



A cross-sectional survey of herbal remedy taking to prevent Covid-19 in Turkey

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Received: 25 April 2021 / Revised: 18 November 2021/ Accepted: 18 November 2021

ABSTRACT: The Coronavirus disease 2019 (Covid-19), caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), has led to unprecedented challenges for human life. During this pandemic, Turkish people have used various herbal remedies for both the prevention of Covid-19 and the alleviate of its symptoms. The present study aimed to investigate the herbal remedies used to prevent Covid-19 in Turkey and to determine whether the usage of herbal remedies was associated with sociodemographic properties. A cross-sectional study using an online questionnaire was conducted between November and December 2020. A total of 871 individuals (15 years of age or older) who lived in various provinces of Turkey participated in this study. Analysis was made in SPSS version 26.0 software using the descriptive statistics and appropriate tests of statistical significance for the comparisons. About 54.4% (n = 474) of the participants reported that they have used herbal remedies during the pandemic period. We identified a total of 45 plant species, the most frequently cited were ginger (*Zingiber officinale* Roscoe), linden (*Tilia* spp.), elderberry (*Sambucus nigra* L.), sage (*Salvia* spp.), and rosehip (*Rosa canina* L.), respectively. It has been found that the usage of herbal remedies was associated with several demographic variables. A considerable proportion of the participants reported the use of herbal remedies in order to prevent disease. This paper demonstrated the potential herbal remedies that can be used against Covid-19. Further research should be carried out to evaluate the efficacy of these medicinal plants and should control the flow of misleading information.

KEYWORDS: Covid-19; herbal remedies; medicinal plants; Turkey.

1. INTRODUCTION

At the end of 2019, the novel coronavirus disease (Covid-19), has initially started in Wuhan, China and has spread worldwide. Not long after that, the virus hotspot has moved to the United Kingdom, Italy, France, Iran, Spain, Russia, Turkey, and the USA [1,2]. World Health Organization (WHO) on 11th March 2020 declared the outbreak a global pandemic [3]. The first case Covid-19 of Turkey was detected on March 10, 2020 and the number of cases has increased rapidly since then [4]. Important steps have been taken by the government of the Republic of Turkey in fighting the Covid-19 pandemic, including taking under control the trips abroad, restricting the domestic trips, closing the schools and all public gathering places, and starting the weekend curfews. In addition, public and private hospitals have played an important role in the fight against the Covid-19 outbreak [5,6].

Since the time of the declaration of the first Covid-19 case, scientists have focused on understanding the virus in every aspect. Covid-19 was caused by the severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2). This virus was defined as enveloped and single-stranded positive RNA type of virus. SARS-CoV-2 enters host cells by binding of its spike protein to the angiotensin-converting enzyme 2 (ACE2) receptor, which is expressed in various human organs [7,8]. The common symptoms of Covid-19 include fever, cough, loss of taste and smell, chest pains, and shortness of breath. In severe cases, pneumonia and severe acute respiratory syndrome can occur, especially in a patient with chronic diseases [2,9,10]. Although most of the Covid-19 patients have mild or moderate course, a substantial minority of global mortality rate calls for the essential need to find an effective antiviral treatment for Covid-19. According to the treatment guidelines of WHO,

How to cite this article: Erarşlan ZB, Kültür Ş. A cross-sectional survey of herbal remedy taking to prevent Covid-19 in Turkey. J Res Pharm. 2021; 25(6): 920-936.

several well-known drugs and combined drugs are used for Covid-19, such as chloroquine, hydroxychloroquine, lopinavir/ritonavir, favipiravir, and remdesivir. However, there is no permanent drug available for this disease. Hence, in the current situation, people are looking for complementary and alternative methods to protect themselves from infection [10-12].

At least 250,000 species of higher plants are known throughout the world. A large number of these plants have important uses for people, including foods, building materials, dyes, spices and medicinal plants. All modern medicine is derived originally from ancient herbal practices. Most plant-derived pharmaceuticals and phytomedicines that are commonly used today came into use through the study of traditional herbal remedies. WHO concludes that approximately 80% of the world's population still relies on medicinal plants for the treatment and prevention of diseases. It is said that fewer than 300 species researched in detail for their pharmacological and toxicological effects and even fewer have been evaluated for clinical efficacy. Numerous medicinal plants have been analyzed not only for their pharmacological properties but also for other qualities, such as chemical constituents and nutritional quality [13]. Scientific researches have demonstrated that medicinal plants may be a good and safer alternative to modern synthetic drugs. Medicinal plants may be beneficial for the prevention of Covid-19 by boosting the immune system of humans or showing antiviral activity [1,14,15].

Turkey has ample resources of herbal remedies as evident from its rich floral diversity and traditional botanical knowledge from the past [16]. Turkey is one of the leading countries in terms of plant diversity. The flora contains over 11,000 flowering taxa, about 34% of these are endemic [17]. Medicinal plants which are consisted of this floristic richness are also promising for the treatment of various diseases as well as Covid-19. Medicinal plants, which constitute the main component of traditional herbal remedies, can be used to alleviate the symptoms of Covid-19 patients and to provide raw materials for novel antiviral drugs [1,14,9]. In this regard, the scientific evaluation of medicinal plants has become much more common, particularly as a number of drug discovery studies have begun the regular screening of plants containing antiviral compounds. Many studies have described the potential metabolites from plant sources that have antiviral properties [1,14,18,19]. However, no studies have been conducted on the use of herbal remedies against Covid-19 in Turkey. Therefore, the current study aims to assess the herbal remedies used to prevent Covid-19 in Turkey and to determine whether the usage of herbal remedies was associated with sociodemographic properties. Also, related information about these herbal remedies, including detailed utilization and procurement information, people's attitudes and beliefs, the notification status to physicians were demonstrated.

2. RESULTS

A total of 871 individuals responded to the questionnaire, of which 670 (76.9%) were female. Participants came from a wide age range, with similar numbers of people in each age group. Approximately 97.7% of those who stated their location of residence lived in urban surroundings. The majority of participants were married (58.2%) and lived with their family members (89.3%). Education was on a scale ranging from primary school to higher education (Master/Ph.D.). Overall, 214 (24.6%) participants worked in the private sector, and 276 people with a monthly income of 5001-10000 tl. Although only 80 participants were diagnosed with Covid-19, there were 274 people who indicated that first-degree relatives were diagnosed with Covid-19. The detailed demographic characteristics of the participants are shown in Table 1.

In terms of the use of vitamin/mineral supplement, while a substantial minority of respondents (28.9%) declared that they did not use vitamin/mineral supplement, 32.4% of the participants used vitamin/mineral supplement regularly every day in order to protect themselves from Covid-19 (Figure 1). Demographic differences of gender, age, marital status, occupation, monthly income, and the status of first-degree relatives diagnosed with Covid-19 were statistically significant for vitamin/mineral supplement usage. Women, those who belonging to the 46-55-year-old group, who were married, who worked as healthcare professional, who had a monthly income of 5001-10000 tl ($p < 0.001$), and participants who had relatives diagnosed with Covid-19 ($p < 0.05$) were more likely to use vitamin/mineral supplement regularly every day (Table 2). When asked about taking herbal remedies, a total of 474 participants declared that they used herbal remedies to avoid Covid-19 (Figure 2). As a result of the chi-square test of independence, women ($p < 0.001$) and those who worked as a healthcare professional ($p < 0.01$) showed a higher frequency of herbal remedies use. Covid-19 diagnosis status was also found as statistically significant for the taking of herbal remedies (Table 3).

Table 1. Demographic characteristics of the participants (Section 1).

		n	%
Gender	Female	670	76.9
	Male	201	23.1
Age	15-25	184	21.1
	26-35	186	21.4
	36-45	101	11.6
	46-55	214	24.6
	56 and older	186	21.4
Location	Urban	851	97.7
	Rural	20	2.3
Marital status	Married	507	58.2
	Single	308	35.4
	Divorced or widow	56	6.4
Education status	Primary school	15	1.7
	Middle school	16	1.8
	High school	93	10.7
	University	584	67.0
	Higher education (Master/Ph.D.)	163	18.7
Occupation	Private sector	214	24.6
	Housewife	121	13.9
	Public sector	76	8.7
	Student	154	17.7
	Healthcare professional	177	20.3
	Retired	109	12.5
	Unemployed	20	2.3
Monthly income	0-2500 tl	197	22.6
	2501-5000 tl	194	22.3
	5001-10000 tl	276	31.7
	10000 tl and over	204	23.4
Living status	Family	778	89.3
	Friends	15	1.7
	Alone	78	9.0
Have you been diagnosed with Covid-19?	Yes	80	9.2
	No	791	90.8
Has any of your first degree relatives been diagnosed with Covid-19?	Yes	274	31.5
	No	597	68.5
How do you ensure your social isolation to avoid Covid-19?	I stay at home	67	7.7
	I go out in case of necessity	612	70.3
	I go out whether necessary or not	192	22.0

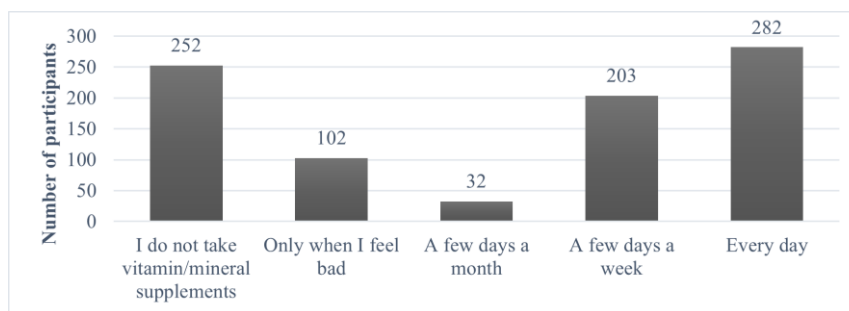


Figure 1. Vitamin-mineral usage (Section 1).

Table 2. Comparison of the frequency of vitamin/mineral use according to the demographic characteristics of the participants.

		I do not take vitamin/mineral supplement n (%)	Only when I feel bad n (%)	Few days a month n (%)	Few days a week n (%)	Every day n (%)
Gender $X^2 = 18.802$ $p < 0.001$	Female	174 (26.0)	79 (11.8)	21 (3.1)	160 (23.9)	236 (35.2)
	Male	78 (38.8)	23 (11.4)	11 (5.5)	43 (21.4)	46 (22.9)
Age $X^2 = 94.886$ $p < 0.001$	15-25	86 (46.7)	31 (16.8)	7 (3.8)	36 (19.6)	24 (13.0)
	26-35	56 (30.1)	29 (15.6)	9 (4.8)	47 (25.3)	45 (24.2)
	36-45	24 (23.8)	8 (7.9)	0 (0.0)	31 (30.7)	38 (37.6)
	46-55	39 (18.2)	17 (7.9)	11 (5.1)	52 (24.3)	95 (44.4)
	56 and older	47 (25.3)	17 (9.1)	5 (2.7)	37 (19.9)	80 (43.0)
Marital status $X^2 = 61.148$ $p < 0.001$	Married	121 (23.9)	50 (9.9)	16 (3.2)	120 (23.7)	200 (39.4)
	Single	120 (39.0)	47 (15.3)	15 (4.9)	73 (23.7)	53 (17.2)
	Divorced or widow	11 (19.6)	5 (8.9)	1 (1.8)	10 (17.9)	29 (51.8)
Occupation $X^2 = 109.778$ $p < 0.001$	Private sector	54 (25.2)	28 (13.1)	4 (1.9)	50 (23.4)	78 (36.4)
	Housewife	40 (33.1)	15 (12.4)	5 (4.1)	22 (18.2)	39 (32.2)
	Public sector	18 (23.7)	10 (13.2)	4 (5.3)	26 (34.2)	18 (23.7)
	Student	75 (48.7)	28 (18.2)	8 (5.2)	25 (16.2)	18 (11.7)
	Healthcare professional	24 (13.6)	11 (6.2)	7 (4.0)	44 (24.9)	91 (51.4)
	Retired	33 (30.3)	9 (8.3)	4 (3.7)	29 (26.6)	34 (31.2)
	Unemployed	8 (40.0)	1 (5.0)	0 (0.0)	7 (35.0)	4 (20.0)
Monthly income $X^2 = 81.733$ $p < 0.001$	0-2500 tl	94 (47.7)	23 (11.7)	8 (4.1)	38 (19.3)	34 (17.3)
	2501-5000 tl	53 (27.3)	36 (18.6)	7 (3.6)	46 (23.7)	52 (26.8)
	5001-10000 tl	63 (22.8)	24 (8.7)	10 (3.6)	80 (29.0)	99 (35.9)
	10000 tl and over	42 (20.6)	19 (9.3)	7 (3.4)	39 (19.1)	97 (47.5)
Has any of your first degree relatives been diagnosed with Covid-19? $X^2 = 11.302$ $p < 0.05$	Yes	71 (25.9)	27 (9.9)	10 (3.6)	56 (20.4)	110 (40.1)
	No	181 (30.3)	75 (12.6)	22 (3.7)	147 (24.6)	172 (28.8)

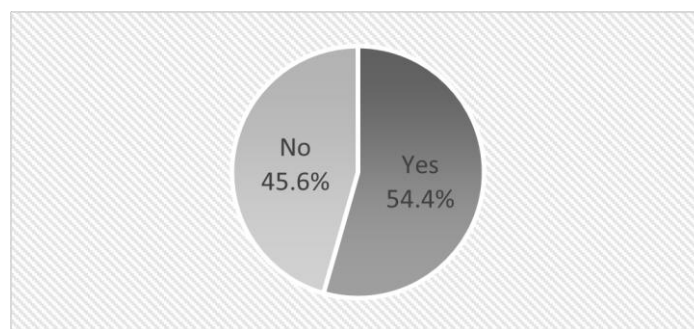


Figure 2. The frequency of the use of herbal remedies (Section 1).

Table 3. Comparison of the herbal remedies use according to the demographic characteristics of the participants.

		Yes, n (%)	No, n (%)	Total, n (%)
Gender	Female	388 (57.9)	282 (42.1)	670 (100.0)
	Male	86 (42.8)	115 (57.2)	201 (100.0)
Occupation	Private sector	105 (49.1)	109 (50.9)	214 (100.0)
	Housewife	73 (60.3)	48 (39.7)	121 (100.0)
	Public sector	40 (52.6)	36 (47.4)	76 (100.0)
	Student	71 (46.1)	83 (53.9)	154 (100.0)
	Healthcare professional	115 (65.0)	62 (35.0)	177 (100.0)
	Retired	58 (53.2)	51 (46.8)	109 (100.0)
	Unemployed	12 (60.0)	8 (40.0)	20 (100.0)
Have you been diagnosed with Covid-19?	Yes	60 (75.0)	20 (25.0)	80 (100.0)
	No	414 (52.3)	377 (47.7)	791 (100.0)
Has any of your first degree relatives been diagnosed with Covid-19?	Yes	169 (61.7)	105 (38.3)	274 (100.0)
	No	305 (51.1)	292 (48.9)	597 (100.0)

Herbal remedies were used in various forms of medicinal plants, most of which were herbal dietary supplement (63.5%) or medicinal plants in the crude form (drugs) (22.6%). Filtering tea bags (8.6%) and other forms (aromatherapy, homeopathy, etc.) (5.3%) were also preferred by participants (Table 4). When the responses on the usage of herbal remedies were examined according to the demographic features, healthcare professionals and the participants who are in the age group 46-55 with a monthly income of 5001-10000 TL were more likely to use herbal remedies in the form of supplement than other participants and the differences were found to be statistically significant between the groups ($p < 0.001$) (Appendix A-D).

Table 4. Detailed data on the herbal remedies usage of the participants (Section 2).

		n	%
In which form do you take herbal remedies to protect against Covid-19?	Plants in crude form (drugs)	107	22.6
	Herbal dietary supplement	301	63.5
	Filtering tea bag	41	8.6
	Other	25	5.3
How often do you take herbal remedies?	Only when I feel bad	50	10.5
	Few days a month	26	5.5
	Few days a week	253	53.4
	Every day	145	30.6
What are your primarily sales channel preferences for herbal remedies?	Herbalist	195	41.4
	Pharmacist	195	41.4
	Friends-relatives	16	3.4
	TV-Internet	17	3.6
	Other	48	10.2
What is your primarily consideration when procuring herbal remedies?	Safety	315	66.5
	Efficacy	106	22.4
	Recognition	36	7.6
	Recommendation of friends-relatives	14	3.0
	Price	3	0.6
How much do you spend on average per month for the purchase of herbal remedies?	0-50 tl	129	27.2
	51-100 tl	183	38.6
	101-500 tl	139	29.3
	500 tl and over	23	4.9
Do you think that herbal remedies are beneficial for protection from Covid-19?	Yes	462	97.5
	No	12	2.5
Do you recommend the herbal remedies to others?	Yes	449	94.7
	No	25	5.3
Do you inform physician about herbal remedies?	Yes	388	81.9
	No	86	18.1
Have you seen any adverse effects from the herbal remedies?	Yes	11	2.3
	No	463	97.7
Do you consult a physician about the interaction of the herbal remedies?	Yes	385	81.2
	No	89	18.8

A wide range of medicinal plants was used as herbal remedies for protection from Covid-19; 474 participants reported taking 45 different species of plants. Since the participants responded with the common Turkish names of the medicinal plants, the scientific names, English and Turkish common names of the plants were also given in Table 5. The most popularly cited plants were ginger (304), linden (231), elderberry (165), sage (161), rosehip (146), thyme (65), echinacea (51), and turmeric (37), their common names and scientific names are given (Figure 3). Participants had used either a single plant species or a mixture of plants, 367 participants (77.4%) declared taking more than one concurrently; most of them had taken two or three plant species (49.3%) (Figure 4).

Table 5. Medicinal plants used by participants to protect from Covid-19.

Response of participants	Turkish common names	English common names	Scientific name
Zencefil	Zencefil	Ginger	<i>Zingiber officinale</i> Roscoe
Ihlamur	Ihlamur, Gümüşi ihlamur, Büyük yapraklı ihlamur, Kafkas ihlamuru, Kırmızı ihlamur	Linden	<i>Tilia</i> spp.
Kara Mürver	Kara Mürver, Melesir, Patlangaç	Elderberry, European elder	<i>Sambucus nigra</i> L.
Adaçayı	Adaçayı, Şalba, Dağ çayı, Kara ot	Sage, Silver sage, Greek sage, Turkish sage, Clary sage, Culinary sage	<i>Salvia</i> spp.
Kuşburnu	Kuşburnu, İt gülü, Köpek gülü	Rosehip, Dog rose, Briar rose, Common briar	<i>Rosa canina</i> L.
Kekik	Kekik, Taş kekiği, Sütçüler kekiği, İzmir kekiği, Anzer çayı, Mercanköşk, Beyaz kekik, Kaya kekiği, Dağ kekiği	Thyme, Thyme spiked, Thyme-leaved savory, Creeping thyme, Summer savory, Sweet marjoram, Marjoram	<i>Thymus</i> spp., <i>Thymbra</i> spp., <i>Satureja</i> spp., <i>Origanum</i> spp., <i>Coridothymus</i> spp.
Ekinezya	Ekinezya	Echinacea, Purple coneflower	<i>Echinacea angustifolia</i> DC., <i>Echinacea pallida</i> (Nutt.) Nutt., <i>Echinacea purpurea</i> (L.) Moench
Zerdeçal	Zerdeçal, Hint safranı, Safran kökü	Turmeric, Curcuma	<i>Curcuma longa</i> L.
Çörek otu	Çörek otu, Çöre otu, Karaca, Cöcce	Black cumin	<i>Nigella sativa</i> L.
Limon	Limon	Lemon	<i>Citrus limon</i> (L.) Osbeck
Karanfil	Karanfil	Clove	<i>Syzygium aromaticum</i> (L.) Merr. & L.M.Perry
Nane	Nane, Taş nanesi, Dere nanesi, Yarpuz, Kara nane, Antep nanesi	Peppermint, Mint, Horsemint, Asian mint, Garden mint, Spearmint	<i>Mentha</i> spp.
Yeşil çay	Yeşil çay	Tea, Green tea	<i>Camellia sinensis</i> (L.) Kuntze
Tarçın	Tarçın, Darçın	Cinnamon, True cinnamon tree, Ceylon Cinnamon	<i>Cinnamomum verum</i> J.Presl
Sarımsak	Sarımsak, Taş sarımsağı	Garlic, Shallot, Leek	<i>Allium sativum</i> L.
Udi Hindi	Udi Hindi, Ud Hindi	Agarwood, Heartwood, Eaglewood	<i>Aquilaria</i> spp.
Kara biber	Kara biber, Karabiber	Black pepper	<i>Piper nigrum</i> L.
Sumak	Sumak, Mavru, Tahru, Tutum, Tetere	Sumac, Tanner's sumach, Sicilian sumac	<i>Rhus coriaria</i> L.

Response of participants	Turkish common names	English common names	Scientific name
Ökalyptus	Ökalyptus, Sıtma ağacı	Eucalyptus, Red gum, Blue gum	<i>Eucalyptus camaldulensis</i> Dehnh., <i>Eucalyptus globulus</i> Labill.
Zeytin	Zeytin, Zeytin ağacı	Olive, Common olive	<i>Olea europaea</i> L.
Ayva	Ayva	Quince	<i>Cydonia oblonga</i> Mill.
Keten	Keten, Bezir, Bızıktan	Flax, Linseed	<i>Linum usitatissimum</i> L.
Soğan	Soğan	Onion, Bulb onion, Common onion	<i>Allium cepa</i> L.
Biberiye	Biberiye, Kuşdili	Rosemary	<i>Rosmarinus officinalis</i> L.
Defne	Defne, Tehnel, Nehtel	Laurel, True laurel, Bay, Sweet bay	<i>Laurus nobilis</i> L.
Hibiskus	Hibiskus, Kerkede	Hibiscus, Red sorrel, Roselle	<i>Hibiscus sabdariffa</i> L.
Nar	Nar	Pomegranate	<i>Punica granatum</i> L.
Nioli	Nioli	Niauli	<i>Melaleuca viridiflora</i> Sol. ex Gaertn.
Paçuli	Paçuli	Patchouli	<i>Pogostemon cablin</i> (Blanco) Benth.
Servi	Servi, Selvi	Cypress	<i>Cupressus sempervirens</i> L.
Çam	Çam, Kara çam, Kızıl çam, Halep çamı, Sarı çam, Fıstık çamı, Sahil çamı	Pine, Black pine, Redwood, Pumilio pine	<i>Pinus</i> spp.
Trabzon hurması	Trabzon hurması, Japon hurması	Persimmon, Kaki plum	<i>Diospyros kaki</i> L.f.
Çay ağacı	Çay ağacı	Tea tree	<i>Melaleuca alternifolia</i> (Maiden & Betcher) Cheel
Devedikeni	Devedikeni, Mübarek diken	Milk thistle, Marian thistle	<i>Silybum marianum</i> (L.) Gaertn.
Elma	Elma	Apple	<i>Malus domestica</i> Borkh.
Ginseng	Ginseng	Ginseng, American ginseng, Chinese ginseng, Korean ginseng, Siberian ginseng	<i>Panax ginseng</i> C.A.Mey., <i>Panax quinquefolius</i> L., <i>Panax notoginseng</i> (Burkill) F.H.Chen <i>Eleutherococcus senticosus</i> (Rupr. & Maxim.) Maxim.
Kakule	Kakule	Cardamom, Cardamon	<i>Elettaria cardamomum</i> (L.) Maton
Kayısı	Kayısı	Apricot	<i>Prunus armeniaca</i> L.

Response of participants	Turkish common names	English common names	Scientific name
Kınakına	Kınakına, Kınakına ağacı	Red cinchona, Quina	<i>Cinchona pubescens</i> Vahl
Kiraz	Kiraz	Sweet cherry	<i>Prunus avium</i> (L.) L.
Kivi	Kivi	Kiwi, Kiwi fruit	<i>Actinidia deliciosa</i> (A.Chev.) C.F.Liang & A.R.Ferguson
Mandalina	Mandalina, Mandarin	Mandarin, Tangerine	<i>Citrus reticulata</i> Blanco
Melisa	Melisa, Oğul otu, Limon nanesi, Limon otu, Melisa otu, Temre otu	Balm, Lemon balm	<i>Melissa officinalis</i> L.
Güney Afrika sardunyası	Güney Afrika sardunyası	South African geranium	<i>Pelargonium sidoides</i> DC.
Rezene	Rezene, Raziyan, Rezdane	Fennel, Large fennel, Sweet fennel	<i>Foeniculum vulgare</i> Mill.

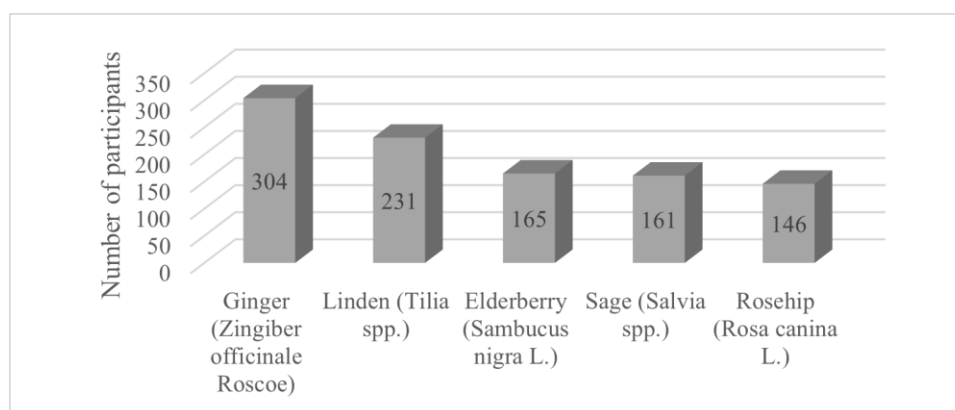


Figure 3. The most frequently cited medicinal plants used to protect from Covid-19 (Section 2).

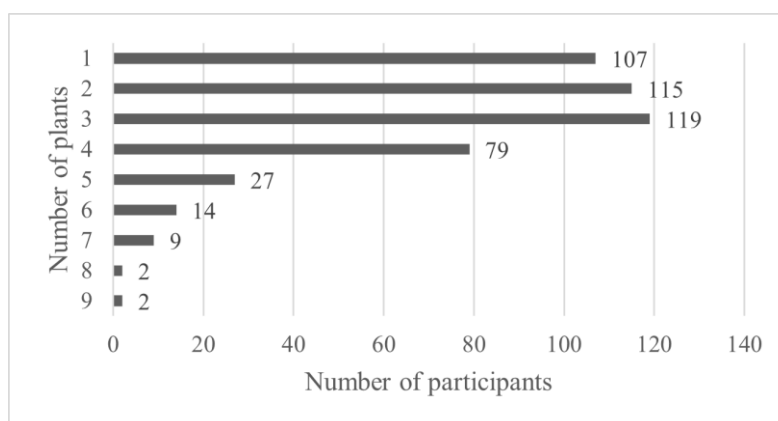


Figure 4. The number of plants used by the participants to protect themselves from Covid-19.

A total of 253 participants (53.4%) reported that they generally used herbal remedies a few days a week (Table 2), this was significantly more likely to be seen in those participants in the age group 26-35 ($p < 0.001$) with a monthly income of 0-2500 TL ($p < 0.001$) (Appendix A-D). Other participants said that they mostly used herbal remedies every day (30.6%); only when I feel bad (10.5%) and few days a month (5.5%).

When they were asked what are their primarily sales channel preferences for herbal remedies the participants stated that they provided their herbal remedies mostly from herbalist (41.4%) or a pharmacist

(41.4%). Moreover, they reported their primarily sales channel preferences as TV-Internet (3.6%); friend-relatives (3.4%) and other (10.2%) (Table 2). While those belonging to the 46-55-year-old group ($p < 0.001$) with a monthly income of 10000 tl and over ($p < 0.001$), who graduated university ($p < 0.001$), who worked as a healthcare professional ($p < 0.001$) were more likely to provide their herbal remedies mostly from a pharmacist, those belonging to the 15-25-year-old group ($p < 0.001$) with a monthly income of 0-2500 tl ($p < 0.001$), who graduated middle school ($p < 0.001$), who worked as a housewife ($p < 0.001$) were more likely to preferred herbalist (Appendix A-D). When they were asked what influenced their purchasing decision, 66.5% reported that they primarily consider the safety of herbal products. Other answers were as follows "efficacy" (22.4%), "recognition" (7.6%), "recommendation of friends-relatives" (3.0%) and "price" (0.6%). These who primarily consider the safety of herbal products were mostly healthcare professionals ($p < 0.05$) in the age group of 46-55 ($p < 0.05$) and graduated university ($p < 0.05$) (Appendix A-D).

When they were asked how much do they spend on average per month for the purchase of herbal remedies participants stated that they often purchased herbal remedies at a monthly cost of between 51-100 tl (38.6%), 101-500 tl (29.3%) and 0-50 tl (27.2%). Only 4.9% stated they bought herbal remedies at a cost of 500 TL and over (Table 2) Participants who answered as "a monthly cost of between 51-100 tl" were mostly those belonging to the 26-35-year-old group ($p < 0.001$) with a monthly income of 2501-5000 tl ($p < 0.001$), graduated from middle school ($p < 0.05$) and housewives ($p < 0.001$). (Appendix A-D). When they were asked whether herbal remedies are beneficial or not in preventing Covid-19, most of the participants (462) indicated that herbal remedies were beneficial. Additionally, a large majority of participants recommended the medicinal plants to other people (94.7%) (Table 2). There was no statistically significant demographic characteristic difference.

The vast majority of participants informed physicians about plants they had used (81.9%) and consulted about the interaction of the plants with the drugs they used (81.2%) (Table 2). Participants who were primary school graduates ($p < 0.01$) and had a monthly income of 5001-10000 tl ($p < 0.05$) were more likely to informed physicians. Most of those who consulted with a physician about drug interactions were participants working in the public sector ($p < 0.01$) (Appendix A-D). Only 11 participants reported that plants used caused adverse effects (Table 2). No significant difference was found between who has reported adverse effects or who has reported no adverse effects, with respect to demographic characteristics ($p > 0.05$).

3. DISCUSSION

Medicinal plants have provided mankind with the means to treat a myriad of diseases and ailments. From ancient times, medicinal plants have been playing a vital role in traditional medicine throughout the world. Today, the compilation of the use of herbal remedies represents a common approach in the investigation of medicinal plants and many have formed the basis of subsequent chemical, pharmacological or new drug research studies [13,20]. To the best of our knowledge, this is the first study in Turkey examining the beliefs about and the utilization of herbal remedies and food supplement which are used for the protection from Covid-19 among Turkish residents. In the present study, the majority of the participants (54.4%) reported that they have used herbal remedies during the Covid-19 pandemic to protect themselves from the disease. Also, around 32.4% of the participants have used vitamin/mineral supplement regularly every day. In a previous study conducted in Saudi Arabia, approximately 22.1% of the participants declared that they used herbal products or nutritional supplement to avoid Covid-19 [21]. Charan et al. [22] reported that most of the participants who were diagnosed with Covid-19 (74.1%) did not use any complementary and alternative medicine (CAM) product or home remedies while only 25.8% of participants used 161 CAM products and home remedies in India. It can be concluded that Turkish people prefer herbal remedies more than other nations, especially, for the protection from Covid-19. In our study, women showed a statistically significant difference in the frequency of using herbal remedies compared to the men, which was consistent with the study conducted by Khadka et al. [23]. Our results indicated that women are more interested in using plants than men. We also found that healthcare professionals showed a higher frequency of herbal remedies use. However, in our research, there was no significant difference between age, education status, and living status and the frequency of using herbal remedies, unlike previous study [23].

Within any community, there are number of social factors which can affect the method used by the person in personal treatment. According to our results, herbal remedies were used in various forms of medicinal plants, including herbal dietary supplement (63.5%), medicinal plants in the crude form (drugs) (22.6%), filtering tea bags (8.6%), and other forms (aromatherapy, homeopathy, etc.) (5.3%). According to our findings, herbal remedies which are in the form of supplement were mostly used by healthcare professionals

and the participants in the age group 46-55 with a monthly income of 5001-10000 TL. More than half (53.4%) of the herbal remedy users stated that they used herbal remedies a few days a week. In our previous study on patients with respiratory diseases, we reported that participants obtained medicinal plants from their friends and relatives [24]. In Nepal and Saudi Arabia, most of the people provided medicinal plants from their own home, home gardens or farms [21,23]. Our current results are not consistent with other studies, participants stated that they have obtained herbal remedies mostly from herbalist (41.4%) or pharmacist (41.4%). It is not interesting to find that people who are 46-55 years of age with a monthly income of 10000 tl, and over, who graduated university and worked as a healthcare professional mostly purchase their herbal remedies from a pharmacist. Several studies have documented that the unconscious consumption of plants that are sold in herbalists, various markets and TV-Internet, may be concluded with serious conditions. Therefore, people should primarily prefer pharmacies to obtain herbal products [25]. Because of the belief that herbal medicines are cheaper and safer than modern drugs, people mostly used them to protect their personal health [13]. We also reported that most participants (66.5%) considered the safety of the herbal remedies before get them and purchased herbal remedies at a monthly cost of between 51-100 (38.6%). In this study as well as in our previous study a large majority of participants declared that herbal remedies are beneficial and recommended the medicinal plants to other people [24]. On the other hand, Alyami et al. [21] reported that most respondents in Saudi Arabia thought that vitamins and herbal supplements can not treat/reduce the incidence of Covid-19. It is of utmost importance to consult with a physician due to the serious risk of drug interactions and adverse effects of medicinal plants. Although most of the participants informed physicians about plants they have used (81.9%) and consulted about the interaction of the plants with the drugs they used (81.2%), there is a substantial minority that needs to be informed about this essential issue. It is a surprising result that participants who were primary school graduates were more likely to inform physicians.

We found that a total of 45 different species of plants have been used during the Covid-19 pandemic. The reported plant number used concurrently by individuals ranged from 1 to 9. Similar results were obtained from Nepal, where it was recorded that respondents used either single plant species or mixed plants up to 12 species. A total of 63 medicinal plant species were recorded used to prevent Covid-19 in Nepal and 23 medicinal plant species were recorded in Morocco [19,23]. In these studies, *Zingiber officinale* Roscoe was reported as one of the most commonly used medicinal plants. Furthermore, *Rosa canina* L., *Tilia tomentosa* Moench, *Thymbra spicata* L., *Origanum onites* L., *Tilia rubra* subsp. *caucasica* (Rupr.) V.Engl. and *Thymus kotschyanus* Boiss. & Hohen. were the most frequently cited medicinal plants in flu treatment in Turkey [26]. Our study confirmed the results of previous studies and ginger (*Zingiber officinale*), linden (*Tilia* spp.), elderberry (*Sambucus nigra* L.), sage (*Salvia* spp.), and rosehip (*Rosa canina* L.) were found as the most cited species in the present study. Furthermore, and confirming the findings of our study, several studies stated medicinal plant species used to prevent Covid-19, similar to our results [14,15,21,22,27-30].

Many studies have reported a variety of plants for their significant antiviral properties and immune system boosting capacities. By the screening of such studies, antiviral effective plants that may be used against Covid-19 can be revealed [14,15]. Here, we evaluated the most cited medicinal plants in terms of their antiviral and immune system boosting properties.

Antioxidant, anti-inflammatory, antimicrobial, respiratory protective, anti-nausea, immune system stimulation and antiemetic activities of *Zingiber officinale* (ginger) have been proven in many studies [31]. The rhizome is mainly used in traditional medicine. Ginger and its bioactive compounds have also bronchodilatory activity and have been used for asthma [32]. A clinical study demonstrated that ginger could modulate inflammation and reduce circulating pro-inflammatory cytokine levels such as plasma interleukin-1 β (IL-1 β), interleukin-6 (IL-6) and tumor necrosis factor- α (TNF- α) in well-trained male endurance runners who used 500 mg capsules of ginger powder for 6 weeks. It showed activity, possibly limiting the chance of infections and reducing the effects of these cytokines concentrations in inducing fatigue-like symptoms [33]. The main compounds of ginger, such as gingerol, geraniol, shogaol, zingiberene, zingiberenol, and zingerone possess good potential as antiviral agents with fair oral bioavailability and flexibility. The potential of these bioactive compounds as anti-SARS-CoV-2 from their interaction to spike and Mpro protein has been investigated in a recent study. Gingerol, geraniol, shogaol, zingiberene, zingiberenol, and zingerone have interacted with key residues responsible for Mpro catalytic domain, while geraniol, shogaol, zingiberene, zingiberenol, and zingerone has interfered S-ACE2 binding shape and increase its binding energy [34]. In addition, gingerol has been shown to have antiviral activity against the human respiratory syncytial virus (HRSV), Avian Influenza virus (H9N2) and swine flu (H1N1) in previous studies [35-37]. Besides, ginger has been approved by the US Food and Drug Administration (FDA) as GRAS (Generally Recognized as Safe) [31].

In Turkey, *Tilia cordata* Mill., *Tilia platyphyllos* Scop., *Tilia rubra* subsp. *caucasica* and *Tilia tomentosa* are commonly known as linden and traditionally used against influenza through their antiviral activities [26]. The inflorescence of the *Tilia* spp. comprises polysaccharides (mucilaginous), condensed tannins, flavonoids, quercetin glycosides (rutin, quercitrin, and isoquercitrin), kaempferol glycosides and phenolic acids (caffeic, p-coumaric, and chlorogenic acids) [38]. Flavanoid content of *Tilia cordata* (hyperoside, tiliroside) has several pharmacological activities, such as antifungal, antiviral, anti-inflammatory and antioxidant activities [39]. Although *Tilia cordata* has not been evaluated clinically for symptomatic relief of flu symptoms, this medicinal plant may be beneficial in relieving respiratory symptoms due to its anti-inflammatory activity [40]. Antiviral and antimicrobial activities of *Tilia tomentosa* (Syn: *Tilia argentea* Desf. ex DC.) have been researched and the relationship between the various flavonoids and their antiviral and antimicrobial activities have been reported [41,42]. Antioxidant activity of water extract of *Tilia argentea* has been demonstrated, and the activity has been higher with an increasing amount of extract [43]. Some *in vitro* and *in vivo* studies have been conducted on *Tilia* spp. However, there is no solid evidence on the possible usage against Covid-19.

Elderberry (*Sambucus nigra*) fruit and flowers include essential oils, consisting of bioactive compounds of polyphenols and anthocyanins, and are highly rich in vitamin C content [44]. This plant has traditionally been used for the treatment of upper respiratory conditions, influenza and fever in many countries as well as in Turkey [16,26]. Preclinical studies have confirmed that elderberry extracts have antimicrobial and antiviral activities, including an effect against influenza viruses by inhibiting viral replication. Moreover, elderberry extracts have increased cytokines that activate immunomodulation. Clinical studies have shown that taking mono-herbal preparations of *Sambucus nigra* within the first 48 hours of symptom onset can reduce influenza-type symptoms, such as fever, headache, nasal congestion and nasal mucous evacuation in adults. Most adults have experienced significant symptom reduction 2-4 days after *Sambucus nigra* treatment [45,46]. *In vivo* studies have reported that elderberry is likely most effective in the prevention of and early infection with respiratory viruses [47]. Barak et al. [48] stated that a specific commercial preparation of elderberry caused an increase in TNF-alpha levels, leading to a cytokine storm. However, this claim is not supported by subsequent studies. There is a considerable preclinical study that elderberry inhibits replication and viral attachment of Human coronavirus NL63 (HCoV-NL63), which is a member of the same coronavirus family as Covid-19 [49]. Based on *in vitro* studies, bioactive compounds have inhibited the biosynthesis of the inflammatory cytokines IL-1a, IL-1b, and tumor necrosis factor- α in human peripheral mononuclear cells [40]. Considering all the studies, elderberry is one of the strongest candidates in preventing Covid-19.

There are several *Salvia* species, especially *Salvia fruticosa* Mill., *Salvia officinalis* L., *Salvia sclarea* L., *Salvia tomentosa* Mill., known as sage in Turkey and they are used in Turkish folk medicine [16,26]. Researchers have confirmed that sage possesses multiple biological activities, including anti-inflammatory, antimicrobial, antioxidant, anti-viral, anti-anxiety, anti-fungal, memory-improving, and anti-cancer activities [50,51]. Although these effects are not promising for the prevention of Covid-19, symptoms related to Covid-19, such as inflammation, anxiety, and amnesia may be reduced. *Salvia* species are rich source of polyphenols. The essential oil contains cineole, borneol, and thujone. It is reported that *Salvia officinalis* (sage) has the highest amount of essential oil compared to other *Salvia* species [50]. Several studies have revealed that *Salvia* possess antiviral activity with a different mechanisms of action. Aqueous extract of the leaves of *Salvia officinalis* has rapidly inhibited human immunodeficiency virus type 1 (HIV-1) infection at non-cytotoxic concentrations [52]. *Salvia fruticosa* has exhibited its antiviral effect both in influenza A/H1N1 and HRV14 by decreasing the replication cycle and progeny virus production [53]. Sivropoulou et al. [54] investigated the antibacterial, cytotoxic, and antiviral potential of *Salvia fruticosa* essential oil and concluded Thujone compound is thought to be responsible for the properties. Choi [55] stated that the essential oil of *Salvia sclarea* has anti-influenza A/WS/33 virus activity. These results may lead studies that will investigate the effect of *Salvia* species against Covid-19.

Although there are few pharmacological studies that can support its use against Covid-19, *Rosa canina* (rosehip) fruits are frequently used in traditional folk medicine to treat various respiratory diseases such as common cold, flu, vitamin C deficiency and lung diseases. Vitamin C, which contributes to its significant antioxidant activity, is highly present in rosehip. Tannins and other bioactive compounds are also considered to provide its anti-inflammatory properties [56,57]. Antibacterial activity against Gram positive and Gram negative bacterial species has been demonstrated in various *in vitro* assays [56,58]. It has been found that the seeds and fruits of *Rosa canina* contain anti-inflammatory galactolipid content. It has been studied in clinical trials regarding the possible effects for the treatment of osteoarthritis, *Rosa canina* has provided significant joint pain relief [28].

Pharmacological properties that can help treat/prevent Covid-19 have been demonstrated, however, it is critical to inform patients about the interactions and adverse effects of some plants. A combination of ginger (*Zingiber officinale*) and blood diluent drugs is not recommended because of the strong inhibition activity of ginger on thromboxane synthetase. Long-term use of ginger may prolong bleeding time [59]. The excessive usage of sage as a treatment should be avoided, the high content of thujone might cause an adverse effect [50]. It can be dangerous to consume uncooked bark, root, leaves, and unripe berries of elderberry due to the risk of cyanide toxicity [27]. Flavonoids that exist in *Tilia cordata* exert an anxiolytic effect and may also interact with serotonergic drugs. Furthermore, some other plant metabolites have been claimed as potential enhancers of ACE2 expression, including baicalin, tanshinones, curcumin, and rosmarinic acid. Particular care, therefore, should be taken when using *Scutellaria* spp., *Salvia* spp., *Curcuma* spp., and *Rosmarinus officinalis* L., by Covid-19 patients [40]. *Aquilaria* spp., known as Udi Hindi, has become very popular in Turkey during the Covid-19 pandemic. However, some precautions should be mentioned here to avoid toxicity. The hydrodistilled solvent-extract of *Aquilaria malaccensis* Lam. was reported to exhibit cytotoxic properties towards human's peripheral blood mononuclear cells. According to another *in vivo* study, aqueous extract of *Aquilaria subintegra* Ding Hou had toxicity on liver and kidney of rats [60].

There are also several limitations that should be mentioned. One of the principal limitations of this study is that a relatively small sample of participants was recruited during this Covid-19 outbreak period. We used an online questionnaire for data collection and therefore, the person who does not have access to the internet or does not use social media could not participate in the survey and we may have missed some of the targeted population. Although participants of different ages, education, and occupation filled the questionnaire, the number of male participants was much less than the number of female participants. Additionally, the response rate for our questionnaire study could not be estimated.

4. CONCLUSION

In summary, this survey demonstrates a high prevalence of medicinal plant use to prevent Covid-19 among Turkish people. In total, 45 different plant species were determined, most frequently cited were ginger (*Zingiber officinale* Roscoe), linden (*Tilia* spp.), elderberry (*Sambucus nigra* L.), sage (*Salvia* spp.), and rosehip (*Rosa canina* L.), respectively. The usage of herbal remedies was associated with demographic variables. We believe that medicinal plants are a candidate for a source of pharmacological products and might contribute to antiviral drug development. Although there is a lack of pharmacological studies in medicinal plants for Covid-19, the general safety and efficacy data that do exist can lead us to its potential use or further investigation. Thus far, there has been no discovery of drugs able to treat or prevent Covid-19. In this aspect, herbal remedies could be used to cure symptoms of Covid-19 such as fever, coughing, as well as for boosting immune system. Further large-scale studies should be taken on this field so that we can accurately assess the attitudes and practices of people and knowledge. Until that time, we hope this present study will provide valuable information on the usage of herbal remedies to prevent Covid-19.

5. MATERIALS AND METHODS

5.1. Study design and data collection

A cross-sectional study using a questionnaire was conducted in the period between November-December 2020. Since it was not feasible to conduct a community-based national sampling survey during this epidemic, we collect the data online. A cross-sectional study design was chosen for examining the relationship between the herbal remedy use and various sociodemographic factors in the selected sample group. Thus, the cause-effect relationship is investigated together in a certain period of time. The study was approved by the Social and Human Sciences Ethics Committee, Istanbul University (protocol number: 17.11.2020-199052). The questionnaire was filled out by 871 participants (15 years of age or older) who lived in various provinces of Turkey. The questionnaire was designed to be anonymously responded online using Google Forms. At the beginning of the questionnaire, the aim of the study was introduced to the potential participants while general information, including the participating researchers, the confidentiality of the research, and the intended management of the collected data, was also presented. Informed consent was obtained from all participants. The questionnaire consisted of 24 questions distributed in two different sections. Most of them were multiple-choice questions; however, the participants were able to add other answers. The first section of the questionnaire concerning demographic information, the incidence of Covid-19 in or around participants, the status of social isolation, and the use of vitamin/mineral and herbal remedies for the protection from Covid-

19. In Section 2, the participants were asked to provide detailed information regarding herbal remedies they used as well as the notification status to physicians. Participants who did not use herbal remedies could not answer the questions in the second section.

5.2. Statistical analysis

The obtained data were recorded and statistically analyzed using Microsoft Office Excel and Statistical Package for the Social Sciences (SPSS) version 26.0 software. Initially, descriptive statistics were processed. For the comparisons, appropriate tests of statistical significance (chi-square test of independence with correction of continuity according to Yeats, Fisher's Exact Test, and Fisher-Freeman-Halton Exact Test) were used and p-value less than 0.05 was considered significant. All data were illustrated with tables and graphs.

5.3. Plant names

Since the participants know only common Turkish names of the medicinal plants, the scientific names, English and Turkish common names of the plants were presented in Table 3. The scientific names of plants were verified using Turkey Plant List (Vascular Plants) [17], the International Plant Names Index (IPNI: <http://www.ipni.org>) and the Plant List (<http://www.theplantlist.org>). English and Turkish common names of the taxa are placed in the table using the Turkish dictionary of plant names [61]; Therapy with medicinal plants in Turkey (past and present) [16], EPPO Global Database (<https://gd.eppo.int>), Encyclopedia of Life (<https://eol.org>), and PDR for Herbal Medicines [62].

Author contributions: Concept – Z.B.E., Ş.K.; Design – Z.B.E., Ş.K.; Supervision – Z.B.E., Ş.K.; Resources – Z.B.E., Ş.K.; Materials – Z.B.E., Ş.K.; Data Collection and/or Processing – Z.B.E., Ş.K.; Analysis and/or Interpretation – Z.B.E.; Literature Search – Z.B.E., Ş.K.; Writing – Z.B.E., Ş.K.; Critical Reviews – B Z.B.E., Ş.K.

Conflict of interest statement: The authors declared no conflict of interest” in the manuscript.

Ethical committee approval: The study was approved by the Social and Human Sciences Ethics Committee, Istanbul University (protocol number: 17.11.2020-199052, approval date: 27.10.2020).

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