugenol, that have antiviral properties. These monoterpenes can interact with viral proteins, such as hemagglutinin, neuraminidase, and matrix protein, and disrupt their structure and function. This can prevent the virus from binding to the host cell receptors, entering the cell membrane, releasing the viral genome, and assembling and releasing new viral particles. Moreover, these monoterpenes can modulate the host immune system and reduce the inflammation and oxidative stress caused by the viral infection [13].

Essential oils can be used as complementary or alternative therapies for influenza virus infection, either by inhalation, topical application, or oral administration. However, the optimal dosage, frequency, duration, and safety of essential oils for antiviral purposes are not well established [12, 13]. Therefore, more clinical trials and studies are needed to evaluate the efficacy and potential adverse effects of essential oils for influenza virus infection56.

3.2 Essential oils against Herpes

Herpes virus is a large family of DNA viruses that cause various diseases in humans and animals, such as cold sores, genital herpes, chickenpox, shingles, and mononucleosis. Essential oils have been shown to inhibit herpes virus replication and infection by various mechanisms, such as disrupting the viral envelope, blocking viral DNA polymerase, inducing apoptosis, and modulating the immune system. Some of the most effective essential oils against herpes virus are lemon balm, peppermint, lavender, chamomile, and sandalwood [14].

These essential oils contain various phenolic compounds, such as rosmarinic acid, menthol, linalool, apigenin, and alpha-santalol, that have antiviral properties. These phenolic compounds can interact with the viral envelope glycoproteins, such as gB, gC, gD, and gH, and inhibit their binding to the host cell receptors, such as nectin-1, HVEM, and 3-O-sulfated heparan sulfate. This can prevent the virus from entering the host cell and initiating the infection cycle. Moreover, these phenolic compounds can interfere with the viral DNA polymerase, which is essential for the replication of the viral genome. By inhibiting the viral DNA synthesis, these phenolic compounds can reduce the viral load and prevent the formation of new viral particles. Furthermore, these phenolic compounds can induce apoptosis, or programmed cell death, in the infected cells, and modulate the host immune system by enhancing the production of interferons and cytokines, which are important for the antiviral response [13-15].

Essential oils can be used as complementary or alternative therapies for herpes virus infection, either by topical application, oral administration, or aromatherapy [15]. However, the optimal dosage, frequency, duration, and safety of essential oils for antiviral purposes are not well established. Therefore, more clinical trials and studies are needed to evaluate the efficacy and potential adverse effects of essential oils for herpes virus infection56.

4. The efficacy and safety of essential oils as antiviral agents, both in vitro and in vivo, and the factors that influence their antiviral activity

Recent studies have highlighted the antiviral potential of essential oils, examining their effectiveness against various viruses in both in vitro and in vivo settings. These studies have been pivotal in understanding the role essential oils could play in antiviral therapies. A comprehensive review by Reichling et al. [3] discussed the antiviral and virucidal activities of essential oils and isolated compounds. This review encompassed a range of essential oils derived from different medicinal and aromatic plants, showing potent antiviral and virucidal properties that inhibit viral progeny by blocking different steps of the viral infection/replication cycle in various host cell lines. The study also highlighted that essential oils could prolong the life of animals infected with viruses causing respiratory diseases, reduce virus titers in tissues, and inhibit the synthesis of proinflammatory cytokines and chemokines.

Another study focused on the antiviral activity of selected Lamiaceae essential oils and their monoterpenes against SARS-CoV-2. This research revealed that certain monoterpenes found in these essential oils exhibited significant inhibition of SARS-CoV-2 in infected Vero 76 cells. The study provides a detailed analysis of the levels of volatile compounds in these essential oils and their specific antiviral activities [16].

Furthermore, research conducted on the essential oils obtained from the bark and fruits of Acacia nilotica assessed their antiviral potentialities against Hepatitis A Virus (HAV) and Herpes Simplex Viruses (HSV1 and HSV2). The chemical profiling of these oils revealed a range of compounds, including di- and sesquiterpenes. The study found that the bark essential oil exhibited moderate antiviral activity, while the fruits essential oil showed weaker activity. This study also incorporated in silico evaluation, providing insights into the molecular interactions of these essential oils with viral proteins [17].

These studies collectively suggest that essential oils, with their complex mixtures of compounds, have significant potential as antiviral agents. The effectiveness of these oils seems to be influenced by their chemical composition, which varies depending on the plant source. The mode of application, concentration, and duration of exposure are likely to be critical factors in maximizing their antiviral efficacy. However, more research, especially in vivo studies, is needed to fully understand their mechanisms of action and to develop practical applications in antiviral therapies.

5. The benefits and risks of using essential oils as complementary or alternative therapies for viral infections, and the potential interactions or adverse effects with conventional treatments or medications

Essential oils have been studied for their potential benefits and risks in treating viral infections, offering an alternative or complementary approach to conventional therapies. These oils, known for their antiviral, anti-inflammatory, and immunomodulatory properties, have shown effectiveness against a variety of viruses, including influenza and herpes simplex. Research indicates that compounds like 1,8-cineole in eucalyptus oil may inhibit viral entry into host cells, suggesting a mechanism of action against viruses like Influenza A [13].

Studies also highlight the virucidal properties of oils like peppermint and manuka, which have been effective against enveloped viruses like herpes simplex. Such findings point to the potential of essential oils in managing viral infections, especially those

resistant to conventional drugs. In the context of the COVID-19 pandemic, the antiviral efficacy of essential oils has gained attention [3, 18]. Research suggests these oils could serve as adjuvant therapies, potentially leading to milder disease courses and improved patient outcomes. Additionally, they may offer benefits like pain relief and mood enhancement, particularly relevant for patients with comorbid conditions like opioid addiction [3].

However, it's crucial to approach the use of essential oils with caution. The need for randomized clinical trials to ascertain their efficacy and safety is emphasized. The development of standardized, high-quality preparations is essential for safe administration to the general public. While promising, the integration of essential oils into conventional treatment regimens necessitates careful consideration of potential interactions or adverse effects with other medications.

6. The best practices and guidelines for using essential oils as antiviral agents, such as the optimal dosage, frequency, duration, route, and combination of essential oils, and the quality and purity standards of essential oils

Essential oils have garnered interest in the scientific community for their potential as antiviral agents. These natural products, derived from plants, exhibit mechanisms of action that target various stages of the viral lifecycle, affecting the virus's ability to infect and replicate. Studies have shown that certain essential oils exhibit virucidal effects against specific viruses like herpes simplex virus type 1 and 2 and have potential against influenza and coronaviruses [3, 5].

The effective use of essential oils as antiviral agents depends on several factors, including appropriate dosage, frequency of application, duration, and route of administration. These factors can vary significantly depending on the type of essential oil and the virus being targeted. For instance, the virucidal activity of oils like peppermint and Leptospermum scoparium (manuka oil) against herpes simplex viruses highlights the need for specific guidelines tailored to each oil and its target virus [1, 19].

Additionally, the combination of different essential oils or their components may offer additive or synergistic effects, potentially enhancing their antiviral efficacy. However, the specifics of these combinations and their effectiveness need further exploration and validation through scientific research. Equally important is the quality and purity of essential oils used as antiviral agents. The efficacy of these oils can be significantly influenced by their quality, underscoring the need for maintaining high standards of purity and production [11, 20].

While essential oils show promise as antiviral agents, it is crucial to consider their safety profile. Not all essential oils are suitable for all individuals, and some may interact with other medications or have contraindications in certain health conditions. Therefore, consultation with healthcare professionals and a thorough review of scientific literature is necessary for the informed and safe use of essential oils as antiviral agents. In conclusion, the growing body of research on the antiviral properties of essential oils is promising, but more comprehensive studies are required to fully understand their mechanisms of action, efficacy, and safety. The findings from these studies will be instrumental in developing detailed guidelines for the optimal use of essential oils as antiviral agents.

5. Conclusion

This review has comprehensively examined the multifaceted roles of essential oils in combating various viruses, including coronavirus, influenza, and herpes, highlighting their mechanisms and modes of action. The evidence suggests that essential oils exhibit significant potential as antiviral agents due to their diverse chemical compositions, which can interfere with various stages of viral replication and infectivity.

Specifically, essential oils have shown promising results against coronaviruses, particularly in inhibiting viral entry and replication. Against influenza viruses, essential oils

have demonstrated the capability to disrupt viral envelopes and inhibit neuraminidase activity, a key enzyme in viral proliferation. In the context of herpes viruses, essential oils have been effective in reducing viral load and preventing reactivation.

The efficacy and safety of essential oils, both in vitro and in vivo, indicate that they can be potent antiviral agents. However, their effectiveness is influenced by factors such as concentration, purity, and the specific strain of the virus. It is important to note that while essential oils show antiviral properties, their safety profile varies, and they should be used cautiously, especially in the context of complementary or alternative therapies.

The benefits of using essential oils as antiviral agents are counterbalanced by potential risks, including interactions with conventional treatments and adverse effects. Thus, it is crucial to understand the potential interactions of essential oils with conventional medications, especially for patients with underlying health conditions or those taking multiple medications. Regarding best practices and guidelines, the review suggests that the effectiveness of essential oils as antiviral agents is maximized when the optimal dosage, frequency, duration, route of administration, and combination of essential oils are carefully considered. Adherence to quality and purity standards is paramount to ensure the safety and efficacy of these natural products.

In conclusion, while essential oils present a promising avenue for antiviral therapy, further research, particularly well-designed clinical trials, is essential to establish their role in clinical settings. The integration of traditional knowledge with modern scientific research could pave the way for innovative, effective, and safe antiviral treatments utilizing essential oils.

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