

Article

Investigation of the Use of Medicinal Plants and Natural Products for COVID-19 Prevention and Respiratory Symptoms Treatment during the COVID-19 Pandemic in Sri Lanka

Navanjana T.P. Uyangoda¹, Tharalamini P. Gamagedara^{2,*}, Ruwani K. Suraweera¹, Lakshika S. Nawarathna³

¹ Department of Pharmacy, Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka

² Department of Basic Sciences, Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka

³ Department of Statistics and Computer Science, Faculty of Science, University of Peradeniya, Sri Lanka

* Correspondence: piumnilg@ahs.pdn.ac.lk

Abstract

Background: With the lack of specific treatment against COVID-19, Sri Lankans were seeking alternative treatment options such as herbal medicines as preventive measures and treatment options against COVID-19. This study aimed to estimate the prevalence of such alternative treatment options usage by Sri Lankans during the pandemic and to assess the self-perceived effectiveness and adverse effects of herbal medicines from the participants' perception.

Methods: An online cross-sectional survey was conducted among the general public. Data was collected using a questionnaire. A total of 804 participants were included in the study. Descriptive analysis was performed for all variables. A Chi-square test was performed to determine the association between the studied variables. **Results:** Among the participants, 90.4% reported using herbal medicines as preventive measures against COVID-19, and 86.7% used them to treat respiratory symptoms. Coriander and ginger were the most commonly used medicinal plants as preventives and in the treatment of respiratory symptoms. These herbs were perceived to be effective in alleviating respiratory symptoms by more than 85% of their users. A minority of the consumers (15.4%) experienced adverse effects associated with the use of herbal medicines as preventive measures. The use of herbal medicines as preventive measures was associated with the participant's age ($p = 0.032$) and education level ($p < 0.001$).

Conclusion: The study highlights the perceived effectiveness of some medicinal herbs in treating respiratory symptoms and recommends future research to isolate the compounds with potential pharmacological effects and conduct clinical trials to determine the effectiveness of the most commonly used plants.

Keywords: COVID-19; Herbal medicine; Medicinal plants; Natural products; Sri Lanka

Introduction

Coronavirus disease of 2019 (COVID-19), a highly transmissible viral infection, was first detected in Wuhan, China, in December 2019 (1). The World Health Organization (WHO) declared COVID-19 a pandemic on 11th March 2020 (2). COVID-19 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which is a β coronavirus (3). This coronavirus mainly affects the respiratory system, including both the lower and upper respiratory tract (4). The common clinical manifestations in patients

Citation: Uyangoda NTP, Gamagedara TP, Suraweera RK, Nawarathna LS. Investigation of the Use of Medicinal Plants and Natural Products for COVID-19 Prevention and Respiratory Symptoms Treatment during the COVID-19 Pandemic in Sri Lanka. Sri Lankan J. Health. Sci. 2022, 1 (2): 16-26.
<https://doi.org/10.4038/sljhs.v1i2.48>

Received: 26.10.2022; Accepted: 20.12.2022; Published: 31.12.2022



Copyright: © 2022 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

with mild infection are fever, fatigue, dry cough, slight nasal congestion, body aches, and muscle pain (5). Shortness of breath associated with dry cough or phlegm production and symptoms of pneumonia can be observed in severe cases. In critical cases of COVID-19, complete respiratory failure, sepsis, septic shock, dysfunction of organs such as the heart, liver, and kidney, metabolic acidosis, and coagulation dysfunction can occur, leading to death (5).

Treatment for COVID-19 is symptomatic and supportive with supplemental oxygen and mechanical ventilatory support when indicated (5). Existing drugs are being tested to be used effectively against COVID-19 (5). Besides, people use different foods and medicinal plants as dietary or complementary therapy to protect themselves from the coronavirus and improve their immune systems. According to the results of certain scientific studies, it has been shown that medicinal plants and vitamins can improve the health condition of COVID-19 patients (6). Herbal medicines are considered a valuable alternative to treat several diseases, including viral infections (5,7). Naturally derived compounds are found to be better tolerated in the human body (8). In the past, antiviral herbal drugs have been used for the treatment of SARS, MERS, influenza, and dengue (9). To date, with the lack of specific medicines to treat COVID-19, the pharmaceutical industry aims to discover appropriate alternative drugs against COVID-19 from phytochemical extracts and medicinal plants as they are concerned with rich sources of bioactive compounds (5,8,10). Since the beginning of the COVID-19 outbreak, traditional herbal medicines have been used in China, and positive effects have been reported in treated patients (7). In this context, several countries in the world have focused on the use of medicinal plants and natural products alone or as supplements in the treatment of COVID-19 (9). Many studies have been conducted in different countries to assess the prevalence of using herbal medicines against COVID-19 by various communities. A study conducted in Saudi Arabia reported that 92.70% of participants had used medicinal plants and natural products during the pandemic as preventive measures against COVID-19 (11). In another study conducted in Peru, 80.2% had used medicinal herbs to prevent COVID-19 infection, while 71% had used them to treat respiratory symptoms (12). A study conducted in Bangladesh indicated that 57.6% of the participants were using herbal foods/products to reduce the risk of COVID-19 (13). Most medicinal plants have antiviral and immunomodulatory properties. Therefore, these could be effectively used to improve the immune system and protect the body against COVID-19 (14). Antioxidant activity and antiviral activity of medicinal plants may also be useful in alleviating symptoms associated with COVID-19 (9). These medicinal plants are rich in bioactive compounds such as essential oils, flavonoids, organosulfur compounds, glycosides, tannins, lignans, coumarins, alkaloids, phenolic lipids, and other compounds that possess antiviral, antifibrotic, antioxidant, anti-inflammatory and immunomodulatory properties (5,8,15). However, some medicinal plants may contain toxic compounds which may lead to various adverse effects (15).

In Sri Lanka, people used different types of medicinal plants and natural products as protective measures during the COVID-19 pandemic. The Ayurveda Department of Sri Lanka has introduced 'Suwadharani' immunizing drink, a 100% natural product to fight against COVID-19 (16). The Ayurveda Department has also advised consuming drinks of *Zingiber officinale* (ginger), *Coriandrum sativum* (coriander), *Allium sativum* (garlic), *Coscinium fenestratum* (Weniwelgeta), and some other medicinal plants to protect against COVID-19 (16). These medicinal herbs may potentially improve immunity, symptom management, lower rates of mortality, and faster recovery. However, WHO confirmed that the prevailing evidence is not sufficient to prove that natural remedies can prevent or cure COVID-19. In this context, the effectiveness of these medicinal plants against this coronavirus needs to be explored further. On the other hand, the excessive use of medicinal plants may lead to various side effects. A previous Sri Lankan study investigated the use of nutritional supplements to improve immunity during the COVID-19 pandemic. The majority of the participants (59.5%) consumed coriander, while other supplements used were Ayurvedic products and herbal products (17). However, the perceived effectiveness and adverse effects of the medicinal plants and natural products used by Sri Lankans for treatment and prevention of COVID-19 have not been assessed. Therefore, this study aimed to assess the use of medicinal plants and natural products by Sri Lankans for protection against COVID-19 and treatment of respiratory symptoms

during the COVID-19 pandemic and to evaluate their perceived effectiveness and side effects as the identified gaps of knowledge in the literature.

Methods

Study design and study population

This study was an online questionnaire-based, descriptive cross-sectional survey. The aim of the study was to assess the prevalence and perceived effects of medicinal plants and natural products used as a protective measure during the COVID-19 pandemic in Sri Lanka. The target population was the general Sri Lankan population.

Data collection tool

An online questionnaire developed using Google Forms was used to assess the prevalence and perceived effects of medicinal plants and natural products used during the COVID-19 pandemic in Sri Lanka. Participants were made aware of the purpose and the procedure of the study and were asked to provide consent before participating in the online survey. A semi-structured questionnaire that was prepared based on the previous questionnaires used to collect similar data in other countries was used in the data collection (11,12,18,19). The questionnaire consisted of 3 main sections: Part A - Demographic data, Part B - Use of medicinal plants, natural products, and dietary supplements as protective measures and for treatment purposes during the COVID-19 pandemic, and Part C - Perceived effects of using medicinal plants and natural products. The questionnaire was prepared in English and then translated into Sinhala and Tamil, the native languages of Sri Lankans. The translated Sinhala and Tamil questionnaires were back-translated to English by two other translators who were native speakers of Sinhala and Tamil. The content and format of the questionnaire used in this study were evaluated using a pre-test involving a convenience sample of 20 participants, including at least 5 participants who responded in each language. Participants were asked to provide feedback on the design of the questionnaire, its relevance, and its flow. The Tamil version of the questionnaire was modified, revising the included Tamil names of the medicinal plants, according to the results of the pre-test. Data from the pre-test was not included in the final analysis.

Sample size

The minimum sample size of this study was 385 participants. This sample size was calculated based on proportion in a single cross-sectional study using the formula $n = Z^2 p (1-p) DEFF / d^2$, where, n = the required sample size, Z = statistic corresponding to the level of confidence, p = expected prevalence or proportion, d = desired level of absolute precision and $DEFF$ = estimated design effect (20). The z-score (Z) for the 95% confidence level was 1.962. The expected proportion (p) was assumed to be 50% to obtain the largest possible sample. The level of absolute precision (d) selected was 5%. However, a larger sample size was targeted to maximize the generalizability of the findings and this study had a sample size of 804 participants.

Sampling strategy

Participants were recruited using convenience sampling. An online questionnaire was used to collect data from the participants. The links to the questionnaires (English, Sinhala, and Tamil) developed using Google Forms were shared on social media platforms such as WhatsApp, Viber, Instagram, and Messenger, and participants were asked to complete the questionnaire in their preferred language. Participation in the survey was voluntary. Participants were included in the study if they were 18 years of age or above, resided in Sri Lanka, and completed the online questionnaire. Participants <18 years, those who submitted incomplete questionnaires, and those who participated in the pre-test were excluded from the analysis.

Data analysis

The data were coded and extracted into the Microsoft Excel version 2019 spreadsheet. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 25. Descriptive analysis based on the frequency and percentage was achieved for all variables, namely age, gender, education level, employment category, province of residence, and being infected with COVID-19. A Chi-square test was performed to determine the association between the studied variables. A p-value of less than 0.05 was considered statistically significant. Ethical approval was obtained prior to the data collection, from the Ethics Review Committee, Faculty of Allied Health Sciences, University of Peradeniya (Reference number: AHS/ERC/2022/008).

Results

Socio-demographic characteristics of study participants

Data collection was done for three months, from 10th March 2022 to 10th June 2022. Out of the 825 responses received, 21 responses were excluded from the analysis according to the exclusion criteria. The final sample comprised the responses of 804 participants. The mean age of the participants was 28 ± 8.16 years (ranging from 18 to 62 years). Most participants were females (66.3%) and educated at the undergraduate/graduate level (69.3%). Regarding the region of residence, 217 (27%) participants were from Southern Province, and 204 (25.4%) participants were from Western Province. In terms of employment, 51.6% of the total participants were students. Out of the total participants, 185 (23%) were infected with COVID-19.

Prevalence of medicinal plants and natural products used during the COVID-19 pandemic

Results of the study revealed that 727 of the total participants (90.4%) reported using medicinal plants and natural products as a preventive measure against COVID-19 during the pandemic. When considering the use of medicinal plants and natural products, 697 (86.7%) participants reported treating respiratory symptoms such as cold, cough, nasal congestion, and asthma during the COVID-19 pandemic. However, 600 (74.6%) participants used them before the pandemic as well. The number of participants who consumed medicinal plants and natural products as preventive measures were higher than those who used medicinal plants and natural products to treat respiratory symptoms during the pandemic. Regarding the frequency of medicinal plants and natural products used as preventive measures during the pandemic, nearly half the users (40.2%) reported taking them irregularly, and 24.6% took them once daily. The other frequencies are listed in Table 1.

Table 1. Frequency of using medicinal plants and natural products as preventive measures during the COVID-19 pandemic (n = 727)

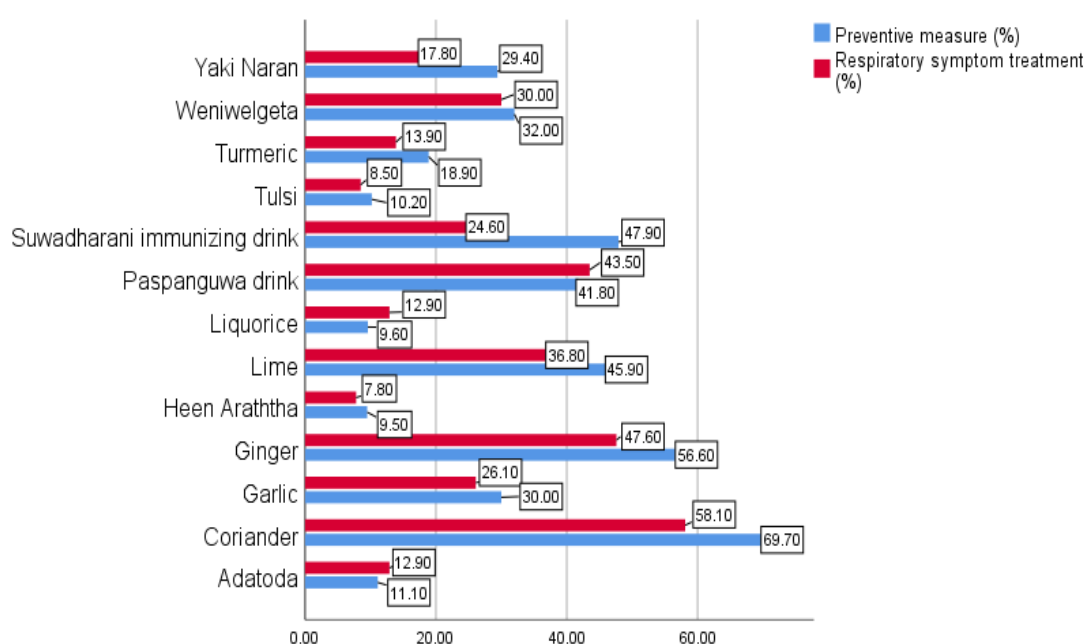
Frequency	n (%)
Once daily	179 (24.6)
Twice daily	124 (17.1)
Three or more times daily	29 (4.0)
One weekly	54 (7.4)
Two times weekly	49 (6.7)
Irregularly	294 (40.2)

When comparing the responses to the source of information related to their use of medicinal plants and natural products, most participants said they had relied on family members and friends (73.7%). The other widely used sources were social media (51.4%), followed by television (46.6%), and previous experience (42%). More details about other information sources are presented in Table 2.

Table 2. Sources of information related to the use of medicinal plants and natural products as preventive measures during the COVID-19 pandemic (n = 727)

Information source	n (%)
Television	339 (46.6)
Newspapers/Published papers	228 (31.4)
Family/Friends	536 (73.7)
Social media	374 (51.4)
Internet	289 (39.8)
Previous experience	305 (42.0)
Other	35 (4.8)

The most commonly used medicinal plants as a preventive measure against COVID-19 during the pandemic were coriander (*Coriandrum sativum*, 69.7%), ginger (*Zingiber officinale*, 56.6%), lime (*Citrus aurantiifolia*, 45.9%), “Weniwelgeta” (*Coscinium fenestratum*, 32%) and garlic (*Allium sativum*, 30%). “Suwadharani” an immunizing drink introduced by the Department of Ayurveda, Sri Lanka was used by 47.9% of the participants, and 41.8% of participants reported using “Paspanguwa” as a preventive measure. The least commonly used medicinal plants were “Heen Araththa” (*Alpinia calcarata*, 9.5%), licorice (*Glycyrrhiza glabra*, 9.6%), “Tulsi/Heen Maduruthala” (*Ocimum tenuiflorum*, 10.2%) and “Adatoda” (*Justicia adhatoda*, 11.1%). Figure 1 shows the prevalence of medicinal plants and herbal products used as a preventive measure during the pandemic by Sri Lankans.

**Figure 1.** Medicinal plants/herbal products used as preventive measures and to treat respiratory symptoms during the COVID-19 pandemic in Sri Lanka (n = 804)

The most frequently used medicinal plants and herbal products for the treatment of respiratory symptoms during the pandemic were coriander (*Coriandrum sativum*, 58.1%), ginger (*Zingiber officinale*, 47.6%), “Paspanguwa” immunizing drink (43.5%) and lime (*Citrus aurantiifolia*, 36.8%). Less

frequently used medicinal plants were “Heen Araththa” (*Alpinia calcarata*, 7.8%) and “Tulsi/Heen Maduruthala” (*Ocimum tenuiflorum*, 8.5%), as shown in Figure 1.

Self-perceived effectiveness of medicinal plants and herbal products

As shown in Table 3, participants reported the self-perceived effectiveness of each medicinal plant/natural product according to their perception. Coriander (*Coriander sativum*, 91.6%) followed by ginger (*Zingiber officinale*, 89.3%), lime (*Citrus aurantiifolia*, 82.1%), “Paspanguwa” (82%) and “Suwadharani” immunizing drink (79.3%) were the medicinal plants/herbal products perceived to be effective by most users in resolving respiratory symptoms. None of the medicinal plants or herbal products were perceived to be ineffective by more than 10% of participants. The medicinal plant that was perceived to be ineffective by the highest number of users was “Tulsi/Heen Maduruthala” (*Ocimum tenuiflorum*, 7.4%) followed by turmeric (*Curcuma longa*, 7.1%) and “Heen Araththa” (*Alpinia calcarata*, 6.3%). Of turmeric (*Curcuma longa*) users, 42% had no opinion on its effectiveness.

Table 3. Self-perceived effectiveness of medicinal plants and herbal products in treating respiratory symptoms

Medicinal plant/ Herbal product	Perceived effectiveness in treating respiratory symptoms (%)		
	Effective	Ineffective	No opinion
Coriander (n = 467)	91.6	1.3	7.1
Ginger (n = 383)	89.3	1.3	9.4
Liquorice (n = 104)	72.1	2.9	25.0
Garlic (n = 210)	70.5	2.9	26.6
Turmeric (n = 112)	50.9	7.1	42.0
Weniwelgeta (n = 241)	74.7	2.1	23.2
Yaki Naran (n = 143)	77.6	2.8	19.6
Lime (n = 296)	82.1	2.4	15.5
Tulsi (n = 68)	63.2	7.4	29.4
Adatoda (n = 104)	64.4	3.8	31.7
Heen Araththa (n = 63)	58.7	6.3	34.9
Suwadharani Immunizing drink (n = 198)	79.3	3.5	17.2
Paspanguwa drink (n = 350)	82.0	2.0	16.0

Adverse effects of medicinal plants and natural products as perceived by users

A minority of the users (15.4%) experienced adverse effects such as diarrhoea, abdominal pain, constipation, and heartburn associated with the use of medicinal plants and natural products as preventive measures against COVID-19, whereas 84.6% had none of the adverse effects. When considering the adverse effects associated with each medicinal plant/herbal product, none of the participants experienced adverse effects with the use of “Heen Araththa” (*Alpinia calcarata*). Ginger (*Zingiber officinale*) was perceived to have adverse effects by the highest number of its users (9.3%) followed by lime (*Citrus aurantiifolia*, 7.1%) and coriander (*Coriander sativum*, 7.0%). When considering the adverse effects of each medicinal plant and herbal product, heartburn was reported in 6.6% of users of ginger (*Zingiber officinale*) and 4.6% of users of lime (*Citrus aurantiifolia*). Table 4 lists the side effects of each medicinal plant/natural product as perceived by the participants.

Table 4. Adverse effects associated with the intake of medicinal plants and natural products during the COVID-19 pandemic from the users' perspective

Medicinal plant/Natural product	Side effects %					
	None	Diarrhoea	Abdominal pain	Constipation	Heartburn	Others
<i>Adatoda</i>	97.7	2.3	0	0	0	0
<i>Coriander</i>	93	1.4	0.9	1.8	1.8	1.1
<i>Garlic</i>	95	1.3	0.8	0	2.9	0
<i>Ginger</i>	90.7	1.3	0.4	0.2	6.6	0.7
<i>Heen Araththa</i>	100	0	0	0	0	0
<i>Lime</i>	92.9	1.1	1.1	0	4.6	0.3
<i>Liquorice</i>	94.8	1.3	0	0	0	3.9
<i>Tulsi</i>	97.5	2.5	0	0	0	0
<i>Turmeric</i>	95.4	3.9	0	0.7	0	0
<i>Weniwelgeta</i>	97.7	0.4	0.4	0	0.8	0.8
<i>Yaki Naran</i>	97.4	0.9	0.4	0	0.9	0.4
<i>Suwadharani</i>	96.1	0.5	0.8	0.8	1	0.8
<i>Paspanguwa</i>	97.9	0.9	0.3	0	0.6	0.3

Association between socio-demographic factors and the prevalence of used medicinal plants and natural products

A Chi-square test was performed to determine the association between the study variables. As shown in Table 5, the use of medicinal plants and natural products as preventive measures during the COVID-19 pandemic is associated with age ($p = 0.032$) and education ($p < 0.001$). However, no association was observed with gender ($p = 0.201$), province of residence ($p = 0.085$), employment category ($p = 0.347$), and being infected with COVID-19 ($p = 0.936$). A higher percentage of the 18-29 age group was reported to consume medicinal plants and natural products as a preventive measure when compared to other age groups.

Discussion

Globally, the COVID-19 pandemic drove people to seek solutions to prevent and alleviate symptoms associated with the disease (12). The majority continued using herbal medicines as a preventive measure against COVID-19 to enhance their immune system and decrease the probability of getting infected (11). The current study revealed that the use of medicinal plants and natural products for prevention purposes and in treating respiratory symptoms was a common practice during the COVID-19 pandemic in Sri Lanka. The number of participants who used medicinal plants and herbal products in treating respiratory symptoms increased during the pandemic. Despite the lack of scientific evidence, people use herbal medicines mainly because of folklore, habitual use, and cultural reasoning. According to the findings, the most commonly used medicinal plants were coriander (*Coriander sativum*), ginger (*Zingiber officinale*), lime (*Citrus aurantiifolia*), “Weniwelgeta” (*Coscinium fenestratum*), and garlic (*Allium sativum*). In this context, the use of ginger (*Zingiber officinale*) and garlic (*Allium sativum*) was reported in other countries; Peru (12), Egypt (18), Nepal (21), Bangladesh (13), Saudi Arabia (11,19), and Morocco (15,22). Even though, medicinal plants and herbal products are used as preventive measures against COVID-19 or in treating respiratory symptoms in many countries worldwide including Sri Lanka, their effectiveness in preventing the disease and alleviating respiratory symptoms needs to be evaluated in clinical settings.

Table 5. Association of medicinal plants and natural products usage with demographic factors

Demographic factor	Used as preventive measures (%)		p-value
	Yes	No	
Age group			
18-29 (n=654)	91.6	8.4	0.032
30-44 (n=89)	87.6	12.4	
45 or above (n=61)	82.0	18.0	
Gender			
Female (n=533)	91.4	8.6	0.201
Male (n=271)	88.6	11.4	
Province			
Central (n=94)	92.6	7.4	0.085
Eastern (n=25)	100.0	0.0	
North Central (n=16)	87.5	12.5	
North Western (n=83)	89.2	10.8	
Northern (n=44)	100.0	0.0	
Sabaragamuwa (n=59)	93.2	6.8	
Southern (n=217)	90.3	9.7	
Uwa (n=62)	91.9	8.1	
Western (n=204)	85.8	14.2	
Education level			
Primary (n=3)	100.0	0.0	<0.001
Ordinary level (n=8)	100.0	0.0	
Advanced level (n=87)	85.1	14.9	
Diploma/Higher diploma (n=101)	92.1	7.9	
Degree/Undergraduate (n=557)	92.3	7.7	
Postgraduate degree/diploma (n=57)	72.9	27.1	
Employment category			
Full-time employee (n=296)	87.5	12.5	0.347
Part-time employee (n=20)	95.0	5.0	
Self employed (n=19)	84.2	15.8	
Unemployed (n=42)	90.5	9.5	
Retired (n=3)	100.0	0.0	
Student (n=415)	92.5	7.5	
Other (n=9)	88.9	11.1	
Infected with COVID-19			
Yes (n=185)	90.3	9.7	0.936
No (n=619)	90.5	9.5	

* The p-values were obtained based on the chi-square test.

According to the findings of the current study, coriander (*Coriander sativum*) and ginger (*Zingiber officinale*) were perceived to be effective in alleviating respiratory symptoms by more than 85% of their users. Ginger (*Zingiber officinale*) contains a variety of bioactive compounds, namely zingiberol with analogs such as the shogaols, paradol, and zingerone, and other sub-compounds, 4-gingerol, 6-gingerol, 8-gingerol, 10-gingerols, 6-shogaols, and 14-shogaols which possess medicinal values (8). A molecular docking study conducted by Ahkam et al. in 2020, found that the bioactive compounds of ginger block

the spike (S) protein from binding to the ACE² receptor or act as an inhibitor for MPro (23). A randomized controlled trial has been conducted in Iran to investigate the effects of ginger on clinical manifestations, and paraclinical features of patients with severe acute respiratory syndrome due to COVID-19. They found an improvement in clinical symptoms within 7 days of treatment, including fever, dry cough, fatigue and other symptoms such as thrombocytopenia, lymphocytopenia and C-reactive protein (24). Garlic (*Allium sativum*), consumed as a condiment in countries around the world, contains a wide spectrum of pharmacological effects. Garlic would also be a good candidate for treatment in COVID-19 because its major bioactive compounds namely, allicin, s-allyl cysteine (SAC), alliin, and diallyl thiosulfonate (allicin) show antiviral, antifibrotic, anti-oxidant, anti-inflammatory and immunomodulatory properties which are responsible for the effects on respiratory tract infections, intra-alveolar edema, pulmonary fibrosis, sepsis, and acute lung injury (5). This study showed that 70.5% of users perceived garlic to be effective in treating respiratory symptoms.

Participants also used the “Suwadharani” immunizing drink, introduced by the Department of Ayurveda, as a preventive measure. This is an immune-enhancing drink for COVID-19 made up of coriander (*Coriandrum sativum*), “Weniwelgeta” (*Coscinium fenestratum*), ginger (*Zingiber officinale*), and “Heen Araththa” (*Alpinia calcarata*) based on traditional indigenous prescriptions. According to the findings of the current study, “Suwadharani” immunizing drink was perceived to be effective in alleviating respiratory symptoms by 79.3% of its users. When considering “Paspanguwa” herbal drink, people consumed it to alleviate respiratory symptoms rather than as a preventive measure. It was perceived to be effective in alleviating respiratory symptoms by 82% of its users. The “Paspanguwa” formulation has five ingredients, namely ginger (*Zingiber officinale*), Pathpadagam (*Hedyotis corymbosa*), Katuwalbatu (*Solanum xanthocarpum*), Weniwelgeta (*Coscinium fenestratum*) and coriander (*Coriandrum sativum*). These medicinal herbs can prevent minor ailments such as cough, cold, fever, and body aches when used in combination rather than on individual consumption (25).

According to the study, 84.6% of users had no adverse effects from the use of medicinal plants and natural products. However, 15.4% experienced adverse effects such as diarrhoea, heartburn, abdominal pain, and constipation from the use of these herbs. However, this was according to the participant’s perception and not clinically verified. Similar results have been reported in a study conducted in Saudi Arabia, where approximately 16% of the users experienced adverse effects (11). However, uncontrolled use or overdose of medicinal plants and natural products may result in mild to severe adverse effects and a high possibility of herb-drug interactions with the concomitant use of other drugs. The use of garlic (*Allium sativum*) in patients taking anticoagulation and/or antiplatelet therapy can cause prolonged bleeding (26). Therefore, cautious use of medicinal plants is recommended to minimize adverse effects.

The participants’ sources of information about the use of medicinal plants and natural products were mainly based on recommendations from family, friends, and social media. This was similar to the findings of recent studies in Saudi Arabia where many people relied on social media and family (11) and in Bangladesh, where the key information source was advice from family/friends (13). However, the accuracy and reliability of these information sources remain unclear as these sources can contribute to the dissemination of misinformation. The validity of information spread through these sources is therefore questionable, and can lead to incorrect practices among people. Hence, potential awareness campaigns about ways to find accurate information from authentic sources will help people to rely on information from medical information sources. According to the findings of the study, the use of medicinal plants and natural products as preventives are associated with age and level of education. Participants of younger generations used these alternatives as preventives compared to other age groups. Comparatively, a study conducted in Saudi Arabia found that the use of herbs and natural products was not linked with any socio-demographic factors except age (11).

This study has some limitations. The platform of an online survey was used to obtain the largest possible number of participants in a short period of time, covering all 9 provinces of Sri Lanka. However, it is acknowledged that this may bias recruitment to younger individuals. The study limited the

participation of individuals with no access to social media and the internet. As the participation of older individuals in the study was limited, this study was not representative of the general public. Therefore, the generalizability of the study findings is questionable, due to convenience sampling being used in the study. Secondly, compared to data acquired in an interview-based setting, the self-administered questionnaire may bias some of the data collected, as it is possible that respondents might have over or underreported their usage of herbal medicines. Also, the data collector had no ability to verify or validate the data acquired from the participants. Another limitation is that the plant part/s used by the users and preparation methods were not assessed in this study.

To the best of the authors' knowledge, there are no previously published research articles on the perceived effectiveness and side effects of medicinal plants and natural products used by Sri Lankans during the COVID-19 pandemic. Therefore, more in-depth research studies regarding the use of medicinal plants in COVID-19 and their effectiveness in preventing the disease and treating symptoms are warranted. The activity of such medicinal plants should be tested further by phytochemical research. Studies are needed to isolate the compounds with potential pharmacological properties and determine proper doses, preparation forms, and potential combinations of these medicinal plants. Also, the study findings indicate the necessity of clinical studies to prove the efficacy and safety of medicinal plants and natural products in treating respiratory symptoms of COVID-19.

Conclusion

The use of herbal medicines for prevention and treatment during the COVID-19 pandemic was a common practice among Sri Lankans. Some medicinal plants have been perceived to be effective in alleviating respiratory symptoms. Future research is needed to isolate the compounds with potential pharmacological effects and conduct clinical trials to determine the effectiveness of the identified medicinal plants.

Author Contributions: Conceptualization, TPG; methodology, NTPU, TPG, RKS and LSN; validation, TPG, RKS and LSN; analysis, NTPU, TPG, RKS and LSN; investigation, NTPU; data curation, NTPU; writing—original draft preparation, NTPU; writing—review and editing, TPG, RKS and LSN; supervision, TPG, RKS and LSN; project administration, TPG, RKS and LSN; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: Authors acknowledge the participants of this study.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Shereen MA, Khan S, Kazmi A, et al. COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses. *J Adv Res.* 2020, 24: 91.
2. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. Available: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020> (Accessed 17 September 2021).
3. Guo YR, Cao QD, Hong ZS, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status. *Mil Med Res.* 2020, 7: 1-10.
4. Malabadi RB, Meti NT, Chalannavar RK. Role of herbal medicine for controlling coronavirus (SARS-CoV-2) disease (COVID-19). *Int J Res Sci Innov.* 2021, 8: 135-65.
5. Thota SM, Balan V, Sivaramakrishnan V. Natural products as home-based prophylactic and symptom management agents in the setting of COVID-19. *Phyther Res.* 2020, 34: 3148-67.
6. Yedjou CG, Njiki S, Enow J, et al. Pharmacological Effects of Selected Medicinal Plants and Vitamins Against COVID-19. *J Food Nutr (Frisco, Tex).* 2021, 7(2): 202.

7. Benarba B, Pandiella A. Medicinal Plants as Sources of Active Molecules Against COVID-19. *Front Pharmacol*. 2020, 11: 1-11.
8. Singh NA, Kumar P, Jyoti, et al. Spices and herbs: Potential antiviral preventives and immunity boosters during COVID-19. *Phyther Res*. 2021, 35: 2745-57.
9. Khan SA, Al-Balushi K. Combating COVID-19: The role of drug repurposing and medicinal plants. *J Infect Public Health*. 2021, 14: 495-503.
10. Boukhatem MN, Setzer WN. Aromatic Herbs, Medicinal Plant-Derived Essential Oils, and Phytochemical Extracts as Potential Therapies for Coronaviruses: Future Perspectives. *Plants* 2020, 9(6): 800.
11. Abdullah Alotiby A, Naif Al-Harbi L. Prevalence of using herbs and natural products as a protective measure during the COVID-19 pandemic among the Saudi population: an online cross-sectional survey. *Saudi Pharm J*. 2021, 29: 410-7.
12. Villena-Tejada M, Vera-Ferchau I, Cardona-Rivero A, et al. Use of medicinal plants for COVID-19 prevention and respiratory symptom treatment during the pandemic in Cusco, Peru: A cross-sectional survey. *PLoS One*. 2021, 16: e0257165.
13. Ahmed I, Hasan M, Akter R, et al. Behavioral preventive measures and the use of medicines and herbal products among the public in response to Covid-19 in Bangladesh: A cross-sectional study. *PLoS One*. 2020, 15: e0243706.
14. Panyod S, Ho CT, Sheen LY. Dietary therapy and herbal medicine for COVID-19 prevention: A review and perspective. *J Tradit Complement Med*. 2020, 10: 420-7.
15. Alami AL, Fattah A, Chait A. Medicinal plants used for the prevention purposes during the Covid-19 pandemic in Morocco. *J Anal Sci Appl Biotechnol*. 2020, 2: 4-11.
16. Department of Ayurveda. Available: <http://www.ayurveda.gov.lk/> (Accessed 20 September 2021).
17. Francis TV, Sooriyaarachchi P, Jayawardena R. Usage of nutritional supplements to improve immunity during the COVID-19 pandemic: An online survey. *Clin Nutr Open Sci*. 2022, 43: 6–19.
18. Khabour OF, Hassanein SFM. Use of vitamin/zinc supplements, medicinal plants, and immune boosting drinks during COVID-19 pandemic: A pilot study from Benha city, Egypt. *Heliyon*. 2021, 7: e06538.
19. AlNajrany SM, Asiri Y, Sales I, et al. The Commonly Utilized Natural Products during the COVID-19 Pandemic in Saudi Arabia: A Cross-Sectional Online Survey. *Int J Environ Res Public Heal* 2021, 18: 4688.
20. Pourhoseingholi MA, Vahedi M, Rahimzadeh M. Sample size calculation in medical studies. *Gastroenterol Hepatol Bed Bench*. 2013, 6(1): 14-7.
21. Khadka D, Dhamala MK, Li F, et al. The use of medicinal plants to prevent COVID-19 in Nepal. *J Ethnobiol Ethnomedicine*. 2021, 17: 1-17.
22. Belhaj S, Zidane L. Medicinal plants used to boost immunity and decrease the intensity of infection caused by SARS-COV-2 in Morocco. *Ethnobot Res Appl*. 2021, 21: 1-17.
23. Ahkam AH, Hermanto FE, Alamsyah A, et al. Virtual prediction of antiviral potential of ginger (*Zingiber officinale*) bioactive compounds against spike and MPro of SARS-CoV2 protein. *Berk Penelit HAYATI J Biol Res*. 2020, 25: 52-7.
24. Safa O, Hassaniazad M, Farashahinejad M, et al. Effects of Ginger on clinical manifestations and paraclinical features of patients with Severe Acute Respiratory Syndrome due to COVID-19: A structured summary of a study protocol for a randomized controlled trial. *Trials*. 2020, 21: 1-2.
25. De Zoysa HKS, Viduranga Y. Paspanguwa Herbal Formula, a Traditional Medicine of Sri Lanka: A Critical Review. *J Complement Med Alt Healthcare*. 2017, 3(2): 1-8.
26. Silveira D, Prieto-Garcia JM, Boylan F, et al. COVID-19: Is There Evidence for the Use of Herbal Medicines as Adjuvant Symptomatic Therapy? *Front Pharmacol*. 2020, 11: 1479.