

TREATMENT AND PREVENTION OF COVID-19 RESPIRATORY SYMPTOMS THROUGH MEDICINAL HERBS IN ISLAMABAD, PAKISTAN

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Abstract

The COVID-19 outbreak has once again prompted individuals to seek treatment through traditional and alternative approaches. Due to their therapeutic properties, chemical makeup, and biological activities, plants with medicinal properties have the ability to both prevent and treat illness symptoms. The purpose of this study was to investigate the effectiveness of medicinal plants used to treat and prevent respiratory symptoms of the COVID-19 pandemic in Islamabad, Pakistan. To gather primary information about the herbal remedies used throughout COVID-19, which extended from January 1st to March 30th, 2021, this study used a web-based survey. The poll received responses from 914 participants in total. The data was collected using a 10-item structured questionnaire via Google Forms. The parameters associated with the utilization of botanical medicines in combating the COVID-19 and the management of respiratory symptoms during the pandemic were evaluated using qualitative statistics and multivariate later multivariate logistic regression (MLR) analysis. This empirical study shows that a total of 914 participants reported their usage of medicinal plants; out of which, 78.44% (n=717) said they used them as preventives, and 68.17% (n=623) were of the view that plants are used for the treatment of respiratory problems. When exhibiting more than one of the respiratory symptoms, no less than 22% of respondents utilize medicinal plants, while a minimum of 10% utilized plants to treat fatigue. The MLR analysis revealed that the majority of respondents used ginger and eucalyptus for both prevention and treatment, while garlic and matico were utilized mainly for prevention. Several community factors and participants having COVID-19 were connected with the considerable usage of medicinal plants for treatment as well as prevention.

Keywords: COVID-19, Medicinal plants, Ethnobotanical survey, Prevention

Introduction

With a concerning number of fatalities and health difficulties brought on by the new coronavirus illness (COVID-19) pandemic, the globe has been battling to identify drugs for both prevention and treatment of COVID-19 (Keni *et al.*, 2020; Boulware *et al.*, 2020; Rome and Avorn, 2020). Numerous experiments (Mitja *et al.*, 2021;

Rosa and Santos, 2020) and variations have been conducted, but have not shown encouraging outcomes. Social media has been used to disseminate a variety of false information about COVID-19, such as the use of herbal remedies to treat or prevent the disease (Pennycook *et al.*, 2020; Franco and Bussmann, 2020; Van, 2014). In accordance with the needs, the relationship

between people and plants is intimate. Many human needs are met by plants, such as those for shelter, medicine, and food. Recently, there has been a rising dependence on botanical remedies, which were historically employed by humans to combat pandemics, as a potential COVID-19 prevention measure (Cunningham, 2021; Martin, 2014; Adnan and Othman, 2012; Arora *et al.*, 2011; Harshberger, 1896; Haris and Hillman, 1989).

Medicinal plants have been recommended by many studies as a viable treatment or prevention for COVID-19. To strengthen COVID-19 patients' immunity, nations like India and China are combining their usage with western therapy. In China, conventional medicine improved treatment of symptoms and decreased rates of increasing death (Shankar *et al.*, 2020; Zhou *et al.*, 2020). However, the World Health Organization (WHO) asserts that while medicinal herbs may be beneficial for health and in boosting the defense system, they cannot be used to prevent or treat COVID-19. Unreliable COVID-19 treatments may make individuals less likely to practice good self-hygiene, increase their reliance on self-medicating and endanger the health of patients.

The number of COVID-19 cases in Islamabad, Pakistan, is increasing daily, highlighting the urgent need for a robust medical care infrastructure to support the growing demand. The existing healthcare system in the nation is inadequate to effectively respond to the rising number of incidents, potentially resulting in challenges in providing adequate care and treatment to patients. Home treatments, such as the usage of medicinal herbs, might be used as an

alternate strategy to fight COVID-19. Thus, the primary objective of this study conducted in Islamabad, Pakistan was to explore the potential use of medicinal herbs in preventing COVID-19 and alleviating respiratory symptoms associated with the disease.

Material and Methods

Study Design

The study used a cross-sectional qualitative analysis with a convenient sampling technique to gather data from the general population of Islamabad. A pre-designed questionnaire was distributed via WhatsApp and email to capture detailed qualitative responses. This approach aimed to gain insights into the perspectives, experiences, and opinions of participants. The cross-sectional design provided a snapshot view of the data, allowing for a comprehensive understanding of the research topic within a specific timeframe.

Data Collection

A questionnaire was designed using Google Forms and distributed to participants through WhatsApp and email for data collection. The creator of the form made a collection of questionnaires and initially tested the Google Form to evaluate the feedback percentage. Each individual contacted through the form received a clear written permission message at the top and was asked for signed consent at the beginning of the form. A consent notice was also provided at the start of the project, and friends were requested to circulate the Google Form to as many people as possible through emails and social networking sites. Between January 1, 2021, and March 30,

2021, a total of 1798 people were reached for the web-based poll, with 914 (76.29%) respondents from Islamabad, Pakistan, provided sociodemographic information.

Ten questions were asked in the survey, including questions about demographics, the use of herbal remedies for treating or preventing COVID-19-related respiratory symptoms in oneself, in one's family, or in one's friends, as well as questions about the use of therapeutic plants and the symptoms of respiration for which they were used. Volunteer participants were requested if they had employed botanical remedies to prevent or cure COVID-19-related respiratory ailments when the country was under lockdown. Participants were then questioned on their own COVID-19 diagnoses as well as any friends or relatives with diagnoses. The last question requested participants to state which symptom(s) motivated them to ingest any of the therapeutic plants listed on the preceding question. The chosen symptoms correspond to the most prevalent COVID-19 signs and symptoms listed by the Centers for Prevention and Control of Diseases.

The significant level for the data evaluation in STATA edition 14 was fixed at p value 0.05. Demographics data underwent descriptive analysis in order to display the incidence and proportion of each response. In the case of the MLR analysis, a test called the chi-square test was used to ascertain if the factors under study were related. The threshold for statistical significant was set at the 95% confidence intervals (CI) and the p-value less than 0.05.

Results

This research included 914 respondents in total. Females made up 62.59% of the study's total participants (n=572). According to professional history 29.11% of the population (n=266) was undergraduate students, and 59.83% of the population (n=548) was graduate students. Regarding the COVID-19 questions and the consumption of herbal remedies, 20.89% (n=191) had the disease, 64.11% (n=586) had a family member or friend who had it, 78.44% (n=717) utilized them for managing respiratory symptoms, and 68.17% (n=623) used them to avoid them (table 1).

Our study found that female respondents (n=483; 84.46%) were more likely to utilize medical plants than male respondents (p 0.001) for the management or prevention of pulmonary problems (table 2).

The responders mentioned using medicinal herbs from a list of plants (Katabchi and Papari, 2021; Magzoub, 2020; Abbass, 2020; Hamulka *et al.*, 2020; Khubber *et al.*, 2020) to address respiratory problems caused by COVID-19. Ginger was the most often used herb, followed by eucalyptus, garlic, chamomile, matico, and coca. All of the medicinal herbs were found to be utilized for two or more respiratory ailments. Following malaise (10–40%) in the bivariate statistics, the usage of therapeutic herbs was linked to the development of more than two symptoms (22-49%) (table 3).

The consumption of ginger for cure and stoppage of breathing symptoms throughout the COVID-19 pandemic was positively associated in the multivariate analysis (PR: 1.27 (1.17-1.38) p 0.001, PR: 1.23 (1.14-1.33) p 0.001),

subsequently followed by the consumption of eucalyptus (PR: 1.19 (1.06-1.31) $p = 0.001$, PR: 1.13 (1.05-1.18) $p = 0.002$). Additionally, there is a favorable correlation between the prevention-only usage of Matico (PR: 1.07 (1.00-1.15) $p = 0.019$) and the use of garlic (PR: 1.09 (1.02-1.12) $p = 0.024$). In order to cure respiratory issues, ginger and eucalyptus were the most often employed herbs, while lemon balm and panty were least frequently used. When it comes to preventive, eucalyptus, ginger, garlic, and matico were among the most popular, while lemon balm was the least popular (table 4).

Discussion

This study revealed that 78.44% of the patients utilized medicinal herbs for preventing the occurrence of COVID-19 symptoms related to breathing. In contrast, a study of the general population in Mexico revealed that the most common ailments treated with plants for medicinal purposes were tuberculosis (4.1%), bronchitis (4.2%), cough (48.2%), pneumonia (6.3%), sore throat (19%), sinusitis (8.57%), and asthma (17.41%) (Juarez and Cabrera, 2019). Additionally, because medicinal herbs are more widely accessible than Western treatment, many communities throughout the world utilize them to avoid COVID-19.

In terms of using medicinal herbs to treat COVID-19 symptoms related to breathing, 68.17% used them, compared to 31.83% who said they did not. Efficient and non-intrusive therapies are needed since one of the most important clinical indications of COVID-19 is the severe damage to the respiratory system, which can result in difficulty breathing and even death. As an origin

of plant metabolites with antimicrobial action, botanical remedies were given newfound importance during this pandemic to treat the symptoms of COVID-19 (Bhuiyan *et al.*, 2020). In accordance with earlier studies, our study found that 78.44% of the participants utilized medicinal herbs whenever they or a family member or acquaintance had COVID-19 (Mostacero *et al.*, 2020).

Our study found that 84.46% of female respondents ($n=483$) utilized medicinal herbs to prevent respiratory problems, which is consistent with the socio-educational characteristics related with their usage. This is consistent with other research showing that women are better knowledgeable about the therapeutic benefits of plants and that they frequently employ these plants to look after the health of their family members. Therefore, it is likely that women are the ones who pass down traditional household knowledge from one generation to the next in the majority of societies (Rosete *et al.*, 2020). The early study revealed that women are more likely than males to use therapeutic herbs (Paulos *et al.*, 2016). Women have an important part in food safety procedures as well as the use of medicinal herbs (Belahsen *et al.*, 2017). This aspect is pertinent in the current COVID-19 pandemic environment, and it is vital to focus on women as a key component of preventive and sane care for COVID-19 patients.

In our study, 22 to 49% of respondents who had more than two COVID-19 respiratory symptoms and 10 to 40% of those who had malaise employed medicinal herbs to alleviate those symptoms. There are research reporting the use of traditional

medicines by many groups and cultures during the COVID-19 epidemic, particularly in Asian nations including India, China, and Japan as well as some regions of Africa (Jahan and Onay, 2020). Inflammation and hemotoxicity are associated with COVID-19 symptoms, hence blood-purifying herbs with anti-inflammatory, antioxidant, and antiviral activities may be suitable for COVID-19 therapy (Jamiu *et al.*, 2020). Our survey found that ginger, eucalyptus, and garlic were the three most often utilized plants. Ginger, eucalyptus, and garlic have been shown to have an inhibitory impact on the replication of SARS-CoV-2; as a result, both may be a potential agent against COVID-19 (Mirzaie *et al.*, 2020). For the management and avoidance of COVID-19 symptoms of respiration Our study's multivariate analysis revealed that the majority of participants utilized ginger and eucalyptus plants for both treatment and prevention, whereas garlic and matico plants were solely utilized for prevention, which is consistent with other studies (Villena *et al.*, 2021).

Limitation of the study

Online surveying was used for this inquiry. Most of the survey data was dispersed among our academic social network acquaintances since they can read and understand the questions, provide their consent, and complete the form in a way consistent with prior research from across the world. It is one of the best methods for gathering

data and handling stressful events (like the COVID-19 lockdown), even if it could bring some bias into the study. Research has shown that educated people tend to embrace modern medicine, however during the COVID-19 period, educated people were aware of the potential of medicinal plants as opportunistic cures. Their rising interest in medicinal plants is influenced by this behavior of educated people.

Conclusion

The three plants that were most frequently used were garlic, ginger, and eucalyptus. The results of the current study showed a connection among the use of 10 medicinal plants and the control or prevention of COVID-19-related respiratory symptoms. The research population used more herbs to prevent disease, when they were affected with COVID-19 disease. It was also shown that female participants employed botanicals for treatment more frequently. Although it is recognized that medicinal plants are effective in helping treat respiratory conditions, further research is needed to determine their effectiveness and uncover compounds that may have pharmacological uses. More study is needed to determine the ideal doses, preparation techniques, and possible combinations of these medicinal plants.

Table 1: Sociodemographic details of the participants

Variable	Patients Numbers (n)	Frequency (%)
Age (Years)^a	32	23 - 42
Gender		
Male	342	37.41
Female	572	62.59
Professional History		
Public sector	170	18.61
Private sector	124	13.56
Self-employed	206	22.53
Housewife	101	11.05
Students (Undergraduates)	266	29.11
Others	47	5.14
Education Background		
Illiterate	28	3.06
Higher School	146	15.97
Technical	192	21.14
University	548	59.83
Diagnosed with COVID-19		
Yes	191	20.89
No	723	79.11
Friend or relative with COVID-19 diagnosis		
Yes	586	64.11
No	328	35.89
Prevention of respiratory problems		
Used plants for prevention	717	78.44
Did not use plants for prevention	197	21.56
Therapy for respiratory symptoms		
Used plants for treatment	623	68.17
Plants weren't used as a therapy	291	31.83
a Median and interquartile range		

Table 2: According to gender, the use of medicinal herbs for treating or preventing respiratory problems

Medicinal plant used as preventative			P value
Gender	Yes	No	
Male	234 (68.43)	108 (31.57)	<0.001
Female	483 (84.46)	89 (15.55)	
Plant that is used as a medicine			P value
Gender	Yes	No	
Male	206 (60.23)	136 (39.77)	0.012
Female	417 (72.90)	155 (27.10)	
The p-value were acquired with chi-square tests.			

Table 3: The proportion of people who treat respiratory problems using medicinal plants

Medicinal plant		N	Multiple symptoms	Sore throat	Cough	Malaise	Headache	Fever	Other	P value
Scientific name	Common Name									
<i>Zingiber Officinale Roscoe</i>	Ginger	647	47%	18%	16%	12%	1%	2%	4%	<0,001
<i>Eucalyptus Globulus Labill.</i>	Eucalyptus	608	46%	8	22%	18%	2%	1%	3%	0,001
<i>Allium Sativum L.</i>	Garlic	579	49%	10	13%	17%	2%	1%	8%	<0,001
<i>Matricaria Recutita L</i>	Chamomile	537	42%	14	7%	23%	4%	1%	9%	<0,001
<i>Piper Aduncum L</i>	Matico	483	46%	16	21%	10%	1%	0%	6%	0,001
<i>Erythroxyllum Coca Lam</i>	Coca	426	38%	8	3%	32%	6%	2%	11%	0,040
<i>Rosmarinus Officinalis L.</i>	Rosemary	367	27%	7	11%	37%	1%	1%	16%	<0,001
<i>Origanum Vulgare L.</i>	Oregano	296	22%	7	8%	40%	5%	3%	15%	<0,001
<i>Melissa Officinalis L.</i>	Lemon balm	207	41%	6	30%	15%	0%	1%	7%	0,013
<i>Cosmos Peucedanifolius Wedd</i>	Panty	157	25%	8	7%	31%	4%	2%	23%	0,076
The p-values were obtained based on the chi-square test										

Table 4: Use of medicinal plants to cure or prevent respiratory symptoms: a multivariate study

Medicinal Plants		For Prevention	For Treatment
Scientific Name	Common Name		
<i>Zingiber Officinale Roscoe</i>	Ginger	1.23 (1.14–1.33) p < 0.001	1.27 (1.17–1.38) p < 0.001
<i>Allium Sativum L.</i>	Garlic	1.09 (1.02–1.12) p = 0.024	p = 0.122
<i>Eucalyptus Globulus Labill.</i>	Eucalyptus	1.13 (1.05–1.18) p<0.002	1.19 (1.06–1.31) p = 0.001
<i>Rosmarinus Officinalis L.</i>	Rosemary	p = 0.216	p = 0.176
<i>Matricaria Recutita L</i>	Chamomile	p = 0.0141	0.99 (1.13–1.24) p = 0.012
<i>Piper Aduncum L</i>	Matico	1.07 (1.00–1.15) p = 0.019	p = 0.516
<i>Erythroxylum Coca Lam</i>	Coca	p = 0.569	p = 0.571
<i>Melissa Officinalis L.</i>	Lemon balm	0.81 (0.84–0.92) p<0.002	0.84 (0.83–0.99) p = 0.017
<i>Origanum Vulgare L.</i>	Oregano	p = 0.871	p = 0.162
<i>Cosmos Peucedanifolius Wedd</i>	Panty	p = 0.907	0.76 (0.74–0.91) p = 0.008
The chi-square test was used to get the p-values.			

References

Abbass, H. S. 2020. Eucalyptus essential oil; an off-label use to protect the world from COVID-19 pandemic: Review-based hypotheses. *Univers. J. Pharm. Res*, 5: 57-60.

Adnan, N., & Othman, N. 2012. The relationship between plants and the Malay culture. *Procedia-Social and Behavioral Sciences*, 42: 231-241.

Arora, R., Chawla, R., Marwah, R., Arora, P., Sharma, R. K., Kaushik, V., & Bhardwaj, J. R. 2010. Potential of complementary and alternative medicine in preventive management of novel H1N1 flu (Swine flu) pandemic: thwarting potential disasters in the bud. *Evidence-*

Based complementary and alternative medicine, 2011. <https://doi.org/10.1155/2011/586506>.

Belahsen, R., Naciri, K., & El Ibrahimy, A. 2017. Food security and women's roles in Moroccan Berber (Amazigh) society today. *Maternal & child nutrition*, 13, e12562.

Bhuiyan, F. R., Howlader, S., Raihan, T., & Hasan, M. 2020. Plants metabolites: possibility of natural therapeutics against the COVID-19 pandemic. *Frontiers in Medicine*, 7: 444.

Boulware, D. R., Pullen, M. F., Bangdiwala, A. S., Pastick, K. A., Lofgren, S. M., Okafor, E. C., ... & Hullsiek, K. H. 2020. A randomized trial of hydroxychloroquine as postexposure prophylaxis for Covid-19. *New England J. Med.*, 383(6): 517-525.

- Cunningham, A. B. 2001. *Applied ethnobotany: people, wild plant use and conservation*. Earthscan.
- Franco, F. M., & Bussmann, R. W. 2020. Rising to the occasion: outlining Ethnobiologists' response to the coronavirus (COVID-19) pandemic. *Ethnobotany Research and Applications*, 20: 1-4.
- Hamulka, J., Jeruszka-Bielak, M., Górnicka, M., Drywień, M. E., & Zielinska-Pukos, M. A. (2020). Dietary supplements during COVID-19 outbreak. Results of google trends analysis supported by P Life COVID-19 online studies. *Nutrients*, 13(1): 54.
- Harris, D., & Hillman, G. 1989. An Evolutionary Continuum of People-Plant Interaction. Foraging and Farming. The Evolution of Plant Exploitation. London: Unwin Hyman.
- Harshberger, J. W. (1896). The purposes of ethnobotany. *Botanical gazette*, 21(3): 146-154. <https://doi.org/10.1086/327316>.
- Jahan, I., & Ahmet, O. N. A. Y. 2020. Potentials of plant-based substance to inhabit and probable cure for the COVID-19. *Turkish Journal of Biology*, 44(SI-1), 228-241. <https://doi.org/10.3906/biy-2005-114> PMID: 32595359
- Jamiu, A. T., Aruwa, C. E., Abdulakeem, I. A., Ajao, A. A., & Sabiu, S. 2020. Phytotherapeutic evidence against coronaviruses and prospects for COVID-19. *Pharmacognosy Journal* 12(6).
- Juárez-Pérez, J. C., & Cabrera-Luna, J. A. 2019. Plantas para afecciones respiratorias comercializadas en tres mercados de la ciudad de Santiago de Querétaro. *Polibotánica*, (47): 167-178.
- Keni, R., Alexander, A., Nayak, P. G., Mudgal, J., & Nandakumar, K. 2020. COVID-19: emergence, spread, possible treatments, and global burden. *Frontiers in public health*, 216..
- Ketabchi, S., & Papari Moghadamfard, M. 2021. Medicinal plants effective in the prevention and control of coronaviruses. *Complementary Medicine Journal*, 10(4), 296-307.
- Khubber, S., Hashemifesharaki, R., Mohammadi, M., & Gharibzahedi, S. M. T. 2020. Garlic (*Allium sativum* L.): a potential unique therapeutic food rich in organosulfur and flavonoid compounds to fight with COVID-19. *Nutrition Journal*, 19: 1-3. doi: 10.1186/s12937-020-00643-8.
- Magzoub, M. 2020. Life style guideline of ginger (*Zingiber officinale*) as prophylaxis and treatment for Coronaviruses (SARS-CoV-2) infection (Covid-19). DOI: 10.36348/sjbr.2020.v05i06.006.
- Martin, G. J. (2014). *Ethnobotany: a methods manual* (Vol. 1). Springer.
- Mirzaie, A., Halaji, M., Dehkordi, F. S., Ranjbar, R., & Noorbazargan, H. 2020. A narrative literature review on traditional medicine options for treatment of corona virus disease 2019 (COVID-19). *Complementary therapies in clinical practice*, 40.

- Mitjà, O., Corbacho-Monné, M., Ubals, M., Alemany, A., Suñer, C., Tebe, C., ... & Clotet, B. 2021. A cluster-randomized trial of hydroxychloroquine for prevention of Covid-19. *New England Journal of Medicine*, 384(5): 417-427.
- Mostacero-León, J., López, E., Cruz-Castillo, L., Gil-Rivero, A., Calderón, A., & Charcape Ravelo, J. 2020. Cold plants" and" Hot plants" potential resources in the prevention and/or treatment of COVID-19. *Manglar*, 13: 209-20.
- Ni, L., Zhou, L., Zhou, M., Zhao, J., & Wang, D. W. 2020. Combination of western medicine and Chinese traditional patent medicine in treating a family case of COVID-19. *Frontiers of medicine*, 14: 210-214. <https://doi.org/10.1007/s11684-020-0757-x>
- Paulos, B., Fenta, T. G., Bisrat, D., & Asres, K. 2016. Health seeking behavior and use of medicinal plants among the Hamar ethnic group, South Omo zone, southwestern Ethiopia. *J. Ethnobiol. Ethnomed.*, 12(1): 1-13.
- Pennycook, G., McPhetres, J., Zhang, Y., Lu, J. G., & Rand, D. G. 2020. Fighting COVID-19 misinformation on social media: Experimental evidence for a scalable accuracy nudge intervention. *Psych. Sci.*, 31(7): 770-780.
- Rome, B. N., & Avorn, J. 2020. Drug evaluation during the Covid-19 pandemic. *New England J Med.*, 382(24), 2282-2284.
- Rosa, S. G. V., & Santos, W. C. 2020. Clinical trials on drug repositioning for COVID-19 treatment. *Revista Panamericana de Salud Pública*, 44, e40. doi: 10.26633/RPSP.2020.40.
- Rosete Blandariz, S., Sáenz Véliz, R. S., Jiménez González, A., & Pin Figueroa, F. E. 2020. Criterios que inciden en la identificación y uso de las plantas de interés para el turismo en Jipijapa, Manabí, Ecuador. *Revista Cubana de Ciencias Forestales*, 8(1): 54-74.
- Shankar, A., Dubey, A., Saini, D., & Prasad, C. P. 2020. Role of complementary and alternative medicine in prevention and treatment of COVID-19: an overhyped hope. *Chinese J. Integ. Med.*, 26(8): 565.
- Van der Veen, M. 2014. The materiality of plants: plant–people entanglements. *World Archaeology*, 46(5): 799-812.
- Villena-Tejada, M., Vera-Ferchau, I., Cardona-Rivero, A., Zamalloa-Cornejo, R., Quispe-Florez, M., Frisancho-Triveño, Z., ... & Yañez, J. A. 2021. Use of medicinal plants for COVID-19 prevention and respiratory symptom treatment during the pandemic in Cusco, Peru: A cross-sectional survey. *PLoS One*, 16(9): e025716.