Possible Effect of Aromatic Plants and Essential Oils against COVID-19: Review of Their Antiviral Activity

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Authors’ contributions
This work was carried out in collaboration of all authors. Authors PTM, DDT, DSTT and KTNN wrote the first draft of the manuscript. Authors EML, CLI, EMN, BZG, JTK and DTM collected information on plants bioactivity. Authors CMM, AM, SOM and GNB collected information on plant phytochemistry. All authors read and approved the final manuscript.

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INTRODUCTION

Since December 2019, in China, a new coronavirus epidemic called the new coronavirus disease (COVID-19) has emerged. This new emerging disease is caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) [1]. It quickly spread from China and became a pandemic that caused more than 630,000 deaths worldwide (situation on 25th July, 2020). Since then, the world has been racing to find an effective remedy for this virus, but so far no universally acceptable medicine or vaccine has been available to date. All approaches are therefore used to find a solution to this pandemic [2-3]. Meanwhile, Traditional Medicine has also been reported to be useful in the treatment of COVID-19 [4-6]. Furthermore, medicinal plants constitute an important source of molecules having various pharmacological properties including the antiviral potential, which can be useful for the search of a solution against COVID-19. According to the World Health Organization (WHO), more than 80% of African population uses traditional medicine to solve primary health problem. It has the advantage of being safe, effective, less expensive and less risky, with significantly reduced side effects compared to modern medicines [7-11].

Aromatic plants (AP) have been used since decades for the treatment of various ailments such as malaria, diabetes, mental disorders, cancer, hypertension, respiratory disorders etc. [12]. Aromatherapy is well known in Africa. Aromatic plants are boiled and stream inhaled to treat colds, coughs or flu. In fact, it is known that, aromatherapy can provide respiratory disinfection, decongestant and psychological benefits. Molecules that enter the nose or mouth pass to the lungs, and from there, to other parts of the body. They can reach the brain, affect the limbic system, which is linked to the emotions; the heart rate, breathing, memory, stress and hormone balance and then can have a subtle, yet holistic effect on the body [13-14]. Besides, Alamgeer et al. reported the use of aromatic plants in the treatment of respiratory disorders in Pakistan. Recently, it was reported the use of aromatic herbs to relieve the signs of COVID-19 in Africa [15].

Essential oils (EO) are the main active molecules in aromatic plants. They are mixtures of different lipophilic and volatile substances, such as monoterpenes, sesquiterpenes, and/or phenylpropanoids, and have a pleasant odor [16]. They possess various applications mainly in health, cosmetic, agriculture and food industries. Biological properties of essential oils include not only antimutagenic, anticancer, antioxidant, antiprotozoal activities but also anti-inflammatory, antimicrobial, immuno-modulatory and antiviral that can be useful in COVID-19 treatment [17]. In fact, many drugs that are on trials now are antiviral (Ribavirin, Remdesivir, Sofosbuvir, Galidesivir, Tenofovir, Lopinavir or Ritonavir etc.) or immuno-modulators (chloroquine) combine to antibiotics (e.g. azithromycin) [18].

Based on the relevant clinical characteristics of the SARS-CoV-2 patients, the virus enters the
cell via angiotensin-converting enzyme-2 (ACE-2), leading to severe injury in the lungs (pneumonia) and dissemination of the virus to several other organs that may be infected in the course of illness. Pathophysiologically, the most important feature is that the pneumonia (an acute inflammatory lung injury), which itself varies depending on the disease severity level, but also alveolar damage that can precipitate acute respiratory distress syndrome (ARDS) uses a wide variety of biomolecules, mainly immunological in nature. The innate immune response is then to produce pro-inflammatory cytokines and chemokines to contain and stop the infection.

The main goal of this manuscript was to make a review on the antiviral properties of aromatic plants along with the essential oils.

2. METHODOLOGY

The literature review was made using the COVID-19 resources that have been made freely available to the scientific community (COVID-19 open research dataset https://pages.semanticscholar.org/coronavirus-research), as well as on the usual databases such as PubMed and Google scholar. The terms Aromatic plants, essential oils, antiviral activities and COVID-19 were used as keywords for the search. Finally, bibliographical references were made using bibliographical software "Mendeley".

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Phytochemistry

Different antiviral activities of EO are attributable to the chemical composition of each EO. They are complex natural mixtures and their main constituents are responsible of their bioactivities. For instance, EO from eucalyptus, tea tree and thyme and their major monoterpenic compounds namely γ-terpinene, δ-terpinene, α-pinene, p-cymene, terpinen-4-ol, α-terpineol, thymol, citral and 1,8-cineole were examined for their antiviral activity against herpes simplex virus type 1 (HSV-1) in vitro [19].

The yields of EO ranged from 1.5 to 3.5%. The chemical composition of many EO were reported depending on their ecological condition [20]. *Laurus nobilis* L. berry oil was characterized by the presence of β-ocimene (21.83%), 1,8-cineol (9.43%), α-pinene (3.67%), and β-pinene (2.14%) as major constituents while two interesting sesquiterpenes, i.e., eremanthin (3.65%) and dehydrocostuslactone (7.57%), were also identified. *Thuja orientalis* oil was characterized by 43 constituents (86.68% of the total oil) in which the main components were α-pinene (35.72%), d-3-carene (9.48%), and α-cedrol (9.55%). A total of 48 compounds (82.39% of the total oil) were identified in *Juniperus oxycedrus* ssp. oxycedrus berry oil. α-pinene (27.4%) and β-myrcene (18.9%) were the major constituents. Other identified compounds were α-phellandrene (7.1%), limonene (6.7%), epicycloesquiphellandrene (2.3%), and δ-cadinene (2.2%). Forty-one components, representing 80.91% of the total, were identified in *Satureja thymbra* oil, in which p-cymene (10.76%), α-pinene (10.15%), thymol (9.92%), sabinene (8.64%), γ-terpinene (7.56%), carvacrol (4.98%), trans-caryophyllene (3.67%), β-pinene (2.90%), and linalool (2.81%) were the main abundant compounds. *Cupressus sempervirens* ssp. pyramidalis oil was characterized by 19 components, representing 90.45% of the total oil. The main components were α-pinene (53.56%), α-terpinene (18.90%), thymol (3.84%), and terpinolene (3.15%). Twenty-six compounds were identified in *Salvia officinalis* (94.39% of the total oil) in which 1,8-cineol (43.62%), α-thujone (12.99%), sabinene (6.97%), camphor (5.71%), α-pinene (4.72%), α-humulene (3.41%), α-terpinol (3.18%), and β-pinene (3.01%) were identified as major compounds [21-22]. Fig. 1 displays different chemical structures of some major EO identified from aromatic plants having an antiviral activity.

3.1.2 Antiviral activity

The antiviral properties of EO of several plant extracts, responsible for their characteristic smell, have been described in recent years. Various viruses, including the human pathogen herpes simplex, have been shown to be very sensitive to the inhibitory activity of EO. These results support the potential use of EO from medicinal plants as agents for the treatment of viral infections and suggest the application of this type of natural products such as antiviral drugs [23].

Rocío et al. [24] showed that several compounds present in plants can inactivate a broad spectrum of animal viruses in vitro. The inhibitory effect of EO of *Lippia alba*, *Lippia origanoides*, *Oreganum vulgare* and *Artemisia vulgaris* on yellow fever
virus (YFV) was demonstrated. The CC\textsubscript{50} values were below 100 μg/mL and MIC values were between 3.7 and 11.1 μg/mL. The mode of action appears to be a direct inactivation of the virus. For Laurus nobilis, EO were evaluated for their inhibitory activity against the replication of SARS-CoV-1 with an IC\textsubscript{50} value of 120 μg/mL and a selectivity index (SI) of 4.16 and HSV-1 \textit{in vitro} by visual scoring of the cytopathogenic effect induced by the virus after infection. Laurus nobilis oil showed activity against CoV-SARS. This oil was characterized by the presence of beta-ocimene, 1,8-cineol, α-pinene and beta-pinene as main constituents [25].

For the genus Eucalyptus, Ameur et al. showed that EO of \textit{E. sideroxylon}, \textit{E. lehmannii}, \textit{E. leucoxylon} and \textit{E. odorata} showed no inhibition of viral infection, while the most significant antiviral activity was demonstrated with EO of \textit{E. sideroxylon}, \textit{E. lehmannii}, \textit{E. leucoxylon} and \textit{E. odorata}. bicostata (IC\textsubscript{50} = 0.7 - 4.8 mg/mL) and \textit{E. astringens} (IC\textsubscript{50} = 8.4 mg/mL), followed by EO of \textit{E. cinerea} (IC\textsubscript{50} = 102-131 mg/mL) and \textit{E. maidenii} (IC\textsubscript{50} = 136.5 - 233.5 mg/mL) [26]. EO of \textit{E. cinerea} and \textit{E. maidenii} showed an antiviral activity at a concentration of 150 mg/mL when incubated with cells. This activity was dose-dependent and the antiviral activity decreased with the diminution of EO concentration. The antiviral activity of aromatic plants on different type viruses and their major EO compounds is presented in the Table 1.

Fig. 1. Chemical structures of some major EO identified from aromatic plants having antiviral activity
<table>
<thead>
<tr>
<th>Plants (Family)</th>
<th>Viruses</th>
<th>Typical</th>
<th>Major compounds</th>
<th>EO</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetracera alnifolia Willd. (Dilleniaceae)</td>
<td>E7, E19</td>
<td>RNA non-enveloped viruses</td>
<td>-</td>
<td>[27]</td>
<td></td>
</tr>
<tr>
<td>Terminalia ivorensis A.Chev. (Combretaceae)</td>
<td>E7, E19</td>
<td></td>
<td>δ-3-carene, α-pinene, β-caryophyllene, cedrol, terpinolene</td>
<td>[27-28]</td>
<td></td>
</tr>
<tr>
<td>Aloysia gratissima (Gillies &amp; Hook.) Tronc. (Verbenaceae)</td>
<td>HSV-1/HSV-2</td>
<td>DNA enveloped viruses</td>
<td>1,8-cineole, sabinen, guaiol, bicyclogermacrene, germacrene B</td>
<td>[29-30]</td>
<td></td>
</tr>
<tr>
<td>Artemisia arborescens (Vaill.) L. (Compositae)</td>
<td></td>
<td></td>
<td>α-pinene, β-thujone, camphre, terpinen-4-ol, chamazulene</td>
<td>[31]</td>
<td></td>
</tr>
<tr>
<td>Artemisia douglasiana Besser ex Besser (Compositae)</td>
<td>HSV-1</td>
<td></td>
<td>Camphor, artemisia kenone, artemisia alcohol, α-thujone, 1,8-cineole</td>
<td>[29,32]</td>
<td></td>
</tr>
<tr>
<td>Cinnamomum verum (Lauraceae)</td>
<td></td>
<td></td>
<td>Eugenol, linalool, piperitone</td>
<td>[33]</td>
<td></td>
</tr>
<tr>
<td>Eucalyptus globulus Labill. (Myrtaceae)</td>
<td>HSV-1/HSV-2</td>
<td></td>
<td>1,8-cineole, isovaleraldehyde, spathulenol, α-terpineol, α-pinene</td>
<td>[34-35]</td>
<td></td>
</tr>
<tr>
<td>Eupatorium patens Philippi (Compositae)</td>
<td></td>
<td></td>
<td>(E)-caryophyllene, γ-murolene, α-pinene, bicyclogermacrene, (z)-β-ocimene</td>
<td>[29,36]</td>
<td></td>
</tr>
<tr>
<td>Hyssopus officinalis L. (Lamiaceae)</td>
<td></td>
<td></td>
<td>Isopinocamphone, β-pinene, terpinen-4-ol, pinocarvone, carvacrol</td>
<td>[37-38]</td>
<td></td>
</tr>
<tr>
<td>Illicium verum Hook.f. (Schisandraceae)</td>
<td></td>
<td></td>
<td>Trans-anethole, 2-(1-cyclopentenyl)-furan, cis-anethole, γ-terpineol, limonene</td>
<td>[33,37]</td>
<td></td>
</tr>
<tr>
<td>Juniperus oxycedrus L. (Cupressaceae)</td>
<td></td>
<td></td>
<td>α-pinene, limonene, caryophyllene oxide, β-pinene, β-myrcene</td>
<td>[39]</td>
<td></td>
</tr>
<tr>
<td>Lavandula latifolia Medik. (Lamiaceae)</td>
<td>HSV-1</td>
<td></td>
<td>1,8-cineole, linalool, camphor, β-pinene, α-pinene</td>
<td>[40]</td>
<td></td>
</tr>
<tr>
<td>Leptospermum scoparium J.R.Forst. &amp; G.Forst. (Myrtaceae)</td>
<td>HSV-1/HSV-2</td>
<td></td>
<td>β-Elemene, calamenene, linalool, α-selinene, α-cubebene</td>
<td>[41-42]</td>
<td></td>
</tr>
<tr>
<td>Matricaria recutita L. (Compositae)</td>
<td></td>
<td></td>
<td>α-bisabolol oxide, camphene, 1,8-cineole, camphor, limonene</td>
<td>[33,37]</td>
<td></td>
</tr>
<tr>
<td>Melaleuca alternifolia (Maiden &amp; Betch) Cheel (Myrtaceae)</td>
<td></td>
<td></td>
<td>Terpinen-4-ol, α-terpinéol, α-pinène, α-terpinène, γ-terpinène, p-cymène, aromadendrène, β-caryophyllène, 1,8-cineole</td>
<td>[34]</td>
<td></td>
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<tr>
<td>Mentha piperita L. (Lamiaceae)</td>
<td></td>
<td></td>
<td>Menthol, acétate de menthyle, menthone, acétate de néomenthyle</td>
<td>[43]</td>
<td></td>
</tr>
<tr>
<td>Origanum majorana L. (Lamiaceae)</td>
<td>HSV-1</td>
<td></td>
<td>Terpinen-4-ol, γ-terpinene, cis-sabinene hydrate, α-terpinene, α-terpineol</td>
<td>[40,44]</td>
<td></td>
</tr>
<tr>
<td>Plants (Family)</td>
<td>Viruses</td>
<td>Typical</td>
<td>Major compounds</td>
<td>Reference</td>
<td></td>
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</tr>
<tr>
<td>Pinus mugo Turra (Pinaceae)</td>
<td>HSV-1/HSV-2</td>
<td>Typical</td>
<td>Bornyl acetate, α-terpineol, (E)-caryophyllene, dehydroabietal, α-cadinol</td>
<td>[37,45]</td>
<td></td>
</tr>
<tr>
<td>Rosmarinus officinalis L. (Lamiaceae)</td>
<td>HSV-1</td>
<td></td>
<td>α-pinene, camphene, camphor, verbenol, p-cymene</td>
<td>[33,37]</td>
<td></td>
</tr>
<tr>
<td>Santalum album L. (Santalaceae)</td>
<td>HSV-1/HSV-2</td>
<td>RNA enveloped virus</td>
<td>Thymol, p-cymene, caryophyllene, α-pinene, β-myrcene</td>
<td>[33,37]</td>
<td></td>
</tr>
<tr>
<td>Santolina insularis (Gennari ex Fiori) Arrigoni (Compositae)</td>
<td>HSV-1</td>
<td>Typical</td>
<td>Caryophyllene oxide, (E)-β-damascenone, γ-eudesmol, terpinen-4-ol</td>
<td>[29,36]</td>
<td></td>
</tr>
<tr>
<td>Thymus vulgaris L. (Lamiaceae)</td>
<td>HSV-1/HSV-2</td>
<td>RNA enveloped virus</td>
<td>Thymol, p-cymene, caryophyllene, α-pinene, β-myrcene, Caryophyllene, spathulenol, germacrene-D, α-terpineol, α-caryophyllene</td>
<td>[47-48]</td>
<td></td>
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<tr>
<td>Laurus nobilis L. (Lauraceae)</td>
<td>SARS-CoV</td>
<td>RNA enveloped virus</td>
<td>1,8-cineole, α-terpinyl acetate, sabinene, α-pinene, terpinen-4-ol</td>
<td>[39]</td>
<td></td>
</tr>
<tr>
<td>Lippia junelliana (Moldenke) Tronc. (Verbenaceae)</td>
<td>Junin virus</td>
<td>RNA enveloped virus</td>
<td>Piperitenone oxide, limonene, myrcenone, p-cymene, α-pinene, Limonene, piperitenone oxide, 1,8-cineole, α-thujone, β-caryophyllene</td>
<td>[29,36]</td>
<td></td>
</tr>
<tr>
<td>Ageratum conyzoides (L.) L. (Compositae)</td>
<td>E7, E19</td>
<td>RNA non-enveloped viruses</td>
<td>Precocene I, (E)-caryophyllene, γ-murolene, bicyclogermacrene, α-humulene</td>
<td>[27]</td>
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<td>Bryophyllum pinnatum (Lam.) Oken (Crassulaceae)</td>
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<td>Nonanal, (E)-geranylacetone</td>
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<tr>
<td>Crinum jagus (J.Thomps.) Dandy (Amaryllidaceae)</td>
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<td></td>
<td>β-ocimene, hexadecane, tetramethylpentadecane, phytol, hexacosane</td>
<td>[27,50]</td>
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<tr>
<td>Lippia multiflora Moldenke (Verbenaceae)</td>
<td></td>
<td></td>
<td>1,8-cineole, thymol, linalol, germacrene-D, p-cymene</td>
<td>[27,51]</td>
<td></td>
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<tr>
<td>Macaranga barteri Müll.Arg. (Euphorbiaceae)</td>
<td></td>
<td></td>
<td>Eremophilene, 6-epi-shyobunol, methyl salicylate, β-eudesmenes, allo aromadendrene</td>
<td>[27]</td>
<td></td>
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<tr>
<td>Mondia whitei (Hook.f.) Skeels. (Apocynaceae)</td>
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<td></td>
<td>(E)-2-hexen-1-ol, heptacosane, phytol, 1-hexanol, (E)-2-hexenal</td>
<td>[27]</td>
<td></td>
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<tr>
<td>Spondias mombin L. (Anacardiaceae)</td>
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<td></td>
<td>Ethyl acetate, ethyl butyrate, ethyl hexanoate, hexyl butyrate, linalool</td>
<td>[27]</td>
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<tr>
<td>Ocimum basilicum L. (Lamiaceae)</td>
<td>Virus de l’herpès (HSV)</td>
<td>DNA enveloped virus</td>
<td>monoterpenoids</td>
<td>[carvone, fenchone, geraniol, myrcene]</td>
<td>[52]</td>
</tr>
<tr>
<td>Plants (Family)</td>
<td>Viruses</td>
<td>Typical</td>
<td>Major compounds ( \text{EO} )</td>
<td>Reference</td>
<td></td>
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</tr>
<tr>
<td>Eucalyptus bicostata Maiden, Blakely &amp; Simmonds (Myrtaceae)</td>
<td>Adénovirus (ADV)</td>
<td>DNA non-enveloped virus</td>
<td>and thujone), sesquiterpenoids (caryophyllene and farnesol), triterpenoid (ursolic acid) and flavonoid (apigenin), linalool, 1,8-Cineole, β-farnesene, β-elemene and β-elemene</td>
<td>[52]</td>
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<td>Eucalyptus astringens (Maiden) Maiden. (Myrtaceae)</td>
<td>Coxsackie virus B1 (CVB1)</td>
<td>DNA non-enveloped virus</td>
<td></td>
<td>[52]</td>
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<td>Eucalyptus cinerea F.Muell. ex Benth. (Myrtaceae)</td>
<td>Entérovirus 71 (EV71)</td>
<td>DNA non-enveloped virus</td>
<td></td>
<td>[52]</td>
<td></td>
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<tr>
<td>Eucalyptus maidenii F.Muell. (Myrtaceae)</td>
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<td>DNA Unwrapped virus</td>
<td></td>
<td>[52]</td>
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<td>Eucalyptus caesia Benth. (Myrtaceae)</td>
<td>Virus de l’hépatite B (VHB)</td>
<td>DNA enveloped virus</td>
<td></td>
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<td></td>
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<tr>
<td>Eucalyptus caesia Benth. (Myrtaceae)</td>
<td>JUNV</td>
<td>DNA non-enveloped virus</td>
<td></td>
<td>[52]</td>
<td></td>
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<tr>
<td>Citrus limonum Risso (Rutaceae)</td>
<td>HSV-1</td>
<td>DNA enveloped virus</td>
<td></td>
<td>[33]</td>
<td></td>
</tr>
<tr>
<td>Cymbopogon citratus (DC.) Stapf. (Poaceae)</td>
<td>HSV-1</td>
<td>DNA enveloped virus</td>
<td></td>
<td>[40]</td>
<td></td>
</tr>
<tr>
<td>Heterothalamus alienus (Spreng.) Kuntze. (Compositae)</td>
<td>JUNV</td>
<td>RNA enveloped virus</td>
<td></td>
<td>[56]</td>
<td></td>
</tr>
<tr>
<td>Artemisia kermanensis Podlech (Compositae)</td>
<td>HSV-1</td>
<td>DNA enveloped virus</td>
<td></td>
<td>[52]</td>
<td></td>
</tr>
</tbody>
</table>

**Legend:** HSV = Herpes Simplex Virus (DNA virus); DEN = Dengue virus (RNA virus); NDV = Newcastle Disease Virus (DNA virus); SARS = Severe Acute Respiratory Syndrome; SARS-CoV = SARS-associated coronavirus (RNA virus); Junin virus (RNA virus), Adenovirus (ADV)
Fig. 2. Different families identified and their specific richness

Fig. 3. Rate of major essential oil compounds from antiviral aromatic plants concentration of essential oils in the majority of antiviral aromatic plants
Fig. 2 illustrates different families identified and their specific richness.

As shown in the Fig. 2, tree botanical families out of the 19 possess 64.4% of listed species. These specific families are the following: Compositae (20%), Lamiaceae (17.7%), Myrtaceae (17.7%) and Verbenaceae (8.8%).

Fig. 3 shows major EO compounds antiviral aromatic plants.

It emerges from this Fig. 3 that among EO identified in antiviral aromatic plants, 18 compounds are in the majority with a predominance of α-pinene (18%) followed respectively by 1,8-cineol (13%), α-terpineol, limonene and p-cymène (7% to each), Terpinen-4-ol (6%), Y-terpinène, camphor and linalool (5% to each), β-thujone and β-caryophyllene (4%). (E)-Caryophyllene, aromadendrene, caryophyllene, germacrene-D, Myrcene, sphathulenol and β-elemene in the last position with at least 3% to each.

3.2 Discussion

COVID-19 is an emerging infectious disease with highly variable clinical expression similar to that of common respiratory diseases [1]. At a time when COVID-19 is raging throughout humanity, causing loss of human lives and when the prospect of developing a new drug in the short and medium term is not feasible due to numerous constraints, thus it is urgent to find an alternative solution to this major public health problem in order to save lives. To this end, fumigation with aromatic plants is one of the alternative therapeutic means to be encouraged in Africa where more than 80% of the population uses medicinal and aromatic plants for treatment [8,10-11,15]. In fact, the scientific evidence regarding the effects of EO on RNA and/or DNA viruses is very numerous and well documented [17,23]. Since the most important cause of COVID-19 related deaths is respiratory failure which is due to pneumonia and that the main reason that causes morbidity and mortality in SARS-CoV-2 patients is the overproduction of proinflammatory cytokines, molecules that act via anti-inflammatory mechanism of action are potential therapeutic agents since they can inhibit several proinflammatory cytokines. As stated above, Winska et al have reported the anti-inflammatory activity of EO.

EO molecules were also reported to interact with the viral life cycle, such as the viral entry, replication, assembly, and release, as well as targeting virus–host through specific or noncovalent interactions such as hydrogen bonds, π/π and van der Waals interactions [57-59]. Among aromatic plant species, Ocimum basilicum that is widely distributed in DRC possess antiviral activities against DNA viruses like HSV, ADV and hepatitis B virus and RNA viruses (coxsackievirus B1 (CVB1) as well as enterovirus 71 (EV71)). Others aromatic plant species belonging to the Lippia, Eucalyptus and Artemisia have antiviral activities [19,25]. Loizzo et al. reported the inhibitory activity of Laurus nobilis EO against SARS-CoV which has 96% of the same genetic background as SARS-CoV-2 [39]. This revealed that naturally occurring EO chemo-types containing beta-oicimene, 1,8-cineole, alpha-pinene and beta-pinene being the main constituents could act as therapeutic agents against SARS-CoV-2’s main protease, the causative agent of COVID-19.

4. CONCLUSION

The present study was carried out with the aim of documenting the antiviral properties of aromatic plant species which can justify their use against SARS-CoV-2. Many scientific evidences revealed that EO display bioactivity against RNA and/or DNA viruses. Thus, the present review proposes the development of alternative based-method of relevance using reverse pharmacology approach. Molecular docking investigations and pharmacoinformatics of some naturally occurring EO chemo-types against SARS-CoV-2 proteases are in progress in order to identify the potential inhibitors.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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