https://doi.org/10.48047/AFJBS.7.4.2025.1063-1084

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Ethnobotanical study of medicinal plants used against COVID-19 in Algeria

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Volume 7, Issue 4,apr 2025

Received: 15 feb 2025

Accepted: 05 mar 2025

Published: 05 apr 2025

doi:10.48047/AFJBS.7.4.2025.1063-1084

Abstract

The coronavirus disease has a significant mortality rate and has spread rapidly worldwide. People are searching for alternative ways to treat or reduce the harmful effects of this outbreak. For this reason, an ethnobotanical study was conducted in Algeria to identify medicinal plants used to treat COVID-19. Five hundred and two members of closed Facebook groups participated in this study; 72.1% of them were infected. The analysis of the survey results reveals widespread use of medicinal plants among the Algerian population, where the participants used 19 plant species from 11 different families as a means of prevention against COVID-19. The biological effects of these medicinal plants, potentially due to compounds like Eugenol, may slow down this viral attack and could be beneficial in treating COVID-19. As a result, the integration of herbal medicine with conventional medicine is proving to be a promising avenue for treating COVID-19

Keywords: COVID-19, Medicinal plants, Algeria, Ethnobotanical study, Traditional medicine, SARS-CoV-2

Introduction

In December 2019, a novel coronavirus, SARS-CoV-2, was identified in Wuhan, China. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a viral agent that has caused a new disease worldwide due to its highly contagious nature. On March 11, 2020, the WHO declared a global pandemic due to the rapid spread of the virus throughout the rest of the world, as reported by Haoud and Mellali (2020). Since there is currently no vaccination to prevent SARS-CoV-2, researchers have conducted a thorough investigation of natural substances to find potentially useful treatment options (Goetz, 2014). The World Health Organization encourages developing countries to integrate herbal remedies into their official health systems, ensuring their characteristics, safety, effectiveness, and quality are guaranteed (Bouzabata, 2016)

The objective of our study is to identify the different medicinal plants used in Algeria to prevent and treat COVID-19.

Materials and methods

An ethnobotanical study was conducted among 502 people between April and June 2022. Due to the containment measures implemented in the country during the study period, relevant announcements were shared on social networks, particularly in closed Facebook groups focused on COVID-19 prevention and control, as well as university groups from various regions of Algeria. Participants in this study were recruited mainly through advertisements in private Facebook groups focused on the prevention and control of COVID-19, as well as in university groups spread over several regions of Algeria. Inclusion criteria included: being resident in Algeria, being at least 18 years old, having Internet access and being an active member of these groups. This non-probability snowball sampling approach enabled us to reach a diverse population in terms of age, gender, level of education and experience with COVID-19. Participation in the survey was free and anonymous, ensuring that the confidentiality of responses was protected.

The collected data were analyzed using IBM SPSS Statistics version 25 software. According to Alwhaibi et al. (2020), the following formula is used to determine the minimum number of survey participants. N is the minimum sample size, z is the confidence level according to the normal standard distribution, which corresponds to the 95% confidence level based on the normal standard distribution corresponding to a 95% confidence interval (z=1.96), p represents the prevalence of COVID-19 (0.25%) according to WHO (2020), q = (1–p), and is the desired level of precision of 5% (0.05).

$$N=(1.96)2\times0.25\times(1–0.25)/(0.05)2=289$$

The survey form is divided into two parts: one section allows for the collection of sociodemographic data (age, gender, level of education, and whether the respondent had COVID-19), and the second section concerns medicinal plants used during the pandemic. The information on the plants was as follows: the vernacular name, part of the plant used, method of preparation, frequency of use (FU), and duration of treatment. The FU is collected for each species. According to Oliveira et al. (2021), we used the following formula to calculate this measure :

$FU = \Sigma U/n$

FU is the frequency of use of a species; ΣU is the total number of citations for species; and n is the number of informants. Assuming that any person can name all species.

To guarantee the validity of the ethnobotanical data, we implemented a rigorous taxonomic validation process. In the context of this online study, as the collection of physical samples was not feasible, several measures were adopted. Firstly, the vernacular plant names provided by participants were checked against Algerian regional reference floras, such as Quezel and Santa's (Quézel & Santa, 1962-1963), and the online African Plant Database (African Plant Database, 2022). This step enabled us to establish correspondences with valid scientific names. In the event of ambiguities or synonyms, further research was carried out to clarify the identity of the plants. In addition, participants were asked to provide detailed descriptions of the plants they used, including information on their morphology (size, leaf shape, flower color, etc.) and habitat. These descriptions were essential for confirming plant identification using the reference floras.

Results and discussion

Distribution of participants according to sociodemographic and phytotherapy characteristics

In total, 502 people participated in our survey, 81.3% women and 18.7% men. Van Andel and Carvalheiro (2013) state that women are more likely to participate in surveys. The most dominant age group is between 18 to 44 years old, and 91.8% of survey participants have a university level. According to Kouame et al.(2021), the respondents were academics during the study. Da Silva et al. (2011) and Kouame et al. (2021) found that people with higher education levels frequently use herbal medicines. 72.1% of people are infected with COVID-19, and 60% are women aged 25–34 years old (Table 1).

Table 1: Profiles of study participants (Total n= 502)

Variable	**Categories**	***n***	**Percentage(%)**
Gender	Female	408	81.3
	Male	94	18.7
Age (years)	18-24	219	43.6
	25-34	160	31.9
	35-44	64	12.7
	45-64	56	11.2
	< 65	3	0.6

Education	Elementary school	3	0.6
	Secondary school	38	7.6
	University	461	91.8
Having COVID-19	yes	362	72.1
	no	140	27.9

Furthermore, 50.6% of participants believe that medicinal plants have therapeutic potential and can cure patients with COVID-19, compared to 3.1% who do not believe in the effectiveness of herbal medicine to cure COVID-19. According to Calixto.(2000), several factors contribute to the widespread use of medicinal plants, including their effectiveness against COVID-19, their safety regarding side effects, and their affordability compared to conventional medicines. The findings demonstrate that the people of Algeria frequently use herbal medicine to combat COVID-19 (Figure. 1).

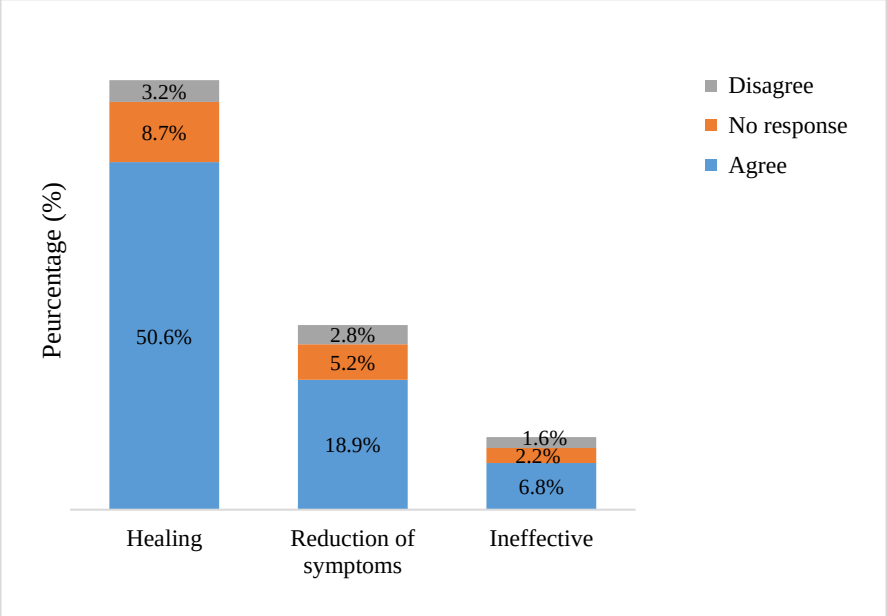

Figure 1: Participants' opinions on the use of medicinal plants during the COVID-19 pandemic.

As Ekor (2014) points out, the use of herbal medicine is due to other reasons, including consumer preference for natural therapies and greater interest in alternative medicines, as well as the belief that it can treat illnesses that conventional medicine cannot cure. According to the results of this study, women attach great importance to medicinal plants in the fight against COVID-19. However, Karami and Ghanba (2019) state that women have carefully preserved knowledge of medicinal plant use as a valuable cultural heritage that contributes to the health

and well-being of families. Also, the results of the study show that most people in Algeria prefer combining medicinal plants with conventional drugs to treat COVID-19 (Figure. 2).

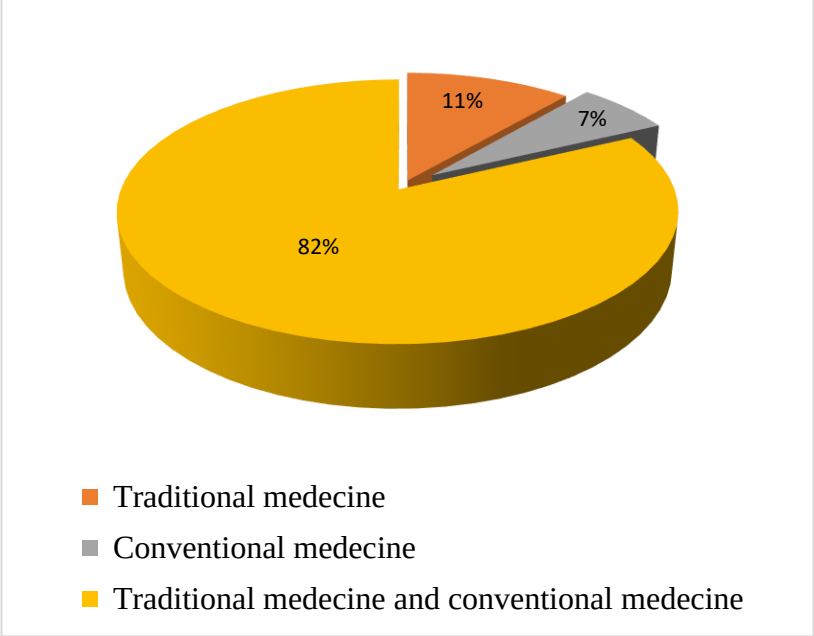

Figure 2: Therapeutic approaches to treat COVID-19.

Inventory of medicinal plants used against COVID-19

The analysis of data collected during the ethnobotanical survey on medicinal plants used in the treatment of COVID-19 made it possible to identify 19 species belonging to 11 different botanical families: Lamiaceae, Apiaceae, Myrtaceae, and Zingiberaceae (Table. 2).

Table 2 : Medicinal plants used against COVID-19 in Eastern Algeria

Family and species	Vernacular name	Part used	Preparations	Other forms of use
Amaryllidaceae *Allium cepa*	Onion	Bulb	Raw, cooked	
Apiaceae *Pimpinella anisum*	Anise	Seed	Infusion	
Apiaceae *Foeniculum vulgare*	Fennel	Seed	Infusion	
Asteraceae *Artemisia herba-alba*	Mugwort	Leaf	Infusion	
Lamiaceae *Melissa officinalis*	Lemon balm	Leaf	Infusion	
Lamiaceae *Mentha Spicata*	Mentha	Leaf	Infusion	Essential oil
Lamiaceae *Origanum vulgare*	Oregano	Leaf	Infusion	
Lamiaceae *Rosmarinus officinalis*	Rosemary	Leaf	Infusion	Essential oil
Lamiaceae *Salvia officinalis*	Common sage	Leaf	Infusion	
Lamiaceae *Thymus vulgaris*	Thyme	Aerial parts	Infusion	Essential oil
Lauraceae *Cinnamomum verum*	Cinnamon	Bark	Infusion	
Myrtaceae *Syzygium aromaticum*	Cloves	Seed	Infusion	Essential oil
Myrtaceae *Eucalyptus globulus*	Eucalyptus	Leaf	Infusion	Essential oil
Oleaceae Olea europeae	Olive tree	Leaf, fruit	Infusion	Oil
Ranunculaceae *Nigella sativa*	Black cumin	Seed	Infusion	
Rutaceae *Citrus limon*	Lemon	Leaf, Fruit	Infusion	
Verbenaceae *Aloysia citriodora*	Verbena	Aerial parts	Infusion	
Zingiberaceae *Zingiber officinale*	Ginger	Rhizome	Infusion	
Zingiberaceae *Curcuma longa*	Turmeric	Rhizome	Infusion	

Our results agree with those of El Alami et al. (2020), who claimed that 23 species of medicinal plants belonging to 11 families were used to stimulate immunity against SARS-CoV-2 in Morocco. Thus, the most commonly used method of preparation was infusion. Our results are similar to those of Helali et al. (2020) and El Alami et al. (2020), who have confirmed that this method of preparation is very popular with respondents, which explains its ease of implementation. The results of the survey allowed us to identify ten species of medicinal plants most commonly used, in order of importance (Figure.3) :

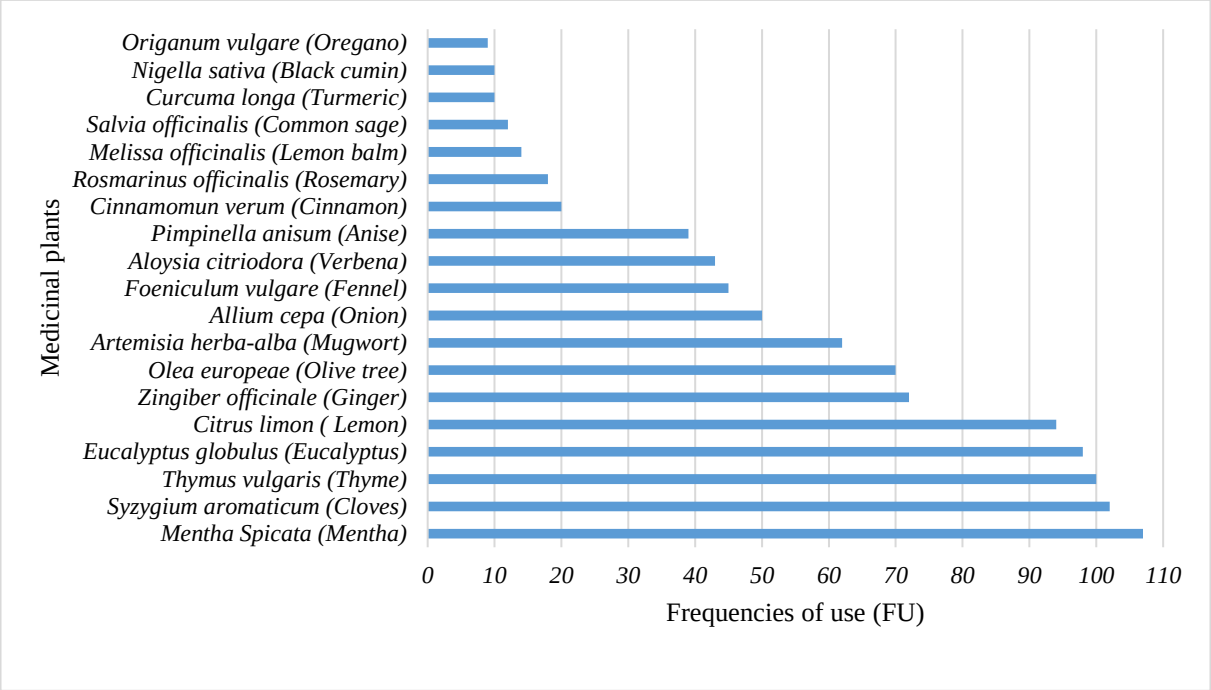

Figure 3: Frequencies of use of medicinal plants by participants to treat COVID-19.

Additionally, El Alami et al. (2020) reported that Eucalyptus globulus, Foeniculum vulgare, and Zingiber officinale are the most used medicinal plants in Morocco, given their therapeutic value as well as the active compounds that they contain to prevent and treat COVID-19. The essential oils of Mentha Spicata, Rosmarinus officinalis, Thymus vulgaris, Syzygium aromaticum, and Eucalyptus globulus have been widely used during the COVID-19 pandemic. As El Alami et al. (2020) report, essential oils are well known for their beneficial biological effects on respiratory and circulatory functions. Orafidiya et al. (2004), confirm that for centuries, essential oils have been used in medicine and have demonstrated a multitude of health benefits, particularly against infectious, chronic, and acute diseases (Table. 3).

Table 3 : Phytochemical and pharmacological profiles of ethnomedicinal plants used against COVID-19 in Algeria : A comparison of traditional claims with laboratory/clinical data

Family Species	**Phytochemical and Pharmacological Compounds (Antiviral / Immunodulatory properties)**	**Laboratory / clinical data**	**Traditional claims**
Amaryllidaceae *Allium cepa*	- Alkaloids: Compounds such as lycorine and pancratistatin from Amaryllidaceae have shown weak anti-SARS-CoV-2 activity, with EC50 values ranging from 40 to 77 µM (Le et al, 2023). - Allium Compounds: Contain bioactive compounds, including flavonoids and sulfur-containing compounds, which have demonstrated antiviral effects against various viruses (Lengbiye et al, 2020). - Compounds from Allium species may modulate immune responses, potentially alleviating severe COVID-19 symptoms (Romadhona et al, 2024).	- In silico studies: Research indicates that certain compounds from Allium and Amaryllidaceae exhibit promising binding affinities to viral targets, warranting further clinical investigation (Romadhona et al., 2024; Amallah et al., 2024).	- Boosting immunity and overall health
Apiaceae *Pimpinella anisum*	- Cyanidin, malvidin, and isorhamnetin have shown significant binding affinity to the SARS-CoV-2 3C-like protease, suggesting potential inhibitory effects on viral replication (Hasan et al, 2020). - These compounds may exert antiviral effects by blocking viral entry and replication, as well as modulating immune responses to enhance host defense mechanisms (Ahmed et al, 2024).	- In Silico Studies: Molecular docking studies have demonstrated that certain phytochemicals from Pimpinella anisum can bind effectively to viral proteins, indicating their potential as therapeutic agents (Hasan et al, 2020). - A review of medicinal plants highlighted that many phytochemicals, including those from Pimpinella anisum, have shown antiviral activity in various studies, warranting further clinical investigation (Amallah et al, 2024). - Clinical Trials: There is a need for in vitro and in vivo studies to validate the efficacy of these phytochemicals against COVID-19 in clinical settings(Hasan et al., 2020; Ak, 2023).	- Relief of respiratory symptoms and digestion
Apiaceae *Foeniculum vulgare*	- Flavonoids, phenolic acids, and essential oils known for their antioxidant and anti-inflammatory properties. - These compounds may inhibit viral entry and replication, as well as modulate immune responses, enhancing the body's defense against infections (Amallah et al, 2024 ; Ahmed et al, 2024). - Inflammation Reduction : Fennel's compounds may help mitigate the inflammatory response associated with COVID-19, potentially reducing lung injury and improving patient outcomes (Majnooni et al, 2020).	- Clinical Data : While specific clinical trials on fennel for COVID-19 are limited, the broader category of phytochemicals has shown promise in preclinical studies, indicating a need for further investigation (Bijelic et al, 2022 ; Majnooni et al, 2020).	- Used for overall health

	- Antiviral Activity: Studies have shown that phytochemicals from fennel can exhibit direct antiviral effects, potentially reducing viral load in infected cells(Bhargav et al., 2022).		
Asteraceae *Artemisia herba-alba*	- Rutin, 4,5-di-O-caffeoylquinic acid, and schaftoside, which have shown potential in molecular docking studies against SARS-CoV-2 (Hasan et al, 2022). - Terpenoids, flavonoids, and artemisinin are recognized for their broad pharmacological activities (Kshirsagar & Rao, 2021). - Antiviral properties : Artemisia species exhibit significant antiviral effects against various viruses, including SARS-CoV-2, through mechanisms such as direct viral replication interference and immune modulation (Orosco, 2023). - Artemisia compounds may enhance immune responses, potentially reducing the severity of COVID-19 symptoms and associated comorbidities (Hasan et al., 2022; Orosco, 2023).	- Clinical Insights: While in silico studies provide a foundation, clinical trials are necessary to validate the therapeutic efficacy of these compounds against COVID-19 (Hudaib, 2022).	- Used against infections and inflammations
Lamiaceae *Melissa officinalis*	- Flavonoids, phenolic acids, and terpenes are known for their antioxidant and anti-inflammatory properties. These compounds can inhibit viral entry and replication, modulate immune responses, and reduce inflammatory cytokines like IL-6 and TNF-α(Das et al., 2023; Kianmehr et al., 2023).	-In Vitro Studies: Laboratory tests have shown that extracts from Melissa officinalis can reduce viral load and inflammation in cell models, supporting its use as a complementary treatment(Liana & Phanumartwiwath, 2021; Ahmed et al., 2024). - Clinical Data: Specific clinical trials on Melissa officinalis for COVID-19 are limited; its historical use in traditional medicine suggests potential efficacy (Amallah et al., 2024). - Cytokine Modulation: Compounds from Melissa officinalis can enhance the production of anti-inflammatory cytokines, which may help in managing the cytokine storm associated with severe COVID-19 cases (Kianmehr et al., 2023). - Antioxidant Activity: The antioxidant properties of its phytochemicals can help mitigate oxidative stress, a significant factor in COVID-19 pathology(Ahmed et al., 2024).	- Used for overall health
Lamiaceae *Mentha spicata*	- Essential oils rich in monoterpenes, particularly carvone and menthol, have demonstrated antiviral properties against various viruses, including coronaviruses (Zrig, 2022 ; Kianmehr et al, 2023). - These compounds may inhibit viral entry into host cells and reduce inflammation by modulating cytokine levels, such as	- In Vitro Studies: Laboratory studies have shown that extracts from Mentha spicata can reduce viral replication and inflammatory responses in cell cultures, suggesting its potential as a therapeutic agent against COVID-	- Relief of respiratory symptoms and soothing sore throat

	increasing anti-inflammatory cytokines like IFN-γ while decreasing pro-inflammatory markers. The antioxidant capacity of these compounds may also protect against oxidative stress, a significant factor in COVID-19 pathology (Kianmehr et al., 2023).	19 (Das et al., 2023; Kianmehr et al., 2023). - Clinical Relevance: While clinical data specifically on Mentha spicata is limited, the broader category of Lamiaceae plants has been associated with reduced symptoms and improved immune function in COVID-19 patients (Amallah et al., 2024). - Cytokine modulation: Phytochemicals from Mentha spicata can influence the immune response, potentially alleviating the cytokine storm associated with severe COVID-19 cases (Das et al., 2023; Kianmehr et al., 2023).	
Lamiaceae *Origanum vulgare*	- Thymol and Carvacrol: These are the primary active compounds in oregano, known for their antiviral and anti-inflammatory properties. They have been shown to reduce inflammatory mediators such as IL-1β, IL-6, and TNF-α, while increasing anti-inflammatory cytokines like IFN-γ (Kianmehr et al, 2023). - Polyphenols: These compounds can inhibit viral entry into host cells, as demonstrated in molecular docking studies, suggesting a potential mechanism for reducing viral load (Kianmehr et al., 2023). - Antiviral Activity: Oregano's phytochemicals have been documented to interfere with virus entry and replication, which are critical stages in the SARS-CoV-2 lifecycle (Das et al., 2023; Amallah et al., 2024). - Immunomodulatory effects: The compounds in oregano can modulate immune responses, potentially preventing the cytokine storm associated with severe COVID-19 cases (Das et al., 2023; Rai et al., 2024).	- In Vitro and In Vivo Studies: Studies have shown that oregano's phytochemicals can effectively reduce viral replication and modulate immune responses in laboratory settings(Das et al., 2023; Ahmed et al., 2024). - Potential for Clinical Use: While promising, further clinical trials are necessary to validate these findings in human subjects and to develop effective formulations with improved bioavailability (Das et al., 2023; Amallah et al., 2024).	- Used for overall health.
Lamiaceae *Rosmarinus officinalis*	- Bioactive polyphenols and terpenoids such as apigenin, luteolin, and rosmarinic acid, which have shown potential as inhibitors of SARS-CoV-2 Mpro (Patel et al., 2023). - These compounds may interfere with viral entry and replication, as well as modulate inflammatory responses by acting on cytokine levels (Das et al., 2023; Kianmehr et al., 2023).	- In Vitro and In Vivo Studies: Studies have demonstrated that phytochemicals can reduce inflammatory markers like IL-6 and TNF-α, while enhancing anti-inflammatory cytokines such as IFN-γ(Kianmehr et al., 2023). - Clinical Relevance: The low cost and fewer side effects of these plant-derived compounds make them attractive alternatives to conventional antiviral therapies (Das et al., 2023). - Cytokine Modulation: Phytochemicals from Rosmarinus officinalis may help alleviate cytokine storms associated with severe COVID-19 cases, potentially	- Used for overall health.

		reducing complications(Das et al., 2023; Kianmehr et al., 2023). - Antioxidant Properties: These compounds also enhance antioxidant capacity, which is crucial in managing oxidative stress during viral infections(Kianmehr et al., 2023).	
Lamiaceae *Salvia officinalis*	- Bioactive compounds such as rosmarinic acid, carnosic acid, and flavonoids which have demonstrated antiviral properties (Liana & Phanumartwiwath, 2021; Ahmed et al., 2024). - These compounds can inhibit viral entry and replication, modulate immune responses, and reduce inflammation by downregulating pro-inflammatory cytokines like IL-6 and TNF-α(Kianmehr et al., 2023; Ahmed et al., 2024).	- In Vitro Studies: Laboratory tests have shown that extracts from Salvia officinalis can reduce viral load and inflammatory markers in cell cultures (Das et al., 2023; Kianmehr et al., 2023). - Clinical Trials: While specific clinical data on Salvia officinalis for COVID-19 is limited, the broader category of Lamiaceae plants has been associated with positive outcomes in managing respiratory infections (Amallah et al., 2024).	- Used for overall health.
Lamiaceae *Thymus vulgaris*	- Thymol and carvacrol possess antiviral, anti-inflammatory, and antioxidant effects, which can modulate immune responses and alleviate symptoms associated with COVID-19. - Inhibition of viral entry: Thyme extracts have shown the ability to inhibit the interaction between the SARS-CoV-2 spike protein and ACE2, a critical entry point for the virus into host cells, with inhibition rates of up to 86.4% (Yao et al., 2023).	- Molecular Docking Studies: Phytochemicals like thymol and carvacrol have demonstrated potential in preventing viral entry through molecular docking analyses (Kianmehr et al., 2023). - Cytokine Modulation: Thyme extracts can reduce pro-inflammatory cytokines (IL-1β, IL-6, TNF-α) while increasing anti-inflammatory cytokines (IFN-γ), which is crucial in managing COVID-19-related inflammation (Kianmehr et al., 2023). - Clinical evidence: A randomized clinical trial indicated that thyme essential oil significantly reduced symptoms such as fever, cough, and fatigue in COVID-19 patients (Sardari et al., 2021).	- Treatment of respiratory infections
Lauraceae *Cinnamomum verum*	- Cinnamon extracts contain numerous bioactive compounds, including saccharumoside C and various proanthocyanidins, which have been identified as having antiviral properties (Xie et al, 2023).	- In silico studies have highlighted nine specific phytochemicals from cinnamon that show promise as inhibitors of the SARS-CoV-2 main protease (Prasanth et al, 2021). - Cinnamon extracts have demonstrated the ability to suppress the binding of the SARS-CoV-2 spike protein to ACE2, a critical receptor for viral entry, in a dose-dependent manner (Xie et al, 2023; Wu et al., 2024). - In vitro studies provide a foundation for the antiviral potential of cinnamon ; further clinical trials are necessary to validate these findings in human subjects(Amallah et al., 2024).	- Used for overall health

Myrtaceae *Syzygium aromaticum*	- Campesterol, stigmasterol, crategolic acid, oleanolic acid, and bicornin demonstrated significant binding affinities to the SARS-CoV-2 main protease (-7.7 to -9.2 kcal/mol) (Wafae & Djahira, 2023) - These compounds may interfere with viral entry and replication and possess anti-inflammatory properties that could mitigate cytokine storms associated with severe COVID-19 cases (Das et al., 2023).	- In Vitro and In Vivo Studies: Various studies have documented the antiviral effects of Syzygium aromaticum, showing its potential to act against SARS-CoV-2 through multiple pathways, including immunomodulation (Amallah et al., 2024; Ahmed et al., 2024).	- Relief of cough, cold, and as a general antiseptic
Myrtaceae *Eucalyptus globulus*	- α-pinene and globulol have shown promising antiviral effects against SARS-CoV-2 in vitro (El-Shiekh et al., 2024). - These phytochemicals can interfere with viral entry and replication, providing a dual mechanism of action by also modulating inflammatory responses (Das et al., 2023). - Eucalyptus compounds may enhance immune responses, potentially improving outcomes in COVID-19 patients by regulating pro-inflammatory cytokines (Amallah et al., 2024).	- Clinical studies have highlighted the anti-inflammatory properties of Eucalyptus extracts, which may help alleviate cytokine storms associated with severe COVID-19 cases (Das et al., 2023). - The essential oils have been linked to reduced viral load and improved respiratory function in preclinical models (Zrig, 2022).	- Decongestant, relief of cold and flu symptoms
Oleaceae *Olea europaea*	- Oleuropein, hydroxytyrosol, apigenin-7-O-glucoside, and luteolin-7-O-glucoside are notable for their antiviral properties (Abdelgawad et al, 2022). - These compounds can interfere with viral entry and replication, and they also possess anti-inflammatory effects that may mitigate cytokine storms associated with severe COVID-19 cases (Das et al, 2023).	- In Vitro Studies: Olive leaf extracts have shown efficacy in inhibiting the SARS-CoV-2 main protease (Mpro), a critical enzyme for viral replication (Al Matroudi, 2025). - Clinical Relevance: The anti-inflammatory and immunomodulatory effects of olive leaf extracts can help manage symptoms and complications in COVID-19 patients, potentially reducing the need for corticosteroids and other conventional treatments (Ahmed et al., 2024).	- Boosting immunity and overall health
Ranunculaceae *Nigella sativa*	- Thymoquinone: The primary active ingredient in NS, known for its anti-inflammatory and antioxidant properties(Usmani et al., 2023). - Other compounds: Includes nigelledine, α-hederin, and hederagenin, which have shown potential in inhibiting SARS-CoV-2 replication (Koshak & Koshak, 2020). - Immunomodulatory effects: NS has been shown to enhance immune response and reduce inflammation, which is crucial in managing COVID-19 symptoms (Islam et al., 2021).	- Clinical Data: Several studies indicate that NS can reduce COVID-19 risk and improve recovery rates, with one trial showing significant symptom improvement when combined with honey (Usmani et al., 2023; Khan et al., 2022).	- Used for overall health
Rutaceae *Citrus limon*	- Flavonoids (quercetin, hesperidin), terpenoids, and carbohydrates are known for their antioxidant and anti-inflammatory properties (Shorinwa & Otu, 2023; Raman et al., 2024).	- Molecular Docking Studies: Phytoconstituents like rutin and eriodictyol have demonstrated strong binding affinities to SARS-CoV-2 proteins, suggesting potential as antiviral agents(Raman et al., 2024; Khan et al., 2021). - In Vitro Assays: Compounds such as rutin exhibited an IC50 value of 17.50 μM against the virus,	- Boosting immunity and relief from cold and flu symptoms

		indicating effective inhibition of viral activity(Raman et al., 2024). - Clinical and Preclinical Data: The extract's ability to modulate immune responses may help mitigate the cytokine storm associated with severe COVID-19 cases (Das et al., 2023).	
Verbenaceae *Aloysia citriodora*	- Flavonoids, phenolic acids, and essential oils are known for their antioxidant and anti-inflammatory properties. These compounds may inhibit viral entry and replication, as well as modulate immune responses, potentially reducing the severity of COVID-19 symptoms (Amallah et al., 2024; Ahmed et al., 2024). - Antiviral activity: Studies have shown that phytochemicals from various medicinal plants, including those in the Verbenaceae family, can exhibit direct antiviral effects against coronaviruses (Bhargav et al., 2022; Ak, 2023).	-Clinical Data: While specific clinical trials on Aloysia citriodora are limited, the broader category of phytochemicals has demonstrated efficacy in preclinical studies, suggesting a promising avenue for future research(Bijelic et al., 2022).	- Used for overall health
Zingiberaceae *Zingiber officinale*	- Bioactive compounds such as gingerols, shogaols, and zingerone, which exhibit anti-inflammatory and antioxidant properties (Amini Fard et al, 2023). - Specific compounds like cyanin and quercetin have shown potential in silico as inhibitors of SARS-CoV-2(Siregar et al, 2022). - Studies have demonstrated that ginger extracts can bind to viral components, including proteases and the spike protein of SARS-CoV-2, suggesting a direct antiviral action (Luca and Natasha, 2023) - Ginger has been identified as an immunomodulator, enhancing the body's immune response against infections, which is crucial in managing COVID-19 (Turner, 2022).	- Clinical Data: A non-randomized study indicated that Sunthi (dry ginger) significantly improved the quality of life and alleviated COVID-19 symptoms in participants(Dubey et al., 2023).	- Reducing inflammation, relieving nausea, and boosting immunity
Zingiberaceae *Curcuma longa*	- Curcumin: The primary active compound, known for its antiviral properties, inhibits SARS-CoV-2 entry by binding to critical proteins like the S-protein and TMPRSS2 (Kali & Charles, 2024). - Other Compounds: Additional constituents such as Calebin A, cyclocurcumin, and quercetin also interact with various COVID-19-related proteins, enhancing the overall therapeutic potential of C. longa(Indradi et al., 2022). - Immunomodulation: Curcumin modulates immune responses by reducing pro-inflammatory cytokines and enhancing anti-inflammatory cytokines, which is crucial in preventing severe COVID-19 outcomes (Kali & Charles, 2024). - Antiviral Activity: Studies suggest that C. longa extracts exhibit antiviral effects	- Clinical and Laboratory Data: While preclinical studies show promise, clinical evidence remains limited. Further research is necessary to establish optimal dosages and formulations for effective treatment against COVID-19 (Kali & Charles, 2024).	- Used for overall health

	against enveloped viruses, including SARS-CoV-2, through multiple mechanisms (Balaji et al., 2022).		

The species cited by the participants contain bioactive molecules that can prevent the spread of SARS-CoV-2 by acting on the 3CL protease protein (Mpro) and the ACE-2 receptor, which disrupts the virus replication process. The Algerian population chose these medicinal plants because of the local culture, from which they have empirically acquired important indigenous knowledge from generation to generation. Whereas Bouasla and Bouasla. (2017), argue that indigenous knowledge has been passed down orally from one generation to another for thousands of years.

This ethnobotanical study presents a detailed overview of the identified medicinal plants, highlighting the integration of traditional knowledge with scientific evidence. Table 3 summarizes the phytochemical compounds present in each plant species, linking them to their reported pharmacological activities, particularly antiviral and immunomodulatory properties relevant to COVID-19. Notably, the inclusion of both laboratory and clinical data, where available, alongside traditional claims, provides a balanced perspective on the potential therapeutic benefits of these plants. This compilation underscores the importance of further research to validate traditional uses and explore the potential of these plants in combating COVID-19, thereby supporting their integration into potential therapeutic strategies (Table 3). Despite promising findings, further clinical research is essential to fully understand the antiviral, immunomodulatory, and therapeutic applications (Orosco, 2023), as well as other medicinal plants with reported anti-COVID-19 properties (Amallah et al., 2024; Ahmed et al., 2024; Das et al., 2023; Kali & Charles, 2024).

This study has some limitations. Data collection was conducted exclusively online, which may have restricted the participation of individuals without Internet access, potentially introducing a selection bias. Furthermore, the absence of physical plant samples for taxonomic validation is a limitation, although rigorous measures were implemented to minimize the risk of misidentification. Despite these limitations, the diversity of participant profiles and the efforts made to validate the identity of the cited plants strengthen the credibility of the results.

Conclusion

According to our survey, medicinal plants are widely used in Algeria to prevent and treat COVID-19. Clinical studies on medicinal plants are necessary to ensure their safe and effective use for the benefit of the population. Moreover, the combination of herbal medicine and conventional medicine is a promising therapeutic approach for the treatment of COVID-19. Further research should focus on isolating and characterizing the bioactive compounds in these plants to develop potential therapeutic interventions.

Conflict of interest

The authors declare that they have no conflict of interest.

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